The Philippine Association of Marine Science (PAMS) was organized in 1990 during the First National Symposium in Marine Science held at the Bolinao Marine Laboratory in Pangasinan. PAMS was a response to the need for a national organization that would link together various academic, government and private institutions, NGOs and industries involved in marine science research and development in the country. Since then, PAMS has grown from a modest association of 76 charter members composed of delegates from Luzon, Visayas and Mindanao, to more than 200 members today. PAMS carries the task of promoting growth of marine science in the country. It recognizes and gives importance to the role of Philippine scientists in furthering knowledge on tropical marine ecosystems. PAMS organizes the National Symposium on Marine Science once every two years held alternatingly among the three major regions of the country, Luzon, Visayas and Mindanao. It has become a tradition to elect the incoming president of PAMS from the next host region. The biennial symposium is intended to bring together researchers and practitioners of marine science from all over the country and abroad so they may share their findings and experiences from research and development activities. This has become excellent venue for interaction between the experienced and budding scientists and have opened doors to knowledge and opportunities, particularly in addressing critical issues and in finding solutions to problems in marine conservation and environmental management.
ACKNOWLEDGEMENTS

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Session Chairs
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EXECUTIVE SUMMARY

The 15th National Symposium on Marine Science was held on 4-6 July 2019 at the Aklan State University, Banga, Aklan. The Symposium, with the theme *Fostering synergy of science, community and governance for healthy seas*, was endeavored to catalyze deeper collaboration vital to advancing knowledge on tropical marine and coastal ecosystems and applying transdisciplinary action and advocacy to aid our ailing seas and coastal communities. It was also envisioned to encourage knowledge exchange, healthy discussion and strengthen cooperation between and among the scientific community, local communities, government, private sector and non-government organizations.

As the Philippine Association of Marine Science continues to undertake the task of promoting growth in marine science in the country, the PAMS15 focused on highlighting the complex people-sea relationship and looked more closely on the ways by which we can address the emerging issues and threats to food security, biodiversity, and community resilience.

The symposium was attended by 530 participants, coming from 41 colleges and universities, 10 government agencies and 16 non-government organizations. There were 10 session topics which hosted a total of 283 oral and 108 poster presentations.

The Keynote Address was delivered by Dr. Nygiel Armada. There were three (3) plenary talks given by notable scientists working on the scientific, social and management aspects of marine science, namely Dr. Alice Joan G. Ferrer, Dr. Wilfredo L. Campos, Academician Dr. Jurgenne H. Primavera and Dr. Lourdes J. Cruz.

There was also a public forum organized as a plenary session entitled, *Hinun-anon nahanungod sa Kadagatan*, which was a first for PAMS to hold a multi-stakeholder forum on community experiences and solutions towards effective fisheries management and sustainable marine resource use.
A. INTRODUCTION

The 15th National Symposium on Marine Science was held on 4-6 July 2019 at the Aklan State University, Banga, Aklan. The Symposium, with the theme “Fostering synergy of science, community and governance for healthy seas,” aimed to catalyze deeper collaboration among different sectors vital to advancing knowledge on tropical marine and coastal ecosystems and applying transdisciplinary action and advocacy to aid our ailing seas and coastal communities.

As the Philippine Association of Marine Science (PAMS) continues to undertake the task of promoting growth in marine science in the country, PAMS15 focused on highlighting the complex people-sea relationship and look more closely on the ways by which we can address the growing issues and risks to food security, biodiversity, and community resilience. It was also envisioned to encourage knowledge exchange, healthy discussion and strengthen cooperation between and among the scientific community, local communities, government, private sector, non-government organizations.

Oral and poster presentations focused on the following themes:

1. Novel research methods and technologies (NRM)
   Features innovations in instrumentation, software development, field and lab methods, and data analyses

2. SMART fisheries and aquaculture (FIA)
   Showcases advancements in fisheries and aquaculture, e.g., methods, efficiency, sustainability, automation, safety, and health

3. Species, communities and ecosystems (SCE)
   Highlights studies across multiple levels of organization including new species reports, research on biodiversity and systematics, as well as ecosystem studies and status reports

4. Land-sea interactions (LSI)
   Emphasizes the critical connectivity of land- and sea-based activities, processes, and interventions

5. Ecosystem connectivity (ECN)
   Covers studies on integrated marine ecosystems

6. People and nature (PAN)
Showcases the connection of people with their environment including Citizen Science, community-based resources management, indigenous knowledge systems, education and advocacy campaigns on marine-related issues

7. Marine resources governance and management (MGM)
   Covers current studies, programs and issues on marine and coastal environments and the related scientific, civic and government interventions conducted

8. Global and local ocean stressors (GOS)
   Includes researches on climate change, ecosystem resilience, marine pollution and toxicology, emerging pollutants, and disease outbreaks

9. Blue Carbon

   The Blue Carbon Session introduces the blue carbon concept and the results of research and development endeavors on the topic. It includes presentations from the BlueCARES Project and the IAMBlueCECAM Program as well as other papers on blue carbon submitted to PAMS15

10. Ecosystem approach to fisheries management in the Visayan Sea

   The papers presented in the Visayan Sea session includes the fisheries and related studies conducted relevant to the management of the fisheries in the area using the ecosystem approach. These are also seen to be precursors, part of the scientific bases for policies and regulations to be framed for the Visayan Sea as a Fisheries Management Area.
Participants/Attendees

The symposium was attended by around 530 participants, coming from 41 colleges and universities, 10 government agencies and 16 non-government organizations. The list of institutions are as follows:

<table>
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<tr>
<th>Colleges and Universities</th>
<th>Government Agencies</th>
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<td>1. Aklan State University</td>
<td>1. Bureau of Fisheries and Aquatic Resources</td>
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<td>2. Ateneo de Manila University</td>
<td>2. DENR - SMARTSeas PH Project</td>
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<td>3. Balayan National High School - Batangas</td>
<td>3. Department of Agriculture - National Fisheries Research and Development Institute</td>
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<td>4. Batangas State University</td>
<td>4. Department of Environment and Natural Resources</td>
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<td>5. Bicol University Tabaco Campus</td>
<td>5. Department of Environment and Natural Resources - Biodiversity Management Bureau</td>
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<td>7. Caraga State University</td>
<td>7. Department of Science and Technology-PCAARRD</td>
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<td>9. Cavite State University</td>
<td>9. Philippine Nuclear Research Institute</td>
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<td>15. Don Mariano Marcos Memorial State University</td>
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<td>16. Graduate School of Science, Hokkaido University</td>
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<td>18. Manila Central University</td>
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<td>19. Mariano Marcos State University</td>
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<td>21. Mindanao State University - Tawi-Tawi</td>
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<td>22. National Museum of the Philippines</td>
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<td>23. Philippine Nuclear Research Institute</td>
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<tr>
<td>24. Tubbataha Management Office</td>
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Non-Government Agencies

1. Agriculture Sustainability Initiatives for Nature, Inc.
2. Big Blue Network
3. Catholic Organization for Relief and Development Aid (Cordaid) Philippines
4. Coastal Conservation and Education Foundation, Inc.
5. Environmental Defense Fund
6. Independent researcher
7. Large Marine Vertebrates Research Institute Philippines, Inc.
8. Marine Conservation Philippines
9. Marine Environment and Resources Foundation, Inc.
22. Negros Oriental State University
23. Old Dominion University
24. Philippine Science High School - Western Visayas Campus
25. Silliman University
26. Southern Cross University
27. Southern Leyte State University
28. Southern Philippines Agriculture and Marine and Aquatic School of Technology
29. Surigao del Sur State University Lianga Campus
30. University of Queensland Australia
31. University of San Carlos
32. University of the Philippines Visayas
33. University of the Philippine Los Baños
34. University of the Philippines Cebu
35. University of the Philippines Diliman
36. University of the Philippines Mindanao
37. University of the Philippines Training Center for Applied Geodesy and Photogrammetry
38. University of the Philippines Visayas-Tacloban College
39. Visayas State University-Tolosa, Leyte
40. Western Philippines University
41. Xavier University

10. Marine Wildlife Watch of the Philippines
11. NGO Big Blue Network
12. Organic and Stable Isotope (OASIS) Geochemistry Laboratory
13. People and the Sea
14. Rare Philippines
15. SEAFDEC/AQD

Of the total number of participants with complete information, 170 were students while 352 were non-students (Figure 1). There were more females than males (Figure 2).
The 15th National Symposium on Marine Science full program and schedule of presentations are found in Annex x and x.
B. OPENING PROGRAM PROPER

Dr. Yasmin Primavera-Tirol, President of PAMS15, formally opened the symposium. She presented this year’s theme *Fostering synergy of science, community and governance for healthy seas* and how the PAMS15 logo depicts the vision for strategic cooperation between the scientific community and the different facets of the local institutions and the government to achieve wholesome and sustainable seas.

Hon. Larry Maming, representative of Hon. Erlinda M. Maming, Municipal Mayor of Banga; Dr. Danilo E. Abayon, President, Aklan State University; and Hon. Carlito S. Marquez, Congressman of the 1st District of Aklan welcomed distinguished guests and participants of the Symposium. Highlights of the opening preliminaries include:

1. The 15th National Symposium on Marine Science will serve as a focal point of environmental reform.
2. Consensus research initiatives and strategies driven by excellence in each specialization may help pivot fellow Filipinos towards an improved quality of life.
3. PAMS need to maximize this venue to inform and refine local programs in marine science. The insight of the community may shape government and private institutions into viable units of compassionate and technology-enabled service.

C. KEYNOTE ADDRESS

“The Philippines’ journey to sustainable fisheries – from simple to complex fisheries management interventions” | Dr. Nygiel Armada, Chief of Party USAID Fish Right Project

Dr. Nygiel Armada discussed how fisheries managers have continuously developed management interventions to address complex and intertwined issues of overfishing, threats to marine biodiversity and fishery resources decline. He presented perspectives and insights from over a decade of research, which included cohort analysis, demersal fish stocks surveys, and understanding mortality model exploitation rates. Output of long-term research on demersal fish shows that stocks are in continuous decline since the 1940s, with 62% - 70% of current fish stock being already overexploited. Cohort analysis of sea mullet revealed two peaks of fishing mortalities at juvenile and adult stage. Dr. Armada emphasized that these information are crucial and inform fisheries management. Science-based information provides solid basis for management options; and more importantly, provides credibility to the interventions themselves.

He continued on his presentation by sharing his move from teaching and research to development work, focusing on fisheries management planning, applying ecological principles on designing marine protected areas and networks, registration and licensing and, most importantly, leading information and education campaign based on science. He learned the importance of communicating science properly, and the need of a shift in language, where scientific or technical language needs to be
popularized to be understandable to fishers, local chief executives and communities. He further noted that fisheries resource management paradigms and approaches have evolved and have somehow shifted through the decades and the management tools, although have retained their basic elements, have also evolved and shifted to conform with the changing approaches and paradigms. He stressed the importance of engaging stakeholders at the early part of every research and management intervention to achieve high compliance.

Dr. Armada highlighted fisheries management interventions that have been developed and applied in the country. The interventions, from simple to complex, have been developed to provide solutions to issues and problems in capture fisheries and have also evolved from single-species to multi-species and ultimately to ecosystem approach. The single- and multi-species approaches dealt solely with exploited fish and invertebrate stocks, but the ecosystem approach considers the non-exploited component of the marine ecosystem.

Finally, his presentation also tried to address important gaps as well as future directions in managing capture fisheries in the tropical third world context. It outlined the ultimate challenge of confronting excessive fishing effort and over-capacity by optimizing harvest from marine ecosystems through the re-allocation and right-sizing of fishing effort among the users.

D. PLENARY SESSIONS
1. Hinun-anon nahanungod sa Kadagatan: a multi-stakeholder forum on
community experiences and solutions towards effective fisheries
management and sustainable marine resource use

Panelists:

Martha Cadano
Municipal Fisherfolk Representative
National FARMC Member, Samar

Romeo Gupong
Municipal Fisherfolk
National FARMC Member
Malayang Samahan sa Ikauunlad nang Catabangan Inc.
Samahan nang Mangingisda sa Rehiyon at Lokal, Bicol

Keith Manares
Chair, Municipal Agriculture and Fisheries Council, Makato, Aklan

Roberto Baylosis
Executive Vice President
Southern Philippines Deep See Fishing Association Inc., Zamboanga

Wilfredo Yap
Executive Director
SANTEH Aquaculture Science and Technology Foundation, Manila

Guillermo Vicente, Sr., Elder
Evangeline Taboon, Member
Boracay Ati Tribal Organization, Boracay, Aklan

Bernabe Ochavo
President, Pinamuk-an Small Fisherfolk Association
New Washington, Aklan

Moderator:
Dr. Hilly Roa-Quiaoit

Hinun-anon nahanungod sa Kadagatan was the first for PAMS to hold a multi-faceted
discussion with the stakeholders of the coastal and marine environment. PAMS15
envisioned this as an opportunity to get to know the other sectors’ points of view,
resulting in greater flexibility and deeper insights to come up with larger-scale, longer-
term, well-consulted and more participatory-vetted ways of doing things, working at,
and accomplishing targets together. For this PAMS15, the organizers thought of
zeroing in on the community, the primary stakeholders, to give them the center stage
to speak and be heard. The Hinun-anon was seen as an initiative to open up new ways
of democratic engagement, participative governance and scientific investigations and undertakings gelling together.

The panelists were provided with a set of questions, and each was given ample time to discuss their relevant experiences.

1. *Paki bahagi ang isang hindi malilimutan na karanasan ng inyong sector o organisasyon sa pagtugon sa nagiging issue, problema o pangangailangan sa inyong komunidad*

**Issues raised:**
- a. Oil price hike resulted to ceasing of fishing operations of *tamban*
- b. Conversion of rice farm to aquaculture
- c. Only big companies have access to mariculture park proposed as farm to market road. This resulted to shortage of products and raised issues on zoning of fish cages.
- d. Ban on trawl fishing and decreasing availability of mother prawn. This resulted to fishing group importing, with additional cost
- e. Difficulty in accessing funds, and most are project-dependent activities
- f. Aklan fishing groups do not have access to offices issuing health certificate before they can export prawn
- g. Displacement and harassment of indigenous people due to tourism-related activities in Boracay. It took the group 11 years to process or apply for CADT.

2. *Ano sa palagay ninyo ang pinaka-critical na isyu sa larangan ng marine science at fisheries sa ating bansa sa panahon ngayon?*

   a. Urging science to look into the long overdue review of policies (e.g., penalties) that are no longer responsive to changing circumstance such as climate.
   b. Full support of the government for commercialization or adoption of new or improved science-based technologies to improve fish/food production
   c. Review RA 8550 and other policies to enhance services or assistance from BFAR and DENR for small fishpond operators; equal opportunity for fishers and farmers
   d. Scientist have presented evidences and urged the government for action and reform
   e. Determine size limit, right size, maximum catch limit and carrying capacity and provide valuation of resources
   f. Linking of landscape and seascape initiatives to address dwindling stocks
   g. Address conflict on resource use and how to address the displacement of IPs

Open forum
Mr. Jose Ingles agreed that science cannot work alone. He emphasized that there is a need to develop the right policy and judgment. He added that there is a need to compile data to knowledge to policy. Data sharing is important along with unity and cooperation between scientists and resource users.

3. **Plenary Talk by Dr. Alice Joan G. Ferrer, Professor, University of the Philippines Visayas**

“**Importance of Economic Valuation in Fisheries Management**”

Dr. Alice Ferrer commenced her plenary presentation by asking the audience what “1/391” on her slide represents. Dr. Ferrer pointed out that there is only one paper in PAMS15 that discussed about ecosystem valuation. Despite how fisheries make key contributions to food security, sustainable livelihoods, and poverty reduction, economic value of fisheries resources and their ecosystems has been poorly, if not properly, quantified and accounted. She explained that lack of understanding on the relative importance and the methods that can be used to address information needs limit the use of economic valuation in fisheries management.

Dr. Ferrer emphasized that economic valuation needs to be visible, in order to show how economic principles and economic valuation can help decision making in fisheries management. She elaborated the concept of total economic value as a framework. There is a need to comprehensively evaluate fisheries resources, and identify methods that can be used to collect and analyse economic information for fisheries management. Current data shows that fishery demands and pressure is higher than what our resources can handle, with at least 70% of stocks being already exploited. She pointed out that if we put value on fisheries, people will give attention. It is also important to communicate these values to decision and policy makers. She added that economic valuation help make decisions about allocating resources between competing uses, particularly in identifying the most efficient options for intervention in the fisheries sector.

Dr. Ferrer urged PAMS to continue transdisciplinary and collaboration between marine science and social science. She encouraged the participants to actively engage or conduct more studies on economic valuation. PAMS should continue to provide a proper venue where these efforts can be communicated, especially to decision-makers.
4. Plenary Talk by Dr. Wilfredo Campos, Professor, University of the Philippines Visayas

“Making Science Work For Fisheries Management Areas”

Dr. Wilfredo Campos shared that at least 32 years ago, data already showed increasing fishery effort, resulting to high mortality and overexploitation of small pelagic fish resources. Dr. Campos emphasized that the overfished condition of most of the country’s coastal waters is a principal concern exacerbated by unclear policies, weak enforcement and lack of capacity and will power to manage local resources.

Recent development on fisheries management include the initiatives of the Department of Agriculture – Bureau of Fisheries and Aquatic Resource on the establishment of Fisheries Management Areas (FMAs). In order to adequately address overexploitation of fisheries, DA-BFAR felt the need to work together and coordinate efforts with academic/research and other organizations in the different regions to provide the proper information necessary for effective management. Such coordinated efforts in recent years have led to the formation of the National Science Advisory Group (NSAGE), tasked with providing technical support to BFAR based of the best available scientific knowledge and information i.e., Capture fisheries, Aquaculture, Post-harvest, Social sciences, Policy and Governance, and Economics and trade.

Dr. Campos further discussed that NSAGE provided key recommendations during the workshops held to formulate the research agenda needed to support the fisheries sector. It is also in the process of putting together a position paper that outlines recommendations on issues related to the delineation of zones where commercial and municipal fishing can operate. Finally, the challenges NSAGE faces in fulfilling its tasks effectively were discussed.

Finally, Dr. Campos finished his presentation by emphasizing that science is not the answer to everything. He encouraged PAMS and members to generate new knowledge and existing information to enhance management strategies.

5. Plenary Talk by Academician Dr. Jurgenne H. Primavera, Chief Mangrove Scientific Advisor, Zoological Society of London-Philippines
Dr. Jurgenne Primavera presented the Philippines’ decades-long history of mangrove rehabilitation that dated back to World Bank and Asian Development Bank projects in the 1980s-90s. High rates of mangrove loss were mainly due to brackish water culture pond conversion. She discussed how mangrove protocols evolved to successfully deliver quotas and achieve target indicators (e.g., number of hectares and mangroves to be planted) set by national and international development programs, rather than mangrove survival. She pointed out that the default mode of planting *Rhizophora* on seagrass beds (or mudflats) – the wrong species in the wrong site – was due to instructions of completing the planting in targeted areas, and using up the allocated budget within the prescribed period of time. Dr. Primavera emphasized that mangrove rehabilitation and conservation should be science-based and not quota- or budget-driven. Recommendations for mangrove rehabilitation included the following:

a. Prioritize the reversion of abandoned fish/shrimp ponds to mangroves over seafront planting; by applying Assisted Natural Regeneration, such mangrove reversion could be shortened to ~3 years vs 15-20 years required for Natural Regeneration.

b. Where seafront planting is necessary, plant the right species, particularly the dominant *Avicennia marina* and *Sonneratia alba* rather than the conveniently available *Rhizophora*, at middle to upper intertidal elevation rather than on subtidal seagrass beds and coral reefs (and also intertidal mudflats).

c. International and national development agencies should undergo a paradigm shift in defining success as forest area created or rehabilitated rather than target area planted.

d. CRM/ICM policies and programs incorporate and institutionalize the following mangrove targets:
   i. Restore a 100-m wide protective coastal greenbelt of mangroves (and/or beach forest) to reduce up to 60% of energy from wind and swell waves;
   ii. Maintain a 4:1 mangrove-pond ratio for sustainability of brackish water pond aquaculture;
   iii. Local and national government initiatives in building riverside esplanades and earth-ballng mangroves will be assessed in light of mangrove ecology and biology.

6. **Plenary talk by academician Dr. Lourdes J. Cruz, Project Leader of the Future Earth Philippines Program**
Advocacy for Sustainability and Resilience: The Future Earth Philippines Program (FEPP)

Dr. Lourdes J. Cruz introduced the FUTURE EARTH which is a global initiative for sustainability of the International Geosphere-Biosphere Programme and the International Human Dimensions Programme on Global Environmental Change. Future Earth was conceptualized on 2013 and implemented across Asia and Pacific. Future Earth seeks to implement strategies for sustainable development i.e., ‘meeting the needs of the present without compromising the ability of the future generations to meet their own needs.” The program seeks to address biocapacity loss due to threats such as deforestation, mangrove destruction and destruction of coral reefs and other marine habitats; and large ecological footprint brought about by generating non-renewable and non-recyclable wastes.

Future Earth is also implemented in the Philippines, with the support of the Department of Science and Technology, National Agency for Science and Technology among others. Dr. Cruz explains that FEPP focuses on sustainability and resilience by improving national capability through knowledge to action programs to attain the UN Sustainable Development Goals, and provide science-based policy recommendations.

7. Presentation on the West Philippine Sea of Mr. Rollan Geronimo, Department of Geography University of Hawaii at Manoa

Fishing Activities in the South China Sea

Another relevant topic presented in PAMS15 was related to the issue on encroachment of foreign fishing vessels in the disputed region of the South China Sea. Mr. Rollan Geronimo provided background on the state of the South China Sea stating that fishing from SCS contributes to 12% of global catch. An estimated landed catch value of USD 21.8 million was documented in 2012, 45% of which was attributed to China. Mr. Geronimo shared information on VIIRS to detect boat traffic in the area. Trend on VIIRS through detection of powerful lights on satellite imagery showed an observed increased boat detection in SCS since 2010. Fishing activity in the within the West Philippine Sea has increased to 50% after 2015 when China started the island-building phase and Indonesia started sinking illegal fishing vessels. Mr. Geronimo further explained that other countries, including China, share similar sentiments on declining fish catch and overfishing concerns.
E. SUMMARY OF SESSIONS

Species, Communities and Ecosystems: Reproductive biology and growth of invertebrates | Dr. Cleto Nañola

The topic of this session focused on the reproductive biology of several marine fauna. Invertebrates were represented by the invasive charru mussel (*Mytella charruana*), an anchialine shrimp (*Parhippolyte uveae*), and a semi-terrestrial shrimp (*Merguia oligodon*). A study on tissue regeneration of a sponge was also elucidated by a speaker which makes this group well represented. Vertebrates were also denoted specifically by the small pelagic fishes represented by a sardine (*Sardinella lemuru*), and reef fishes such as a parrotfish (*Chlorurus flavipectoralis*), a snapper (*Lutjanus fulviflamma*) and a rabbitfish (*Siganus guttatus*). Presenters came from various regions of the country but were mostly dominated by graduate and undergraduate students.

The discussion on the green and black mussels was one of the highlights of this session which focused on whether the invasive green mussel, previously known as a pest, became a source of livelihood for some areas in Luzon. But the audience were stirred by the question “would these mussels be promoted considering that they are invasive against the favored *tahong* (green mussel)?”. Good enough an expert clarified that charru mussel is non-Asian in origin as compared to *tahong*. I guess with this information we now know where we stand.

The audience also got acquainted with the different modes of “sexual systems” of semi-terrestrial shrimp in the mangrove areas and in Anchialine pools in Guimaras. It is now theorized that one of the shrimp (*M. oligodon*) can serve as biological indicator species for area recovery such as in the case of the oil spill in 2006 which happened in the area. On the other hand, it can serve as a contribution to the scientific body of knowledge in understanding the evolutionary origin of these two shrimp species. The last highlight was on the topics on the egg size differences of a Bali sardine from two distantly separated areas and on sexual maturity of reef fishes through ageing technique and gonad analyses. Though separately studied and discussed, at the end of each presentation, almost similar questions were asked in related to validation of ageing technique and the interactions or relationships of the following parameters: gonado-somatic index, sizes of the gonads, body size and length, sexual maturity and others. This prompted an expert in the room, Dr. Vincent Hilomen (Program Manager, SmartSeas Program, DENR), to provide a quick lecture on “Fish reproduction 101”.

The take home message of the session was that studying reproductive strategies of different marine fauna employing new techniques could eventually lead us to better understanding these species and ultimately to better management practices.

Species, Communities and Ecosystems: Population biology of invertebrates and giant clams | Dr. Nadia Palomar-Abesamis

The session was composed of 9 presentations on various research done on molluscs, particularly octopus, limpets, gastropods and giant clams. Study sites of the various
presentations covered areas in western Luzon, Occidental Mindoro, Camarines Norte, Antique, Guimaras and the Davao Gulf. One presentation described the octopus fishery in Malalison Island. Because of the dearth of information on octopus fisheries in the country and the high demand for this group, the results of this study were considered significant by a few of the participants because it can be used to feed into the National Octopus Fishery Management Plan currently being developed for the Philippines. Three of the studies presented were on the population biology of intertidal limpets and gastropods from Samal Island. These provided baseline information on the abundance, distribution, size structures and recruitment patterns for exploited species of *Nerita* sp. and an unexploited limpet. The last 5 presentations focused on various aspects of the biology and ecology of giant clams. In terms of diversity, the most common species observed in different study sites were *Tridacna crocea, T. maxima, T. derasa* and *T. noae*. Abundance, distribution and recruitment patterns varied across species and sites but *T. crocea* was consistently the most abundant species. Giant clam species were always more abundant in protected than in fished areas with the presence of both adults and juveniles. Unfortunately, in some sites studied which had a history of giant clam restocking, very few new individuals of *T. gigas* were observed during surveys. One interesting thing shared by a presenter who worked in Apo Reef was the discovery of an area with very high aggregations of *T. crocea*, despite the area having poor coral cover and quality. Another study on the diversity of zooxanthellae in various giant clam species showed that symbionts may be host-specific and that *T. noae* has a high composition of the thermally-tolerant zooxanthellae group *Durusdinium* sp. Overall, the session went smoothly. All of the presenters were undergraduate and early graduate students and the session was a good venue for them to receive constructive comments on their research. Comments and suggestions from the audience were related to data collection, analysis and discussion of their results. Areas for future studies on invertebrate biology and ecology were pointed out by both presenters and audience members and highlight the vast opportunities and need for research in this field.

**Species, Communities and Ecosystems: developments in marine geology, evolution, and biodiversity** | Dr. Arthur R. Bos

The sequence of the presentations of this session followed the evolutionary development of organisms from fossil records of Mollusca and Scleractinia, through speciation and genetic isolation of fishes, diversity of extant Echinodermata, and Soft coral diversity in the Philippines. Fossil records of Mollusk shells and coral skeleton retrieved from relatively shallow rock formation in selected sample locations. The most challenging aspect of studying fossil remains of organisms is identifying specimens to species level, which may be tackled in the future. Moreover, continued research in this field such as collecting samples from various sediment layers, may provide detailed information about speciation and extinctions of Mollusks and Scleractinian corals. Similarly, the phylogenetic history of two fish species (*Epinephelus merra* and *Cheilodipterus quinquelineatus*) and the representatives of the genus *Paracheilinus* spp. (Labridae) exemplified gene flow and genetic isolation among fish populations resulting from changing sea level during recent geological periods. Advancing techniques used for genetic analyses will complement and extend our current knowledge of genetics of fish populations, as well as for other organisms.
The next three presentations dealt with the hidden and largely unknown diversity of taxonomic groups that have received limited attention in the past while being part of the coral reef ecosystems: Crustacea and Echinodermata. When collecting these taxonomic groups in shallow coral reefs and associated habitats, it has been remarkable that the number of sampled species continuously increased during the initial samplings suggesting that the diversity of these groups is much higher than previously thought. Examples of hidden biodiversity were provided from the hermit crabs (including new records for the Philippines as well as newly described species), the brittle stars (Ophiuroidea), and the sea urchin species *Echinometra mathaei* (which consists of four genetically separate types) all studied in the waters off Guimaras. A recently published taxonomic update about the Ophiuroidea was shared among the researchers working on this taxon.

The final presentation of this session discussed the diversity and distribution of soft corals in the Philippines. Soft corals have also received limited attention by researchers especially compared to the closely related skeleton-building hard corals (*Scleractinia*). With ocean acidification and global warming in mind, and the declining ability of hard corals to build strong calcium carbonate skeletons, soft corals may play an increasingly important role in coral reef ecology. Therefore, it was suggested to intensify studies to the biology and ecology of soft corals.

**Species, Communities and Ecosystems: Developments in marine geology, evolution, and biodiversity** | Dr. Maria Celia Malay

The session featured a varied selection of seven excellent talks, shedding light on the phylogenetic systematics of brown algae (Santianez), microbial communities associated with shallow-water hydrothermal vents (Elegado & colleagues) and with the sponge *Haliclona amboinensis* (Nada and colleagues), stock delineation in the sardine *Sardinella lemuru* in Northern Mindanao (Labrador and colleagues), documenting an algal bloom during a fish kill event in Obando, Bulacan (Gernato and Onda), the taxonomy and conservation of wedgefish in the Philippines (Alava and colleagues), and the benthic macrofaunal community near pier structures in Batangas Bay (Afalla and colleagues). Marine researchers are pushing at the edges of scientific knowledge, documenting the diversity and evolution of understudied microbes, flora, and fauna, using a range of different approaches. New species, new genera, and new geographic records were reported at this session (Santianez, Gernato & Onda), as well as novel communities of microbes and marine invertebrates (Elegado et al., Nada et al., Afalla et al.), and new learnings on identity of threatened species and stock delineation of overfished species (Alva et al., Labrador et al.). Discussion also includes the importance of fishery stocks and temporal changes in identification and conservation status.

**Species, Communities and Ecosystems: Movement patterns, behavior and habitat use of marine animals** | Dr. Patrick Cabaitan

The session tackled behavior, habitat use and movement patterns of different marine animals from small bodied harpacticoid copepods, to sea urchin, sea stars, fish gobies, horned helmet shell, a damselfish and a megafauna, tiger sharks. The first talk was on the movement patterns of black-spined sea urchin (*Diadema setosum*) in
Calatagan, Batangas, that showed starvation had no observable effect on the diurnal movements of *D. setosum*. Also, in contrast to previous reports, there was a clear directionality of the movements of sea urchins, which may possibly be influenced by local environmental factors, e.g., food availability. Indo-Pacific horned seastars (*Protoreaster nodosus*) were noted to prefer to move and feed during low tide, which appeared to be related to food availability as well. *P. nodosus* and a helmet shell *Cassis cornuta* exhibit differences in movement pattern between adults and juveniles. Contrary to beliefs, *C. cornuta* are metaturnal - active at night and day, although, most of the time *C. cornuta* are inactive. Interestingly, gobies of different species and a planktivore damselfish *Abudefduf sexfasciatus* exhibit different movement patterns, which appeared to be influenced by predator density and differences in habitat condition. Habitat utilization of small bodied marine animals such as harpacticoid copepods and a seagrass filefish *Areichthys tomentoitus* is related to escape from potential predators. On the other hand, habitat use and movement of tiger shark appeared to be related to mating and reproduction as demonstrated by the presence of all females in Tubbataha Reefs National Park. We also see the different methods and the spatial scale they cover in examining the behaviors of marine animals, i.e., from observing, using a simple camera system, the diel pattern activity of helmet shells in indoor hatchery tanks to visual observation of the behavior of sea urchin, star fish and reef fishes in shallow water intertidal and subtidal zones. Observation of the movement pattern of tiger sharks entails the use of satellite and acoustic tracking devices as they travel a wider area. Findings of the talks have implications on how these marine organisms may respond when their habitats get degraded and food becomes scarce, which are demonstrated by their changes in behaviors.

**Species, Communities and Ecosystems: Coral Reef Dynamics and Community Structure** | Dr. Kent Carpenter

The session began with a presentation on “Coastal Fish Assemblage Structure from Shallow to Mesophotic Depths in the Central Philippines” by Abesamis et al and the talk was given by Silliman University student Lucille Raterta. This talk demonstrated that there are many fishes that specialize in mesophotic habitats although some species are found in both shallow and mesophotic habitats. Miya McGlone presented the second paper on the “Long-Term Pattern of Temporal and Spatial Variability of Chaetodontidae in the Bolinao-Anda Reef Complex, Northwestern Philippines.” This study looked at butterflyfishes that are obligate corallivores and compared their abundance to facultative corallivores and found that certain groups are sensitive to changes in hard coral cover in the study area. The talk on Farmer Damselfish populations in the Bolinao area was cancelled so this time slot was spent further discussing the first two papers. Mr. Jue Lalas presented a paper on the “Distribution of Soft Corals in the Bolinao-Anda Reef Complex” that demonstrated the potential of soft corals to be indicators of change on coral reefs. This was the first such study of its kind and considerable differences were found in community composition across the study area that appeared to be indicative of water quality differences. Mr. Piloton presented a paper on the “Comparison of macrofaunal Associates of the Sponge Melophlus sarasinorum from two Reef Areas that found a considerable diversity of invertebrates living mostly in the larger pores of these sponges. This was reportedly the first study of its kind in the Philippines. The final two papers were presented by John Whalen and Jem Baldissimo that used data from rotenone collections done by
the Smithsonian in the late 1970’s and the California Academy of Sciences in the 2010’s in the same general areas of Siquijor and southern Negros. This showed marked declines in biodiversity and some preliminary evidence of shifts in trophic structures over this decadal timeframe. Mesophotic assemblages Abesamis et al. talk given by SU student Lucille Raterta.

Species, Communities and Ecosystems: Status reports on coral reef communities | Prof. Jerome Benedict P. Cabansag

Initially, the first presentation made mention of the history of reef fish assessment in the Philippines, how it used to be ignored in the very first coral reef assessments around the country, and how reef fish assessments were eventually integrated through the ensuing years. Importance of such assessments could not be overly emphasized, and these include the reef fishes’ alarming rate of exploitation (i.e. reef fishes began to find its way into the daily catches of artisanal fishers) and consequently its role in management and conservation efforts of reef systems. The presentation also highlighted the importance of major works, e.g. Hilomen et al. 2000, Nañola et al. 2006, and Aliño et al. 2012, most if not all, made used of decades of data on a national scale. Over the years, reef fish assessment surveys were able to established that three-quarters of the sites surveyed all over the country exhibited high species richness, albeit low densities in most sites, and only one-third of the sites revealing high biomass.

Other presentations were quite more specific, and these included discussions that focused on the family level, e.g. the status of Fam. Serranidae (commonly known as Groupers) in the Philippines and the seemingly no bearing effect of fishing pressure on the its species richness, density, and even, biomass (i.e. applies on several size categories) hence, more reproductive studies on the family was recommended. Also, Palawan was mentioned as the only area in the country that has a clear management plan for groupers. Another family brought into light was Tawi-Tawi’s Fam. Chaetodontidae (i.e. Butterflyfishes) and its species-wise distribution and/or occurrence over the area’s chosen five island municipalities. Current surveys revealed more species compared to the one conducted by Campos et al. (2017). The butterflyfish data warranted more surveys just to shed light on the family’s richness in the area.

Tawi-Tawi was presented as the ‘heart’ of the Coral Triangle and claimed to be more diverse than any other areas of the country in terms of commercially important reef fish species. More than two years of market survey data revealed about 31% unique species when compared to existing comprehensive market inventories (i.e. of Palawan, and Panay), and relatively low similarity index of only about 26%. Data from Tawi-Tawi also revealed that recorded species richness have yet to reach its peak, meaning more species could be encountered in future surveys and added to its present-day database. In spite of all these, some existing Tawi-Tawi MPAs exhibited lower numbers compared to their non-MPA counterparts, the main reason being the mismanagement or non-existing management measures on these MPAs.

Finally, Tawi-Tawi’s benthic status were presented and said to be in ‘fair’ status (Gomez et al., 1994) and did not fall within the ‘poor’ category (Manchitra, 1999).
Strong enforcement of management policies for existing Marine Protected Areas was also recommended.

**Species, Communities and Ecosystems: Seagrass assemblages and other invertebrates fauna | Dr. Jayvee Saco**

Seagrass-seaweed beds not only provide food for higher trophic organisms but an important and strategic area for other marine organisms i.e., invertebrates, fishes, and epiphytic for their foraging, shelter, and nursing grounds. In addition, these associated fauna provides sediment bioturbation and nutrient cycling. The dynamic synergies between seaweed-seagrass beds and other marine organisms provide an important link on their complex relationship leading to mutualistic benefits among coastal communities by providing food for their tables and livelihood i.e., seaweed farming and processed seaweed-seagrass. Both seagrass-seaweed beds and macrofaunal organisms showed that they are good potential bioindicator species as these species could easily thrive on both pristine and polluted water. Thus, this mutualistic structure could be a potential proxy to evaluate the effect of the immediate surrounding together with their biodiversity analysis and physiological responses.

The presented papers under the seagrass assemblages and other invertebrates fauna of the species, communities, and ecosystems sessions showed that the topography i.e., substrate composition, slope of the substrate; water dynamics i.e., tidal movement, wave exposure, and physicochemical profiles provide insights on the structure and composition of both the seagrass-seaweed beds and the different marine organisms that thrive in the beds. Paper presented ranging from the small-sized seagrass-seaweed composition in Verde Island, Batangas that might be affected by substrate composition and strong water movement; abundance of epiphytic foraminiferans on seagrass leaves as affected by wave exposure and season and by the morphology of the foraminiferans in Southern Guimaras; percent cover of seagrasses affects the number of ichthyofaunal species wherein low cover has a low number of species and high cover has a high number of species in relation to their tidal action; habitat complexity promotes high diversity among bivalves and gastropods alongside seasonality. Interestingly, new insights on the species composition and diversity of macrobenthic fauna in anchialine provide new understanding about the complex ecosystem of this unknown environment.

The data gathered and presented in the session could be used as baseline information that seagrass-seaweeds beds and marine organisms thriving highly depended on the physicochemical parameters on the areas which might be an input of the effects of eminent climate change. Furthermore, this information specifically those economically important species for possible development for mariculture. In addition, inputs on the venomous species i.e., *Conus sp.* is important information that could have health hazards among coastal communities. Conservation efforts on these beds should continuously be advocated by academe through research, NGOs through education, and LGUs through law enforcement that will lead to sustainable coastal communities.

**Species, Communities and Ecosystems: Herbivory and Predator-Prey Interactions | Dr. Victor Ticzon**
The session presented studies conducted by graduate and undergraduate students on herbivory and predator-prey interactions. It showcased researches that elucidated processes associated with these interactions and discussed their implications in the management of coastal marine ecosystems. The talks revolved primarily around herbivory on coral reefs and seagrass beds, and its impact on substrate features. Half of the presented studies in the session highlighted the role of *Diadema setosum* on the ecology of the reef flat of Calatagan. These related studies provided preliminary insights on important gaps in the biology and ecology of the organism. The presentations emphasized the ecological importance of *D. setosum* and contributed to our understanding of its grazing preference across different substrate types. The studies also showed the dominant role of *D. setosum* in grazing both macro- and filamentous algae in the shallow reef flat. Complementing these grazing studies was a work that investigated bioerosion associated with its grazing. For the first time, bioerosion rates attributed to this echinoid was estimated in the extensive reef flat of Calatagan, Batangas. Aside from *D. setosum*, another focal species investigated was the farmer damselfish *Plectroglyphidodon lacrymatus*. This territorial damselfish maintain algal “farms” where they forage for food. The studies presented provided an interesting view on the effect of predators on the activities of this farming fish. Results showed that in the presence of predation risk, the foraging activities of this damselfish significantly decreased. The session also presented interesting initial findings on the effects of benthic feeders on the benthos. In experimental coral transplant set-ups, corallivores and herbivorous fish were found to detach coral nubbins, effectively reducing survivorship of transplants. Corallivores were found to detach 1% to 2% of transplanted coral nubbins while herbivores 4% to 10%. Although the results presented are preliminary, the study provided valuable recommendations in increasing survivorship of coral transplants in its most vulnerable stage. Lastly, the session included a study that attempted to answer one of the more challenging question in dugong (*Dugong dugon*) ecology; its grazing pressure relative to seagrass meadow maintenance. The study estimated seagrass consumption and the area required to sustain an adult dugong based on grazed trails left by the animal. In summary, the session talks showcased works that answered basic research questions with strong implications in conservation and management, and in modeling for impacts of predator and habitat loss. It attracted the attendance of scientists working on community ecology and coral restoration, as well as managers and conservation advocates.

**Ecosystem connectivity | Dr. Rene Abesamis**

This session covered various aspects of connectivity – the linking of populations through the dispersal of individuals as larvae, juveniles or adults. Eight papers were presented, which dealt with a wide range of methods, ecosystems and organisms. Three papers examined mechanisms of connectivity over oceanic scales (100’s-1000’s km). De Maligaya et al. modelled larval connectivity in the eastern Luzon region and showcased the potential role of Benham Bank as a source of coral recruits for northern and eastern Luzon via the Kuroshio. Del Rosario et al. analysed the occurrence and variability of mesoscale eddies that can affect larval transport and survival around the Philippines using satellite-derived data on sea-level anomalies.
Villanoy et al. reviewed the physical oceanography of the West Philippine Sea and stressed the importance of this region for sustaining fish populations in Palawan and for food security in the Philippines, in general. Three papers dealt with connectivity at the scale of internal Philippine seas (few 100’s of km). Mendiola et al. used a combination of genomic analysis and larval dispersal modelling to understand patterns of population connectivity in a species of crab (Scylla olivacea) in the Sulu Sea. Abesamis et al. used a combination of genetic parentage analysis, otolith analysis, hydrographic surveys and mathematical modelling to understand the spatial scale and temporal stability of demographically-relevant larval connectivity in a species of reef fish (Chaetodon vagabundus) and highlighted crucial implications for designing networks of marine reserves. Agustines et al. reported the migration patterns of adult and juvenile whale sharks (Rhinchodon typus) in the Visayas region and Sulu Sea gained from analysing data from satellite tags and photo-documentation by citizen scientists. Two studies dealt with connectivity at much smaller scales. Estacio et al. developed a species-specific agent-based model of mangrove forest dynamics at the scale of 50 x 50 m and highlighted the important role of mangrove propagule dispersal producing more realistic model results. Finally, Gammaru et al. examined how different reef benthic characteristics may affect the properties of the boundary layer and highlighted probable implications for coral larval transport and recruitment success.

This collection of studies shows that ecosystem connectivity remains as an important and active field of inquiry in Philippine marine science.

SMART fisheries and aquaculture: SMART Aquaculture | Dr. Jon Altamirano

The session showcased some recent studies on sea cucumbers, mangrove crab, and sea weeds with applications for aquaculture and production. Two sea cucumber species – Stichopus cf. horrens and Holothuria scabra – were presented by four papers, dealing with culture methods and behavior studies for juveniles. One paper on seaweed Kappaphycus alvarezii, looked at potential of antibiotics in mitigating bacteria associated with ice-ice disease. One paper on the induction for molting of mangrove crab Scylla spp. using hormones for soft-shell crab production applications.

Concerns raised by the audience were on the practicability aspect of the studies and future implications on actual aquaculture production. The cost associated with using expensive synthetic hormones and the high labor requirement for its use in the induction of molting of mangrove crabs, for example, may limit its usability and adoptability by farmers. Same goes to the use of antibiotics to control bacteria causing ice-ice disease in seaweeds, and the expensive squid-meal feed for crabs and processed early-stage feeds as supplement food for sea cucumbers.

All presentations were research works by Msc and PhD students. Comments we also are raised about the design and methods. Examples were the uncertainty of species level identification of the sea cucumber Stichopus cf. horrens and Scylla spp., the pseudo-replication design of the bacterial challenge tests for antibiotics, and the small rectangular tanks used for sea cucumber behavior studies.

Nonetheless, the commodities presented were of high importance and demand for aquaculture especially in the Philippines. The presentations showcased only some aspects of culture for seaweeds, soft-shell mangrove crab, and sea cucumbers. Still,
there are many further research that needs to be addressed in terms of nutrition, culture method, population genetics, as well as the incorporation of cost-benefit analyses.

Global and local stressors: Ocean warming and acidification | Dr. Cecilia Conaco

This session began with a talk that showed that fossil coral cores from northwestern Philippines contained records of sea surface temperate fluctuations, as well as changes in levels of precipitation over time. Another talk highlighted the importance of obtaining baseline information on ocean acidification throughout the Philippine archipelago and establishing long-term monitoring protocols. Other talks presented in this session tackled the impacts of ocean stressors on ecologically important marine organisms, including corals, giant clams, and sponges. One talk revealed the rich repertoire of immune-related genes in corals, which could be part of the mechanism that protects corals from damage under stress. Another talk revealed that certain corals may be able to adapt to different thermal regimes through symbiont shuffling. In particular, Pocilloporid corals from regions in the country that typically experience higher variability in temperature were shown to associate with thermostolerant symbionts, whereas other corals, such as Acroporids and Helioporids, contained the same type of dominant symbiont wherever they were found in the Philippines. Another talk showed that ocean warming has a detrimental impact on endangered giant clams, which, like the corals, contain microalgal symbionts within their tissues. Giant clams subjected to high temperatures characteristic of future ocean conditions exhibited increased immune cell count, decreased symbiont density, and eventual mortality. In contrast, ocean acidification did not appear to have much impact on giant clams under the conditions that were tested. Another talk showed that, in comparison to corals and giant clams, sponges may be more tolerant to future ocean conditions although, the impact of stress varied across species. Susceptible sponges showed a shift in their associated microbial community, with the recruitment of potentially pathogenic and opportunistic bacteria under stress conditions. This indicates that stressors affect not only marine animals, but their associated symbionts, as well. The talks featured in this session highlighted the importance of conducting comparative studies on different organisms and stressors. While not all organisms may be winners under future ocean conditions, we can still hold on to a nugget of hope that some will be able to adapt for success in the changing ocean.

Visayan Sea | Atty. James Kho; Dr. Ari Barcelona

The first two papers on the population dynamics of the Indian squid and swordtip squid provided important basic information on these economically important stocks. Aside from providing data on growth, recruitment and mortality, the key take-away from the papers is that the squids are over-exploited (E value of 0.53 (Indian squid) and 0.66 (swordtip squid), well-beyond the acceptable range of not over 0.4-0.5. Squids from Western Visayas constitute up to 16% of national production.

Sardines a major catch in the Visayan Sea. The study complements NSAP data collection by providing spatial information on the stock using GPS tracking of
cooperating fishing vessels. From the study, there appears to be an area in Visayan Sea where there is no sardine fishing - rocky area considered dangerous or where sardines don’t aggregate - need further study? Species dominance area-dependent: *S. gibbosa* wide-spread, shallow waters; *S. fimbriata* dominant in Masbate area; *S. lemuru* in deeper waters. The study also identifies spawning grounds which may be relevant for designing of closed seasons.

Dr. Wilfredo Campos discussed critical habitats bordering the Visayan Sea stating that these are areas concentrated fishing activities. Initial results in the area of Concepcion, Iloilo and Cadiz. In Concepcion, high fry catch on one side of the islands (mostly engraulids); on the other side, juv blue swimming crabs (near mangrove and seagrass beds). These are degraded areas with low epibenthic fauna. In Cadiz mudflats, >50% juv catch (even if there is thinly distributed mangrove area, there are sill plenty of juveniles); epibenthic biomass very low about 8 times in other comparable areas. Further studies for Bantayan, Asid Gulf.

Mesa, Sheryll presented how Visayan Sea contributes about 14% of national fish production. As early as the 80s, Visayan Sea already overexploited. Trawl surveys conducted since 1948 (considered as baseline), followed in 1976, 2003, 3007, 2013, 2016, every 3 years thereafter. Currently there are 19 tracks being monitored. For the Warfel and Manacop trawl tracks: In 1948, fish biomass was 6 mt/km², dropped to 2.4 mt/km² (2003); 1.8 mt/km² (2007), and stabilized at 2 mt/km² in 2013 and 2016. For all the 19 trawl tracks, notably, there was no recovery in fish biomass comparing 2013 to 2016 data. Very significant finding, trash increasing in proportion of ‘catch’ - in 2016, up to 70% is trash composed of ghost fishing gears (in deeper areas) and domestic trash (in nearshore areas). Study also shows that the fish composition has changed drastically from the 19402 to the present. In the past about 8 fish families compose 80% of catch; in 2016, there more than 15 families (cannot reach 80%), with many of the species not usually commercially important.

The presentation by Dr. Alice Ferrer offered a framework for assessing ‘governability’ as a tool to study the quality of governance - ability to be governed/ to govern. The starting point is to be practical. There is no cookbook recipe; each area is unique (what may work for Visayan Sea, may be different elsewhere). By being practical and knowing limitations - this leads to formulating more realistic goals. Sustainable management of fisheries in the Visayan Sea presents a wicked problem - there is no known solution; only morphing issues. ‘Governors’ - facing very complex issues - there are limitations on what they can do. She further discussed the (co-governance/ highly fragmented) governing system <-> governing interactions <-> system to be governed (natural system, social system). Visayan Sea difficult in governability because there is a mismatch of the governing system (institutions, rules, etc.) with the system to be governed (natural system and social system).

Mr. Rollan Geronimo presented information that variability in fisheries production can be further discussed by looking at critically spatial information and environmental information. Environmental information can be informed through remote sensing e.g. temperature can change reference points, in some fisheries very drastic (e.g. cod fisheries in Maine). In Visayan Sea, times series shows no big difference in CPUE after Yolanda. Looking at various environmental factors, there is 24.6% deviance in
CPUE of selected fishing gears related to the ENSO index. During La Niña conditions - higher catches; El Niño not much effect/ need further study on why.

**People and Nature: Legacy of Dr. Maricar Samson | Dr. Wilfredo Licuanan; Norievill España**

Citizen Science and Youth Education session was organized in relation to the People and Nature theme that focused on educating the youth and how citizen science is seen as an important strategy in managing coastal and marine habitats and resources. This session was dedicated to the late Dr. Maricar Samson, who had major influence on seagrass and mangrove research. Close friends of Dr. Samson attended the session to celebrate her passion for teaching, continued inspiration to the youth and efforts on raising awareness on coastal protection and conservation.

Dr. Wilfredo Licuanan shared how he and Dr. Samson have worked together in conceptualizing the De La Salle University – Coastal Scouts Program. They have partnered with several non-government groups and individuals and have held several camps in a small fishing community in Lian, Batangas, where the DLSU marine station is situated.

Etienne Cancio, a student from DLSU Laguna Campus, was a part of the first coastal scouts auxiliary, which aims to provide experiential learning opportunities to the youth, primarily those in coastal communities, to foster awareness and appreciation for the marine ecosystem of the Philippines and to empower the youth to involve themselves in finding solutions to the problems that affect marine life and coastal communities. He recounts how the auxiliary program have developed his sense of appreciation for the environment.

Part of the extension service of the Batangas State University-VIPCORAL, to raise awareness and strengthen capacity in marine biodiversity research of high school teachers. Dr. Jayvee Saco shared that initial strategy was to conduct needs assessment survey and focused group discussions with the teachers, for them to clearly identify which topics or areas need to be enhanced.

The Big Blue Network also shared their experience in changing the perspectives of students in Negros Oriental. Ms. Analise Andringa discussed how their group implemented a 7-month program with high school students, which includes classroom teaching and field activities to increase awareness on seagrass, mangroves and coral reef conservation. Most activities are hands-on and she shared the importance of using learning tools and methods such as Seagrass Watch and Seagrass Spotter. Ms. Kim Gervereau also shared how the students’ interest and curiosity heightened when they conducted hands-on examination and viewing of seagrass specimens using microscopes. These learning methods provide students with a holistic view and increased understanding of the marine ecosystem.

Dr. Tejada from the Davao del Norte State College presented their efforts on mangrove rehabilitation, aquasilviculture and community-based multi-species hatchery. The program involved community organizers and members of the local...
government unit. It envisioned an increase income for the local communities at the same time developing awareness on environmental conversation.

The session highlighted how science needs to be communicated and the importance of involving the stakeholders. Awareness can be improved by understanding what we have and contributing to the solution in reducing threats to the environment.

It was also recommended to include People and Nature and Citizen Science sessions, training or workshop in the next PAMS.

**People And Nature | Dr. Arnel Yaptinchay**

A line up of 11 presentations made up the morning session on the 3rd day of the Philippine Association of Marine Science 15 under the theme People and Nature. All presentations were delivered by their respective main authors except for one who withdrew from the session last minute. The papers presented highlighted the relationship of research activities and conservation management with stakeholders (people), including Indigenous People, of mostly coastal communities and fisherfolks. Some presentations used Local Ecological Knowledge (LEK) through interview surveys, focal group discussions (FGD), and participatory mapping in data gathering that provide information on marine resources, while one paper used citizen science (SCUBA divers) towards the same objective. Marine resources covered included the coral reef, mangrove, seagrass, estuary, large marine vertebrates, reef-associated fish, and other fishery resources. The status of these marine resources, trends, and their uses were provided in the results of the various research conducted in specific sites. The activities described in the presentations were implemented in different locations in the Philippines, including northern Mindanao, Palawan, Aklan, Tañon Strait in the Visayas, San Miguel Bay in Bicol, Tawi-tawi, and the west Philippine Sea.

Two presentations dealt with tourism, Tubbataha Reefs Natural Park (monitoring sharks and rays) and Pagasa Island (assessment of coastal resources), that were used as a platform to gather data and as a potential industry in terms of development in coastal areas. One presentation focused on a ‘fun’ tool (Fish Card) that allows fisherfolks to open up and participate in fisheries management activities and discussion while another help raise awareness through an online platform (COENOMAP) by providing information on coral diversity. The audience were also encouraged to contribute to the DNA barcoding project of the DOST by providing relevant information and tissue samples from their respective project sites. The morning session presentations highlighted the need to use various tools and methods to gather data, engage stakeholders, disseminate information, raise awareness, and provide opportunities for people to effect management strategies that would benefit the country’s marine biodiversity and the Philippines Seas as a whole.

**Land-Sea Interactions | Dr. Olivia Cabrera**

This session was composed of talks about land processes that affect the sea, proving that we couldn’t talk of marine research and conservation without looking into land and even atmospheric processes. From river discharge and sediment dispersal (Don
Gallentes; Mars Tan) to local land-sea breeze circulation (Lei Solera) and local tectonic processes and global sea level rise (Yvainne Santamaria), these processes affect the ocean currents, salinity, pH, nutrients, and other parameters, and the survival of organisms too. More importantly, where land is, there the people are. And people inevitable impact the ocean with untreated wastes leading to elevated number of microbiota (Marjorie Atole), prevalence of microplastics and its presence in sediments, clams, rabbitfish (Jerome Cabansag; Abner Bucol); and construction of structures such as floodways that affect mangrove stands (positively in the case of Jaro Floodway – Mary Yshabelle Flores). Being an archipelagic country with more than 7000 islands, studies like these should not be limited to selected sites. It would thus be a good idea if the studies in this session could be replicated across sites and up-scaled to countrywide assessments, such as for microplastic research. PAMS will be a good venue to coordinate such studies among the network of members scattered across the country.

The papers presented were from well-established professors and researchers. However, the show-stopper was the talk by Ms. Flores, a student from the Philippine Science High School, who did image analysis of Google historical maps to document the changes in acreage of mangrove stands after the construction of the Jaro Floodway in Iloilo. She was eventually awarded the PAMS15 best oral presentation award. It is witnessing young students like these who exhibit excellence and concern for our marine environment that make attendance to PAMS truly worthwhile.

Global And Local Ocean Stressors | Dr. Maria Lourdes San Diego-McGlone

Nine out of 11 papers were presented in the GLOBAL AND LOCAL OCEAN STRESSORS (GOS) Session. In these presentations, anthropogenically induced local stressors and one stressor with a regional coverage, were discussed. Poor water quality from mariculture activities in Bolinao, Pangasinan is a local stressor that has affected the reproduction (black gonads produced) and feeding potential of sea urchins. It also has an impact on microbial communities and their association with giant clams. And it has affected the development of biofilm which serve as important cues for coral larval settlement. Siltation and heavy metals from large scale mining is a stressor that threaten the marine protected areas in Lanuza, Surigao. An emerging stressor is microplastics, which was seen in the guts of commercial fishes from the Camotes Sea, Cebu; and in oysters from Anda, Pangasinan. The presence of antibiotics in the waters of Mabini, Batangas can pose a threat to the marine environment and local communities in the area. The impact of parasites that inhabit coral reef fishes was seen in Negros and the Siquijor island. On a regional scale the threat of radioactive contamination from the Fukushima accident in Japan has reached Philippine waters as evidenced by presence of toxic radioactive wastes discharged from the nuclear power plant in the coral cores of Baler, Aurora.

The GOS Session had a good mix of papers that highlights various stressors and their effects on the marine environment. After each presentation, the questions asked elicited some discussion and suggestions were given.

Novel Research Methods and Technologies | Dr. Wilfredo Licuanan
There was a total of eight (8) presentations (with two withdrawals) under this session. Ms. K.D. Tan presented evidence of 28S rRNA gap deletion in tridacnine bivalves. Mr. KE Sorgon sought to demonstrate in his presentation the utility of Hill’s numbers in visualizing species richness and evenness in reef fish assemblages both within and outside MPA sites. Dr. Angel Bautista examined radionucleides from nuclear bomb tests in the Pacific Ocean as incorporated into corals in E Luzon and the West Philippine Sea. Dr. W. Licuanan described the current state of Philippine reefs and emphasized the learnings from the application of new assessment scales for hard coral cover and generic diversity and provided baseline numbers for these parameters at the national level and for the six biogeographic regions of the country. Ms. N. Maguyon and Mr E Aca shared lessons learned from the application of Facebook® for establishing baseline data and information on marine wildlife in the country. Mr. M. Go and Dr. K. Carpenter presented their work on citizen science methods for monitoring coral cover and richness of butterfly fish species, respectively. Both methods are meant to be applied in tandem to common sampling stations and without the use of scuba equipment. P. Maloles demonstrated how CTD (conductivity-temperature-depth) data can be used to identify regions of mixing at the junction of the Mindoro, Panay, and Tablas Straits. Finally, Dr. Z Halun (presenting on behalf of MC Ablan-Lagman) introduced various technological innovations in genomics, geographic information systems, and mobile apps developed and refined to improve rearing of mangrove crabs.

All paper presentations in the morning session are generally well-attended and resulted in many interesting discussions, particularly on the papers dealing with citizen science.

**Marine Resources Governance and Management | Dr. Nerissa D. Salayo**

This session presented the results of research and advocacy activities aimed at improving utilization, governance and management of fishery resources in coastal municipalities around the Philippines. The first presentation pointed to the need to protect resource-rich ecosystems such as the Benham Rise. The survey of municipal fishers in Aurora and Quezon province revealed that Benham Rise is a fishing ground for high-value large pelagics, such as tunas and blue marlins, and coral reef fishes, such as groupers and snappers. Meanwhile, the second paper focused on the need to investigate the continuing catch and trade of sharks in 44 study sites around the Philippines in spite of prohibitions. Sharks are reported by fishers as incidental catch. Shark meat are mainly sold locally, hence limiting monitoring by authorities, while fins and oils reach high-demand markets. These two presentations and corresponding discussions during the Session point to the need to continue these kinds of monitoring studies, innovate improved fishing gears to diminish by-catch, strengthen the conservation and management measures to secure these important ecosystems and critical species while providing for food and income source for fishing households.
Two presentations reported the status of the seaweeds industry in the Philippines based on the survey which mapped over 100,000 ha of active seaweed farms in 40 provinces in 15 regions in the Philippines. The presentations noted that country cultivates dozens of seaweed varieties called in various local names, from three species namely, *Kappaphycus alvarezii*, *K. striatum*, and *Eucheuma denticulatum*. The declining production and rank of the Philippines in comparison with the global top producer China was evaluated as related to climate change, disease outbreaks, market fluctuations, and sometimes due to limited government support.

The last two presentations focused on the importance of collaborative participation of local stakeholders in enhancing community well-being in Concepcion in Iloilo province and in three municipalities La Union. Activities on coastal protection and livelihoods have positively contributed to the quality of life of coastal residents. In Concepcion, there are local legislations to provide legal basis for citizen engagement in planning for various concerns. However, in spite of the many existing supportive organizations, some factors such as limited quality of participation and advocacy activities constrain implementation of plans. Meanwhile, the CURE the Sea Project in La Union represents a collaboration between the local government, academe and its citizens to enhance awareness and understanding of the importance, utilization, management and protection of marine environment.

**Marine Protected Areas** | Dr. Romell A. Seronay

Marine reserves in Panay Island were perceived to have a significant positive performance. However, the performance of each of the indicators was mixed across reserves. In general, although marine reserves were perceived to be effective in empowering the local fishing communities, their perceived impact on improving the state of the local fisheries resources remained limited. Majority have high perceived seriousness on the likelihood to suffer tragedy if pertinent laws and policies were not consistently implemented as well as if their communities remained uncooperative to coastal protection program, but have moderate perceived susceptibility to the likelihood that the destruction of mangroves and corals will have negative effects to their community and livelihood.

Furthermore, strong perceived correlation was observed between perceived threat and lack of cooperation from the perspective of San Joaquin communities knowledge, perceived threats, cues to action, and self-efficacy of Iloilo marine reserve and sanctuaries protection and rehabilitation program.

It has been a challenge to evaluate the effectiveness of MPAs management and its relationship to the biophysical indicators. MPA effectiveness indicator such as commercial reef fish biomass and coral cover were selected as a primary indicator of effectiveness. Substrate composition and resilience were considered indirect indicators of effectiveness, being essential for maintaining a source of food security over the long-term. Moreover, the assessment is designed to assess how well the MEAT measures MPA effectiveness from the legal and social context.
Results of the study on management effectiveness of marine protected areas in Tawi-tawi using the MPA Management Effectiveness Assessment Tool showed that the MPAs could hardly pass level 2 (Strengthened) of the MPA MEAT. Management effectiveness was highest in terms of “community participation” and “legal instrument” but weak in all other areas especially in “enforcement”, “financing” and “monitoring and evaluation”.

Conclusion:
1. Marine reserves in Panay Island were perceived to have a significant positive performance.
2. There was a strong perceived correlation observed between perceived threat and lack of cooperation.
3. Commercial reef fish biomass and coral cover were primary biological indicators of MPA effectiveness.
4. Management effectiveness of marine protected areas in Tawi-tawi using the MPA MEAT was highest in terms of “community participation” and “legal instrument” but weak in all other areas especially in “enforcement”, “financing” and “monitoring and evaluation”.

Recommendations:
1. Incorporate ecological and socio-economic considerations in setting reef fisheries management regimes.
2. Educational inputs and workshops should include and highlight the precariousness of coastal resources and their real immediate effect to coastal resources and livelihood.
3. Emphasized how monitoring and evaluation tools should be used to build an iterative process toward a management effectiveness that generates the social and ecological goals.
4. Mechanisms to improve and sustain MPAs effectiveness and other initiatives for coral reef conservation in Tawi-Tawi are desirable.

Marine Protected Areas 2 | Dr. Richard N. Muallil

The establishment of marine protected areas is among the most common initiatives done in the Philippines to address resource depletion and habitat degradation brought about by increasing threats both from natural and anthropogenic sources. In this session, various papers about marine protected areas were presented ranging from biodiversity surveys in MPAs to those discussing the socio-ecological indicators of effective MPAs and insight for sustainable management.

The two studies from Lagonoy Gulf showed the positive impacts of MPAs on coral reefs in terms of improving the condition of both benthic and reef fish communities. The same findings were presented in studies conducted in other areas including one which was done in French Mediterranean. Despite the overall better condition of marine resources inside MPAs, it still begs the question as to whether the current MPAs are effective enough to reverse the impact of the current threats to the marine ecosystems. It was evident that more effort needs be done. Rodolfo et al., suggested to consider onshore-to-offshore geologic continuity which was shown to have diverse flora and fauna as potential criteria for consideration in choosing sites for MPA
establishment. On the other hand Bobdilla et al, suggested that capacitating the MPA management bodies is key for successful and sustainable MPAs. Lastly, Abrina et al., recommended a more comprehensive analyses of the socioeconomic and ecological indicators using existing data and existing MPA management effectiveness tools.

F. SIDE EVENTS AND DISCUSSIONS

1. Zoological Society of London Book Launch
2. USAID Fish Right Experts Meeting

G. CLOSING, AWARD AND RECOGNITION

1. Atty. Gloria Estenzo-Ramos, Vice President Oceana Philippines, graced the closing ceremony with a short presentation on Oceana’s initiatives related to Law, Science and Empowerment in the Journey towards Sustainable Fisheries.

2. Oathtaking and signing of Certificate of Election by PAMS16 Officers;
   a. President: Dr. Romell Seronay, Caraga State University
   b. Vice President
      i. Luzon: Dr. Jayvee Saco, Batangas State University
      ii. Visayas: Dr. Nathaniel Añasco: University of the Philippines Visayas
      iii. Mindanao: Ms. Christine Mae Edullantes, Davao del Norte State College
   c. Secretary: Allyn Duvin Pantallano
   d. Treasurer: Dr. Katherine Escalona
   e. Auditor: Dr. Maria Celia Malay, University of the Philippines Visayas
   f. PRO: Mr. Diovannie De Jesus, Oceana Philippines

3. Two best student oral presentors for 2019 were awarded with cash prizes from the Philippine Association of Marine Science and a trip to the Tubbataha Reefs Natural Park from the Tubbataha Management Office.

   Oral (graduate)
   1. Andrew Torres
   2. Rose Angeli Rioja
   3. Mary Shodipo

   Oral (HS/Undergrad)
   1. Mary Yshabelle Flores
   2. Allena Esther Arteta
   3. Joanna Mae Mong

Poster
1. Andrew Torres
2. Neil Edgar Dex Marza
3. Gerard Louie Marilao

4. The Closing Program was followed by a Farewell Dinner. Dr. Yasmin Primavera-Tirol officially closed the 15th National Symposium on Marine Science on 6 July 2019.
Effects of light on behavior, growth and survival of Stichopus cf. horrens juveniles

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INTRODUCTION

Stichopus cf. horrens are tropical sea cucumber species reported to be nocturnal in both adult and juvenile stages (Purcell et al., 2012). This study investigated the early life stages of S. cf. horrens over a longer rearing duration (30 days), to gain insights on the development of photosensitivity in echinoderms and the possible effects of the presence of conspecifics. Specifically, the study determined the direct and indirect effects of light on the behavior, growth and survival of two early life stages of S. cf. horrens with different feeding modes. Post-settled juveniles (47 days post settlement; 0.24 cm to 1.14 cm) are primarily grazers on periphyton but can also suspension feed. Older juveniles (180 days post-settlement; 4.3 g to 19.4 g) are primarily deposit feeders.

MATERIALS AND METHODS

The post-settled juveniles were subjected to 3 photoperiods: continuous light (24L), continuous dark (24D), and 12:12 light-dark cycle (12L:12D), with either presence (S) or absence (W) of artificial seagrass units (ASU) as shelters. Each treatment had 4 replicate jars (2 liters) with 10 post-settled juveniles. The average illumination was 713 lux and water temperature was 28.3OC. For the older and deposit-feeding juveniles, sediment (2 cm thick) was added to the experimental aquaria (31 cm x 15.5 cm 22.5 cm; 10 liters). The treatments were fully exposed (E) (4726.51 + 1582.43 lux at noon), half-covered (HC) (1015.71 + 272.60 lux), and fully-covered (C) (663.48 + 384.15 lux). Each treatment had 6 replicate aquaria with 3 juveniles.

RESULTS AND DISCUSSION

Results showed that the juveniles had an average daytime feeding at the start of the experiment, which then shifted to nighttime feeding starting day 11 (Figure 1a). This is the first study to provide an empirical evidence that photosensitivity is still developing during the post settlement stage. Notably, the first to exhibit a shift to nighttime feeding were the juveniles in continuous exposure to light (24LxW) and 12L:12D without
shelter (12L:12Dx W) on day 11. The last to exhibit a shift were juveniles in completely dark environment (24DxW and 24DxS) on day 29. This delay indicates that the development of nocturnal feeding is inherent but activated by the light-dark cycle.

Figure 1 Rose plots showing the average feeding periods of post-settled juveniles across days (A), and older juveniles across treatments (B). Each plot corresponds to 24 hours. The shaded portion represents nighttime while the unshaded portion represents daytime. Arrow direction represents the average feeding period (i.e. 11:30 PM). Particularly for the post-settled juveniles, arrow length signifies the magnitude of feeding frequency. Further, mass mortality occurred in 2 out of 4 replicates of treatment 24L x W (green arrow) between days 11 and 19, hence excluded in the representation of succeeding monitoring days.
The older juveniles predominantly fed at night, although some individuals were also seen feeding during the day (Figure 1B). This is in contrast to the behavior of larger juveniles (>20g) reared individually, which exhibited strictly nocturnal activity and feeding (Palomar-Abesamis et al., 2017b). Results of this study may reflect individual variations in feeding activity and the possible effects of the presence of conspecifics on behavior. In terms of location, the juveniles tend to disperse when feeding at night as observed in their distribution (Figure 2a). Meanwhile, juveniles hid under the shade of the half-covered treatment during the day (Figure 2b), an indication of negative phototaxis. Juveniles also exhibited positive thigmotaxis in all treatments, situating themselves at the corners of the aquaria and usually with a conspecific.

Figure 2 Shading matrices showing the average number of feeding (A) and inactive (B) juveniles (180 days post-settlement; 4.3 g to 19.4 g) across grids and monitoring days. To gain insights on the tendency of inactive juveniles to form aggregations, the number of observations where there are more than 2 juveniles per grid was documented (B)
Light indirectly affected the older juveniles by influencing the relative microalgal biomass as indicated by sediment chlorophyll (Chl a). Specifically, Chl a was highest in the exposed treatment (E) (13.44 mg/g + 4.57 SD) due to high light intensities (4726.51 + 1582.43 lux at noon). Concurrently, the highest juvenile absolute growth rate (AGR; 0.095 g + 0.05 SD) was recorded in this set-up (Figure 3B). The decrease in Chl a in treatments E and HC over time suggests that as the juveniles grow, reduction in microalgal biomass due to grazing was greater than its replenishment.

In contrast to the older juveniles, negative phototaxis and thigmotaxis were not evident in the post-settled juveniles reared with conspecifics and provided with artificial shelter. There were no significant differences in the number of juveniles feeding on the surface of the artificial shelter and the jar, but juveniles had higher AGRs compared to those in the treatments without shelter (Figure 3A). The artificial seagrass units could have provided additional substratum for benthic diatom growth, similar to the shelters used in rearing *Apostichopus japonicus* (Han et al., 2016; Yamaguchi et al., 2018). This is consistent with the suggestion that the high association of juvenile *S. cf. horrens* with seagrasses in the wild may be due to accessibility to food (i.e. epiphytes along the blades) as well as shelter (Palomar-Abesamis et al., 2017a).

Continuous exposure to light or high light intensities resulted in lower survival among post-settled and older juveniles (Figure 3). Post-settled juveniles exposed to constant light (713 lux) had the highest mortality, with mass mortalities in 2 out of four replicates, suggesting that continuous exposure to this light intensity may be lethal to juveniles (Figure3A). Survival was also compromised in the exposed treatment (E), having the highest mortality at 50% between 15 to 30 days of rearing. In the wild, juveniles likely sheltered to avoid the ultraviolet light’s damaging effect to dermal tissues (Palomar-Abesamis et al., 2017b).

Conversely, the highest survival was documented in the fully covered treatment (C) (100%), indicating low light conditions favored survival. However, the lowest AGR (-0.07 g + 0.032 SD) in this treatment was associated to low food abundance (4.58 mg/g + 0.73 SD). Meanwhile, post-settled juveniles had highest survival in 24-h dark with ASUs (92.5%), but with highest AGR (0.46 cm/day + 0.04 SD) probably due to the presence of shelter trapping the benthic diatom, hence providing additional access to food.

**CONCLUSION**

Overall, this experiment showed that it is best to rear the post-settled juveniles in continuous darkness (0 lux), and the older ones in low light conditions (663.48 + 384.15 lux) to ensure survival. This is the first study to document changes in photosensitivity in this species, contrary to previous reports that they are nocturnal across all life stages.
Figure 3 Absolute growth rate and survival of post-settled (A) and older juveniles (B) across treatments. Letters denote significant differences (Kruskal-Wallis Test). Arrows indicate mass mortality in 2 out of 4 replicate jars of treatment 24L x W, hence excluded in the statistical analysis.

Acknowledgment

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References


Induction of precocious molting in mangrove crabs Scylla spp.

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INTRODUCTION

Mangrove crabs from the genus Scylla, either harvested from the wild or cultured can demand high prices in the market. One aspect of mangrove crab culture is soft-shell crab production, which is an emerging technology in the Philippines. Soft-shell crabs refer to newly molted crabs with their exoskeleton still being soft and pliable making the whole crab edible when cooked. This characteristic gives soft-shell crabs higher economic value on a per weight basis making it a potentially valuable export commodity.

Molting is a prerequisite for soft-shell crab production. It is the periodic shedding of old exoskeletons in crabs and other crustaceans for growth, metamorphosis, and reproduction. It is regulated by hormones (e.g., peptides, steroids, terpenoids) and external mediators such as endocrine cues [1]. In order to meet the increasing demand for soft-shell crabs, induction of precocious molting can be applied in order to shorten production cycles. Several methods have already been studied to induce molting in a variety of crustaceans [2-5]. Previous studies have demonstrated that administration of melatonin to the crab Oziotelphusa senex senex [1] and Pacific white leg shrimp L. vannamei [6] resulted in precocious molting. To date, the effects of melatonin in relation to precocious molting have not yet been investigated in the crabs of the genus Scylla. The present study thus aimed to determine the effectiveness of melatonin in inducing precocious molting as a strategy for soft-shell crab production.

MATERIALS AND METHODS

Animals

Uninjured mangrove crabs, Scylla spp. with internal carapace width of 6.0-6.9 cm and body weight of 30.0-80.0 g were obtained from SEAFDEC, Dumangas, Iloilo and acclimatized to laboratory conditions for seven days prior to the experiment proper. The crabs were maintained in an experimental flow-through system. The crabs were kept individually in perforated plastic containers to eliminate mortality due to cannibalism, and for ease in monitoring mortality and molting. The containers were housed in large plastic tanks (4 containers/54L tank) with sufficient ambient seawater (salinity=28 or 30 ppt). Salinity was measured using a handheld refractometer. During acclimatization, crabs were fed with squid meat daily ad libitum. A total of 50 mangrove crabs were used in the experiment. The crabs were maintained in experimental containers for 40 days prior to termination. Analysis for survival and molt interval were done. The shed exoskeletons in the containers were also measured. Body measurements of the crab were taken prior to and 3 days after each molt to make sure the crab was in the intermolt stage. The mangrove crabs were measured individually for body weight using an electrical scale and internal carapace width (ICW) was measured using a Vernier caliper.

Treatments
Test chemicals and experimental design

Saline solution and N-acetyl-5-methoxy-tryptamine (MEL; melatonin) were used as the control and test chemical respectively. All the test solutions were prepared fresh prior to the start of the experiment.

Experimental design

The crabs were injected with saline solution or melatonin at a dose of 10^-7mol/crab through the arthrodial membrane of the coxa of the third pair of walking legs in 20µL volumes. The dose of melatonin used for this study was selected based on previous kinetic studies in crabs [7]. Crabs injected with saline solution served as controls [8]. The injections were given on the 1st, 20th, and 29th days and recruitment of crabs into different molt stages was determined on the 40th day.

Determination of molt stages

The number of crabs on the 40th day that had entered into premolt stage/molted were determined. The criteria used in the present study to identify the molt cycle stages in the crab, Scylla spp. are similar to the molt stage description developed by [9] and redescribed by [10]. Molt stages were identified by observing the setal development in the paddle leg of the crab [11,12]. The changes in the setal development were observed under a phase contrast microscope and SHIMADZU Digital Microscope.

Data analysis

Survival and molting rates were determined and measurements of internal carapace widths were expressed as mean ± SD.

RESULTS AND DISCUSSION

Effects of melatonin application

Melatonin-injected crabs were observed to undergo precocious molting with a 48.15% molting rate whereas saline-injected crabs remained in the intermolt stages summarized in Table 1. Crabs that have undergone molting have paddle legs with thin cuticles compared with crabs in intermolt stage which have thick cuticles. Crabs in premolt stage have pronounced separation of the cuticle from the epidermis and formation of the new setae (Fig.1). Melatonin has diverse physiological purposes such as its involvement in the positive regulation of the molting process in crustaceans [1,6,7]. Melatonin’s effect on molting acceleration is indirect as it inhibits the release of molt-inhibiting hormone (MIH) and mandibular organ-inhibiting hormone (MOIH) from the eyestalks [7].
Table 1. Effect of Melatonin Administration on Molting in Crabs

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Number of crabs in different molt stages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (saline-injected)</td>
<td>23 (04)</td>
<td>Intermolt: 19</td>
</tr>
<tr>
<td>Melatonin-injected</td>
<td>27</td>
<td>Intermolt: 2; premolt: 12; postmolt: 13</td>
</tr>
</tbody>
</table>

There appears to be a direct relationship between the frequency of melatonin application and the molting rate wherein as frequency of application increased, the molting rate also increased. It must be noted though that these were just preliminary observations and more detailed experimental designs are still required to investigate the actual effects of melatonin administration frequency on precocious molting occurrence. The melatonin-injected crabs, despite being induced to molt precociously, were also observed with considerable growth as evident in the increase in their mean ICW (7.53cm ± 0.42cm). In comparison to some studies about natural molting, their percentage growth of ICW varied [13,14].

Survival Rate

The survival rates of melatonin-injected crabs and saline-injected crabs were 100% and 82.61%, respectively. Factors such as molting, salinity and temperature fluctuations, feed, and stocking density are some of the reasons for low survival in some mud crab culture systems [15-18].

CONCLUSION

The number of melatonin-injected crabs in premolt and molt stages, pronounced increase in mean internal carapace widths, increasing molting rate of 48.15%, and survival rate of 100% suggest that melatonin induced precocious molting in mangrove crabs, thus presenting melatonin administration as a potential strategy for the more controlled production of soft-shell crabs.

ACKNOWLEDGEMENTS

The sincerest gratitude is given to Dr. Victor Marco Emmanuel N. Ferriols (University of the Philippines) for his patience and persistent support throughout this study. We also express our gratitude to Mr. Jerome G. Genodepa (University of the Philippines) for his helpful suggestions and to Mr. Alan Failaman (University of the Philippines) for his technical advice and contributions including the provision of equipment and facilities which are very essential in the preparation of the experiment. We also thank the personnel of UPV Multi-species Hatchery Complex for their assistance in handling the crabs which made the conduct of experiment easier. We would also like to thank the organizers in this conference for the opportunity to participate.
Figure 1. Appearance of swimming leg of Scylla spp. during postmolt, intermolt, and premolt stages. Postmolt: cuticles are thin (A); Intermolt: cuticles get thicker (B); Premolt: separation of the cuticle from the epidermis and the formation of new setae are observed (C). Abbreviations: cu, cuticle; se, setae; ep, epidermis; ns, new setae. Swimming leg (A-C) under 10x magnification.

REFERENCES


Effects of farnesol and geraniol against bacteria associated with ice-ice disease from the seaweed Kappaphycus alvarezii (Doty)

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Introduction

Ice-ice disease, a disease that develops during extreme conditions such as intense temperature, salinity, and irradiance (6) often plague seaweed farms causing a decline in productivity. Aside from unfavorable environmental conditions, bacterial pathogens have also been associated with ice-ice occurrence (6,7,8,9,12). Conveniently, terpenoids, a diverse class of naturally occurring compounds found mostly in plants are reported to be active against several pathogenic microbes (2). In fact, previous studies (16,17) showed that seaweeds of the genus Laurencia were found to be more tolerant to ice-ice disease than other genera because of their inherent ability to biosynthesize a suite of halogenated secondary metabolites, including terpenoids. In this study, the potential of the terpenoids farnesol (FOH) and geraniol (GOH) as antimicrobial compounds against bacteria associated with ice-ice disease from Kappaphycus alvarezii were evaluated.

Materials and Methods

Ice-ice infected K. alvarezii samples were collected from cultivation farms in Ajuy, Iloilo, in March 2018. A portion of the seaweed’s infected thalli was incised in the lab then homogenized. Aliquots (50 µl) from 10^0 to 10^-4 serial dilutions were spread onto TCBS agar to isolate Vibrio species, bacteria prominent in ice-ice infected seaweeds (6,8,9). Based on morphological features, 2 different colonies were randomly picked from the 10^-2 dilution plate and purified by streaking (12) onto fresh TCBS plates. Since TCBS is a Vibrio selective agar (5), the isolates were presumed to be Vibrio species and were subsequently named Vibrio Isolate 1 and Vibrio Isolate 2. Random colonies from each pure culture were inoculated into 15 ml test tubes containing natural saline solution. The diluted bacterial isolates were swabbed onto the surface of MHA plates for antimicrobial disc diffusion assay. Sterile paper discs were placed onto the agar then impregnated with 20% v/v farnesol and geraniol from 10^0 to 10^-2 (800 mM-8 mM) dilutions. Control discs were prepared with the carrier solvent (dimethyl sulfoxide) alone. Positive control discs were prepared for each isolate with the antibiotic chloramphenicol (100 µM). Inhibition zones were measured around the discs (mm diameter) after 24-hour incubation at room temperature.

Motility assays were performed on semi-solid agar. Each Vibrio isolate was inoculated as 0.5 µl spots on plates containing FOH and GOH. Plates with no FOH or GOH served as negative controls. The plates were incubated for 17 hours, after which motility zones were measured. Results were analyzed by calculating the mean ± standard error of the various indices measured. Significant differences between means were determined by one-way ANOVA subjected to Duncan’s post-hoc test.

Results and Discussion
The results the antibiotic disc diffusion assay using farnesol and geraniol showed that these were able to inhibit growth but at very high concentrations (800 mM). Lower concentrations of farnesol and geraniol (80 mM and 8 mM) were only slightly effective in inhibiting growth. This could be because Gram-negative bacteria such as Vibrio have thinner but difficult to penetrate outer cell membranes that block out toxic substances such as antibiotics (1), therefore higher concentrations of FOH and GOH were probably necessary for the compounds to exert any significant effect. This is further supported by several studies which state that essential oils and their components are generally less effective against Gram-negative bacteria compared to Gram-positive bacteria because they prohibit the entrance of hydrophobic molecules (10). At 800 mM concentration, no significant differences were noted between the antibacterial effect of farnesol and geraniol on isolate 1 (12.50 ± 0.58 and 12.25 ± 1.50 respectively); however, geraniol (11.25 ± 0.50) exhibited significantly greater antibacterial activity on isolate 2 than farnesol (8.75 ± 0.50). The differences in activity between FOH, a sesquiterpene, and GOH, a monoterpene, could probably be due to differences in chemical structure (4). The exact mechanism of membrane disruption may be related to their carbon chain length (13). GOH, having a shorter carbon chain may be able to penetrate better the lipid bilayer of the cell membrane thus exerting greater antibacterial activity.

In the motility inhibition test, both farnesol and geraniol significantly inhibited motility of the isolates at a low concentration of 1.5 mM with geraniol exhibiting a greater inhibitory effect. Motility benefits bacteria in several ways – it enables them to move towards favorable environments and avoid injurious conditions, allows them to translocate to desired hosts and colonize them, and lastly, facilitates proliferation in the environment throughout the course of transmission (11). Additionally, motility is also a critical factor for biofilm development and growth. Biofilm is an aggregation of micro-organisms on surfaces wherein microbial cells adhere to each other within a self-produced matrix of extracellular polymeric substances that allow bacteria to spread across infected surfaces (3). In Vibrio species, it was discovered that motility contributes to the virulence of pathogenic Vibrio through adhesion or biofilm formation (17).

The possibility of enhancing FOH and GOH production in eucheumatoids and other commercially important seaweeds during occurrences of ice-ice disease is not far off. Preliminary search in NCBI revealed the presence of putative phosphatase genes in a variety of red algal species such as phosphatidic acid phosphates in Chondrus crispus and Galdieria sulphuraria. Phosphatases are compounds capable of hydrolyzing FPP and GPP to farnesol or geraniol, respectively. Perhaps novel genes of Kappaphycus that encode for phosphatases could be discovered in later studies and utilized through appropriate molecular biology tools.

Conclusion

In conclusion, FOH and GOH both exhibited antibacterial activity against the isolates but at a very high concentration (800 mM). On a positive note, FOH and GOH had significantly greater effect on the motility of the isolates even at a low concentration of 1.5 mM, demonstrating their potential as compounds that could prevent the rapid spreading and infection of pathogenic bacteria in seaweed farms. To date, no direct remedy for ice-ice is available. Ice-ice can only be controlled through management intervention and polyculture techniques (14). FOH and GOH are natural compounds.
that can potentially prevent ice-ice outbreaks. In the future, bioediting techniques could be employed to allow K. alvarezi and other commercially important macroalgae to overproduce FOH and GOH during the onset of the disease.

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References


Insights on the microbial community and geochemistry of high temperature sediments and microbial mats in a shallow hydrothermal vent in Mabini, Batangas

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INTRODUCTION

Microbes are diverse, ubiquitous, and important organisms in the ocean. Recent estimates of their biomass and distribution show that they are most abundant and likely most active in the form of biofilms. They facilitate global biogeochemical cycles and thus information on their roles throughout Earth’s history are highly sought after. In the ocean they are important links between ‘the inorganic’ and ‘the organic’ and facilitate major ecological processes.

Shallow hydrothermal vents are an understudied type of submarine groundwater discharge bound to <200m depths and are hypothesized to be widespread in tectonically active regions. Often found in coastal environments, they provide a sharp geochemical gradient from extremely reducing high-temperature fluids and sediments to ambient oxidizing environments resulting to ideal conditions where microbial biomass can accumulate as biofilms and thrive chemosynthetically. Exposure to light, and proximity to diverse littoral and even terrestrial ecosystems all contribute to a complex and dynamic setting by which microbial interactions are hypothesized to have primary importance.

Geothermal activity along the coast of Mabini, Batangas, Philippines manifests in the form of diffuse and localized shallow hydrothermal vents interspersed with macrobenthic populations all located within the biologically diverse Verde Island Passage Marine Corridor. Sediments and flocculent microbial mats found at the localized vents are hypothesized to be geochemically distinct substrates for microorganisms participating in chemosynthetic and photosynthetic processes. Like many types of submarine groundwater discharge the fluid and sediments in these vents are hypothesized to be geochemically distinct as a result of water rock interactions and may have an important contribution to the geochemistry of the global ocean. Understanding the microbial ecology, as well as the carbon and energy dynamics of microbial communities in these systems provide another dimension into how these complex coastal environments are modelled and by extension, give us clues to the role of microbes and hydrothermal vents in the Earth’s past, present and future.

MATERIALS AND METHODS
Geochemical parameters within and around a localized vent at 15m depth were measured, namely dissolved oxygen, pH, major ion composition (Cl, Na, SO4, Mg, Ca, K, Br, F) and total iron for water and temperature for sediment samples. Microbial mats and sediments were collected for the extraction and analysis of DNA and fatty acids by amplification and phylogenetic sequencing of the v3-v4 region of the 16s rRNA gene and GC-MS of methyl ester derivatives, respectively. DNA sequences were pre-processed and aligned to SILVA132 reference database via MOTHUR pipeline and visualized using web-based tools.

RESULTS

Geochemical parameters

During its time of collection, pH of vent water was 7.2, dissolved oxygen was 3.77 ppm and temperature of water and sediments ranged from 46 to 87 °C. Compared to the major ions in ambient water, vent fluids were depleted in Cl, Na, SO4, Mg, Br, enriched in Ca and K and elevated by more than ten-fold in total iron concentrations.

Fatty acid profiles

Comparison between the total fatty acid (TFA) profiles of high-temperature sediments (HS) and cold-temperature sediments (CS) shows that while both have the typical even over odd carbon number predominance, HS have a higher concentration of total fatty acids than CS, suggesting an overall enrichment in organic matter (OM). Moreover, low molecular weight fatty acids (C15 to C20) have relatively higher contribution in HS while high molecular weight fatty acids (>C20) have higher contribution in CS. Overall there is also a higher diversity of fatty acid groups in CS than HS. Specifically, 15:0, 16:0 and 16:1 have higher relative abundance in HS while branched fatty acids Me14:0, Me15:0, Me16:0, 20:4 and >20 were relatively more abundant in CS.

Mats have 1.8µg/g TFA. Phospholipid-derived fatty acid (PLFA) and TFA profiles were more similar to HS in which >C20 fatty acids were also undetected. However, unique fatty acids were observed to have a significant contribution, namely cy19/19:1 and 20:1; none of which were detected in either type of sediment.

Microbial community composition

Rarefaction curves showed significantly higher number of sequences in CS versus all other samples. Higher computed richness was also observed for CS across multiple indices. In terms of beta diversity, Venn diagram, cluster tree, and heatmap visualizations show distinct microbial communities across all samples. Upon OTU assignment, 75% of total sequences (1,134,428) were classified, among which the most dominant taxa was Proteobacteria (43%), followed by Bacteroidetes (8%), Aquificae (7%), Chloroflexi (7%), Actinobacteria (3%). Comparison of major groups found in HS and mats with those attributed to other hydrothermal systems shows similarity, particularly in the dominance of members of Gammaproteobacteria, Aquificae, Chloroflexi, Alphaproteobacteria, Zetaproteobacteria, Epsilonproteobacteria, Deltaproteobacteria.
DISCUSSION

Higher concentrations and lower diversity of TFA in high-temperature sediments compared to ambient sediments imply enrichment of microbially derived organic matter (C15 to C20 FA) due to higher microbial activity and biomass. Lower relative abundance of higher plant- or terrestrially derived organic matter (>C20 FA) suggest metabolic or heat induced breakdown, or that background concentrations were overprinted by the more dominant compounds. In the case for mats, similarity between PLFA and TFA suggest that active microbes in the mat sample are main contributors of OM in mats. Differences to 16:0, 18:1 and 18:0 abundances however might be attributed to different lipid classes separated via chromatography.

Occurrence of fatty acids unique to microbial mat samples (cy19/19:1 and 20:1) might be attributed to either of the dominant groups resolved by phylogenetic sequencing data. Community data on sediment and microbial mat samples reveal that environmental selection occurs towards groups possibly adapted to hydrothermal environments, which may have important roles in the system. *Zetaproteobacteria*, in particular are known iron oxidizers and have been observed in marine environments with elevated iron concentrations.

CONCLUSION

Diversity in microbial communities and fatty acid profiles in sediments and mats were investigated and have thus provided evidence for the potential role of bacteria in organic matter contribution in mats and sediments as well as in processes such as iron oxidation. Moreover the presence of taxa and potential biosignatures makes for a unique environment and thus warrants further investigation of microbial interactions in shallow hydrothermal vents in the Philippines.

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Temporal variations in the population of brown-spotted sea cucumber (Bohadschia marmorata) with notes on spawning season

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Introduction

Bohadschia marmorata is one of the heavily harvested sea cucumbers in Palawan, Philippines. In recent years, its collection has become more intense due to scarcity of high-value sea cucumbers in the wild. Preliminary survey in 2015 showed that B. marmorata comprised as much as 90% of the gleaners’ catch. Presently, the collection of sea cucumbers in Palawan is not regulated as pertinent laws on its harvesting and trade are not enforced, inadequate and probably need to be reviewed. This study was therefore conducted to determine the population of B. marmorata by monitoring its density and size structure for a year. It also aims to investigate its spawning season and factors that might affect it for purposes of regulating its collection.

Materials and Methods

This study was conducted in Arrecife Island, Honda Bay, Puerto Princesa City, Philippines, from June 2015 to May 2016. The island is a private area and its foreshore is a fishery reserve where extractive activities like fishing and gleaning are prohibited. Two sites were selected and three 25 m² (5m x 5m) permanent quadrats were established in each site. Monitoring was done every month during low tide in the afternoon. All individuals in the quadrats were measured (cm) and counted. The temperature, salinity and tide level were also monitored and data were analyzed using one-way Analysis of Variance (ANOVA), Tukey Test for post hoc, and correlation for density and tide level.

Results and Discussion

Results showed that the mean density of B. marmorata was 5 ind./25 m², without significant variations between sites (p>0.05). However, densities across monitoring periods displayed significant variations (p<0.05). The highest density was recorded in April at 20 ind./25 m² while the lowest was in September at 3 ind./25 m² (Fig. 1). Densities were also high in May, June, July and December with densities ranging from 12 to 14 ind./25 m².
Figure 2 shows the size frequency distribution of *Bohadschia marmorata* from June 2015 to May 2016. Notice that adults were abundant in April, May and June while juveniles (<10 cm) and sub-adults (10-15 cm) were apparent in July, comprising 47% of the recorded individuals in this month. Density and tide level were negatively correlated, which means that density is highest when tide level is at its lowest ($r^2=0.69$, Fig. 3). The temperature ranged from 31.27°C to 32.53°C while salinity was from 33 ppt to 35 ppt.

The high densities in April, May, and June and also in December were attributed to aggregating individuals while in July, it was due to the presence of juveniles and sub-adults. It was also found out that the high densities are associated with the lowest water levels. Individuals during these periods (March to June) were found to surface as the tide ebbs, rendering high density estimates. The highest temperature was noted in March, which remained relatively high in April until June. This high temperature is therefore presumed to induce aggregation and eventually, spawning of individuals from April to June. Aggregation of individuals is suspected as a prelude to mass spawning- a behavior that was also observed in *Holothuria scabra* wherein individuals are in proximity with each other when spawning. Aggregation is in fact, common among external spawners for it ensures maximum mixing of gametes and therefore
high fertilization rate. Salinity was also highest in April and May and is also seen to induce spawning along with temperature.

Conclusion

Overall, the *B. marmorata*’s variations on its population are associated with its spawning periods, which are influenced by increased temperature, high salinity and extreme differences in tide level. Spawning is noted to occur in April until June as evidenced by the presence of aggregating mature individuals during these periods, and the occurrence of juveniles and sub-adults in July. Aggregations were not noted in March thus it was not identified as a spawning period. Spawning might also occur in December as aggregations were also noted in this month, and few sub-adults were recorded in February. It is therefore suggested to declare the months of March until June as closed season in order to protect the breeding population of *B. marmorata* and prevent its depletion in the wild.

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Major References


The curious case of the missing RNA band: evidence of a gap deletion in giant clam 28S rRNA and its implications in studying non-model organisms

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Introduction

The increased accessibility of advanced and inexpensive sequencing technologies and bioinformatic tools have realized high-throughput RNA sequencing as an effective approach for studying non-model organisms, such as marine invertebrates. While it was formerly assumed that the benchmark for RNA quality assessment based on a 28S:18S ratio of 2 or higher is applicable to all organisms, observations of non-conforming RNA profiles in some groups have demonstrated that this is not usually the case.

Earlier studies in insects have documented a “hidden break,” now known as a gap deletion, in the 28S ribosomal RNA due to the deletion of a short stretch of nucleotides in its central domain, which causes the RNA strand to split equally into two fragments (28Sα and 28Sβ) when denatured [1]. In standard gel electrophoresis, this results in co-migration of the two fragments of 28S rRNA with the 18S rRNA, producing a single band, which can be misinterpreted as degraded RNA and therefore bias quality assessment.

Routine RNA work in giant clams led to the inadvertent observation of an RNA profile that appears to be like those reported in arthropods. Thus, it is hypothesized that the same gap deletion also occurs in giant clam 28S rRNA, especially since this phenomenon is believed to be ubiquitous in protostomes [1]. Here, we provide evidence of the gap deletion in giant clam 28S rRNA obtained from native, denaturing, and automated gel electrophoresis, PCR amplification, and sequence analyses. Furthermore, the tissue- and species-specificity of the gap deletion was examined by sampling from different tissues and giant clam species, respectively.

Materials and Methods

RNA extraction and Agarose Gel Electrophoresis

RNA from giant clam larval and tissue samples were extracted either by mirVana miRNA Isolation Kit (Thermo Fisher Scientific) or by Trizol reagent (Invitrogen), according to the manufacturers’ protocols. Tissue samples were ground in liquid nitrogen while larval samples were homogenized using plastic pestles before extraction. Extracted RNA was visualized on 1% agarose gel prepared in 1× TBE buffer. Samples were run at ~100 V for 30 minutes.

Denaturing Gel Electrophoresis and TapeStation Automated Electrophoresis

Denaturing agarose gels (1%) were prepared in 1× MOPS buffer. Formaldehyde was added to a final concentration of 0.7 M. RNA samples were denatured in GLB II (Invitrogen) at 65 °C for 5 mins and then immediately placed on ice. Samples were run at ~100 V for 30 mins. Total sponge RNA was used as a control. RNA integrity of
representative samples was also measured using TapeStation 2200 (Agilent Technologies).

Results and Discussion

Giant clams have non-conforming rRNA profiles

Routine RNA work in giant clams led to the observation of an RNA profile that appears to be similar with those reported in arthropods, in which the upper 28S band is fainter (or in some cases, totally absent) than the lower 18S rRNA band. Giant clam RNA extracts from larval (egg and trochophore) (Fig. 1A) and adult tissues (outer mantle, inner mantle, and gonad) (Fig. 1B) all exhibited similar rRNA migration pattern. This profile is observed in the mantle tissues of two other giant clam species, *T. crocea* (Fig. 1C) and *T. maxima* (Fig. 1D). In contrast, sponge RNA extracts exhibit the standard RNA profile with both 28S and 18S rRNA bands (Fig. 2A).

**Figure 1.** Native gel electrophoresis images showing the rRNA migration profiles of RNA samples from (A) *T. gigas* larvae, (B) *T. gigas* adult tissues, (C) *T. crocea* mantle tissues, and (D) *T. maxima* mantle tissues. (Trocho, trochophore; OM, outer mantle; IM, inner mantle; GN, gonad).

Heat denatures the giant clam 28S rRNA strand into two equally-sized fragments

The non-conforming RNA profile of giant clams can either be due to degradation caused by RNase contamination or by specific in vivo pre-rRNA processing. We hypothesize the latter, as supported by the increased intensity of the 18S band. This was further established by resolving the samples by electrophoresis on a denaturing formaldehyde agarose gel. Before the run, RNA was heated at 65°C to eliminate secondary structures. This step is also hypothesized to cleave the heat-sensitive 28S strand into two \[^1\]. The faint 28S rRNA band in the native gel electrophoresis of the giant clam samples (Fig. 2A) disappeared under denaturing gel electrophoresis conditions (Fig. 2B). Further analysis by TapeStation electrophoresis confirms the absence of the 28S rRNA band in giant clam RNA (Fig. 3A), revealing instead a single sharp 18S rRNA peak. This peak is assumed to be the combination of the 18S, 28S\(_{\alpha}\) and 28S\(_{\beta}\) rRNA strands. In contrast, control sponge RNA samples retained the same profile in both native and denaturing gel (Fig. 2A-B). The presence of both 28S and 18S rRNA peaks was also seen by TapeStation analysis (Fig. 3B). Further experiments are being done to map the deletion sites in the giant clam 28S rRNA.
Figure 2. (A) Native gel electrophoresis of total RNA from the sponge *Leucetta* sp. (lane 1 and 2) and *T. gigas* veligers (lane 3 and 4) demonstrate the non-conforming profile of giant clam RNA. (B) Denaturing gel electrophoresis results in the loss of the faint 28S rRNA band in the giant clam samples but not in the sponge samples.

Implications in studying non-model organisms

The RNA integrity number (RIN) of giant clam RNA remains high despite the absence of a 28S rRNA peak (Fig. 3A). This pattern can be clearly distinguished from the electropherogram profile of degraded RNA sample with low RIN (Fig. 3C). However, because of the lack of a 28S rRNA peak, high integrity samples fail the quality control standards set by sequencing facilities, which is based on the typical non-protostome RNA profile. Thus, a lack of awareness about the phenomenon of gap deletions in certain non-model organisms can result in delays and costly troubleshooting efforts following the intention of attaining a ‘standard’ RNA profile.

Figure 3. TapeStation electropherograms of total RNA. (A) The single sharp 18S rRNA peak in giant clam samples is hypothesized to be a combination of the 18S rRNA and the 28sa and 28Sβ rRNA fragments. The absence of a broad RNA peak between the 18S rRNA and the ladder peak to the left indicates good RNA quality. (B) Sponge RNA samples demonstrate a ‘standard’ RNA profile with a more intense 28S rRNA peak to the right of the 18S rRNA peak. (C) An example of a partially degraded giant clam RNA with a broad peak below the 18S rRNA peak indicative of RNA fragmentation.

Studies have revealed that gap deletion is a common occurrence in mollusks [3-7], as well as in other groups, including bacteria [8], protozoans [9], higher plant chloroplasts [10], fungi [11], and various other protostomes [12,13]. This suggests that invertebrate RNA
with apparently degraded RNA profiles may, in fact, be of high integrity. As such, the 28S:18S rRNA ratio of 2 or higher may not always be a reliable proxy to evaluate RNA quality [2].

Conclusion

This is the first report providing evidence on the 28S rRNA gap deletion in tridacnine bivalves, supporting the proposition that this phenomenon occurs more widely than previously thought. As high-throughput RNA sequencing is becoming a usual practice in answering biological and ecological questions, studies like this can help identify proxies for assessment of RNA integrity, such as the absence of smearing and the presence of a high intensity 18S rRNA band, for non-model organisms. These findings also provide insight into the evolution of pre-rRNA processing in eukaryotes.

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Major references


Examining connectivity of *Scylla olivacea* populations in the Sulu Sea basin: Larval dispersal modelling and genomic approaches

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Introduction

Connectivity of populations of marine organisms is largely driven by the combined influence of biophysical factors such as oceanographic circulation, habitat distribution, and life history characteristics, on dispersal across the seascape. Understanding the spatial scales and patterns of population connectivity provides important insight to support the design of spatially-explicit management and conservation interventions.

Methods

This study employs larval dispersal modelling combined with population genomic analysis to examine the influence of ocean surface circulation patterns and habitat distribution on connectivity of the orange mud crab, *Scylla olivacea* populations in the Sulu Sea basin. The dispersal model was carried out in the Connectivity Modelling System (CMS) using the Hybrid Coordinate Ocean Model (HYCOM), at 1/25° resolution with configured mangrove habitats (release and settlement) around the Sulu Sea basin, and parameterized based on characteristics of early life history (e.g. mortality rate and PLD) of *S. olivacea*. Genetic connectivity was examined by analyzing single nucleotide polymorphism (SNP) markers generated from reduced representation sequencing (double-digest RAD sequencing approach) of the *S. olivacea* genome. SNP markers were initially mined and processed using the *Stacks* (version 2.2) pipeline, with the minimum proportions of loci allowed across individuals set at 50% (-r option). SNP genotypes showing significant deviation (p < 0.001) from HWE, and with a low minor allele frequency (MAF < 5%), were removed in the dataset using *vcftools*. Global and pairwise *F*<sub>ST</sub> between all pairs of populations were calculated using the *varcomp.glob* and *pairwise.fst* tools of *hierfstat* package in R. Genetic diversity among sampled individuals were summarized and visualized using Principal Component Analysis (PCA), whereas Discriminant Analysis of Principal Components (DAPC) were used to assess the diversity between pre-defined groups. To further investigate population structure and probabilities of cluster membership, we perform the program *structure*, which is a model-based clustering method for estimating ancestry, and *Geneland* which uses georeferenced individual multilocus genotypes to detect number of populations and of the spatial location of genetic discontinuities between populations (Guillot et al., 2005).

Results and Discussion

Connectivity patterns estimated for larval dispersal simulations reveal that the Sulu Sea throughflow, a strong ocean surface current that enters through the Mindoro Strait and exits via the Sibutu Passage, strongly enhances population connectivity along the western boundary of the Sulu Sea basin, which extends from Palawan (North to South) down to the Sulu Archipelago (Tawi-Tawi). Moreover, the inflow of the strong westward current of the Bohol Sea Jet drives asymmetric larval dispersal across the Sulu Sea basin, with predominant influx of larval particles from populations along the eastern
boundary of the Sulu Sea basin. Large influx of larval particles across the Sulu Sea basin provides evidence of the long distance and pelagic duration of *S. olivacea* (Alberts-Hubatsch et al. 2016), and indicates potential basin-scale panmixia of *S. olivacea* populations in the Sulu Sea. The presence of cyclonic circulation features at the southern boundary of the Sulu Sea basin however, promotes the retention of planktonic larvae in the vicinity of natal sites, which results to the high self-recruitment observed in the Southern Palawan (Bataraza) and Sulu Archipelago (Tawi-Tawi) populations. High amount of self-recruit planktonic larvae due to hydrodynamic processes contributes to the growing evidence of larval retention even in ‘dispersive’ taxa (Spouaugle et al. 2002; Teske et al. 2016). However, even with potential panmixia across the basin, restricted gene flow (by means of oceanographic barrier, self-recruitment, etc.) may create fragmented or structured populations, which could have deleterious effects on populations (Méndez et al. 2011).

A total of 1,592 high-quality polymorphic genome-wide SNPs from 135 individuals obtained from 10 localities (4 – East Sulu Sea; 4 – West Sulu Sea; 2 – Outgroups) were used for population genomic analyses. Analysis of genetic differentiation revealed low but significant population structure among all populations ($F_{ST} = 0.0037; p < 0.05$), with calculated pairwise $F_{ST}$ values ranging from 0.0184 – 0.0389. However, model-based clustering using STRUCTURE was unable to detect population structure, where the most likely number of clusters was a single population ($K = 1$). Similar results were obtained after the Principal Component Analysis, which a single cluster consisting of all 135 individuals. On the other hand, initial analysis of population cluster membership using *Geneland* revealed 5 probable distinct clusters. The posterior probabilities estimated by *Geneland* showed that some populations from east and west of the Sulu Sea basin were clustered together, indicative of persisting gene flow across the Sulu Sea basin.

Conclusion

Combination of connectivity patterns estimated from the dispersal modelling and population genomics provides insight on the synergy offered by the integration of the two approaches in examining the influence of major ocean surface currents on population connectivity of *S. olivacea* in the Sulu Sea basin.

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References


*Rapid mangrove colonization at the mouth of a man-made river: a case study in the Jaro Floodway Iloilo, Philippines*
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Introduction

The construction of the Jaro Floodway was completed in 2011 with the goal to minimize the flooding in Iloilo City by diverting the floodwater from the Jaro River to the Iloilo Strait. It is 4.8 km long and 82 m wide and designed to protect the city against a 20-year return (Dodman et al., 2010). However, its construction may pose a threat to the nearby mangrove forest due to its large-scale anthropogenic disturbance (Figure 1). This research determined the change in area covered by mangrove before and after the construction of the Jaro Floodway using freely available high-resolution satellite images from Google Earth.

Materials and Methods

A grid with a 200 m spacing bounded by geographic coordinates 122.5836°E, 10.7487°N and 122.5982°E, 10.7361°N was created in Quantum Geographic Information System (QGIS) software. The grid served as a guide in downloading high resolution images from Google Earth for the years 2005, 2009, 2012, 2014, 2016 and 2018. The images were then mosaicked to create a high-resolution image for each of the given years. The mosaicked images were then hand-digitized in QGIS and classified into four thematic classes, namely, mangrove, fishpond, water, and infrastructure areas.

Historical maps were also available from the National Mapping and Resource Information Authority (NAMRIA) for the years 1953 and 1988 showing the mangrove cover in the study area. A map overlay analysis was then conducted to examine the environmental changes to which the changes in mangrove cover can be attributed.

Results and Discussion

The calculated mangrove cover before the floodway was completed is 8.98 and 9.35 ha for 2005 and 2009, respectively. Mangrove cover then rapidly increased in the succeeding years measuring 11.39 (2012), 16.60 (2014), 26.82 (2016), and 42.98 ha (2018) (Figure 2). The general increase in mangrove cover from 2012 is attributed to a combination of factors such as high sedimentation rate and mangrove planting efforts by the government. The mangrove planting activities were a result of a rehabilitation effort due to the presence of a nearby coal-fired power plant, the Panay Energy Development Corporation Coal Power Plant. However, its contribution to the overall increase in mangrove cover could not be quantified due to the lack of formal documentation on when the mangroves were planted, the exact location of mangrove
planting activities and the number of hectares that have already been planted. Despite this data gap, it is still apparent that sedimentation from the Jaro Floodway played a major in the increase of mangrove cover. Sedimentation has been closely related to the distribution of mangroves as seen in some of the megadeltas in the world (Woodroffe et al., 2016). The construction of the Jaro Floodway lead to the formation of a new delta on which the mangroves currently thrive. Sediment accretion resulted in the gradual shallowing of the water up to the optimal depth for mangroves and allowed the area to be more accessible to coastal managers. Sediment accretion also lead to a seaward movement of the coast that allowed the mangroves to colonize a large area. Historical maps from NAMRIA also showed that delta formation from 1953 to 1988 as a result of a westward shift of the river mouth of the Jaro River increased the mangrove cover from 7.01 to 43.83 ha (Figure 2).

Figure 1. A satellite image of the study area showing the nearby Panay Energy Development Corporation Coal Power Plant.
Conclusion

Mangrove cover increased after the Jaro Floodway was constructed. The increase is attributed to mangrove planting efforts and natural colonization of mangroves. The contribution of mangrove planting efforts could not be quantified due to the lack of formal documentation of government agencies. Sedimentation from the Jaro Floodway lead to the formation of a new delta that increased the area covered by mangroves from 9.35 (2005) to 42.98 ha (2018). Historical maps from NAMRIA also showed that mangrove cover increased from 7.01 (1953) to 43.83 ha (1988) as a result of a formation of a delta due to a westward shift of the river mouth of the Jaro River.

Major References


Movement patterns of black-spined sea urchin (Diadema setosum) in coral reef flats in Calatagan, Batangas

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Introduction

Diadematoids are sea urchins that usually inhabit shallow waters and are important grazers in the marine environment. They can consume 3.6%-10% of the daily seagrass production (Macia, 2000; Tertschnig, 1989), competing with other herbivores, and influence the interactions between algae and coral. The distribution of these invertebrates is affected by several interrelated factors such as larval supply, settlement success, survival, competition, predation, and movement (Dumont, Himmelman, & Russel, 2004). Thus, studying these factors that influence their population dynamics and coexistence with other species are of significance to reef ecology and fisheries management. (Mclanahan et al., 1996)

One major factor that affects sea urchin distribution is movement which in turn is influenced by the availability of food. Food availability has been shown to affect how far groups of sea urchin would move as they graze for food. Tertschnig (1989) found that sea urchins initially located at a seagrass bed where algae are more abundant travelled greater distances than sea urchin initially placed in a patch reef. Other factors like duration of night time and turbulence of the waters also affected the movement patterns of sea urchins when grazing (Tertschnig, 1989). Therefore, understanding the movement patterns of D. setosum is important in examining their spatial distribution, yet few studies have examined how starvation affects their movement.

This study aimed to examine the effects of starvation on the distance travelled and directionality of Diadema setosum. Based on previous observations that starved sea urchins graze more aggressively as the need to find food becomes more urgent, it was hypothesized that there will be an increased movement in starved Diadema compared to well-fed ones.

Materials and Methods

The study was conducted in the reef flat of Sitio Bulihan, Barangay Gulod, Calatagan, Batangas on October 13-14, 2018. A 10m by 10m plot was established on coral pavement perpendicular to the coast. Twenty adult (>5 cm) sea urchins were randomly collected and tagged using a small hook attached to a nylon string and flagging tape. Ten randomly selected urchins were deployed randomly on the coral pavement whereas the other 10 individuals were placed in holding tanks and starved for 16 hours prior to release. Each sea urchin was then observed for one hour and their positions recorded. Using ImageJ, the total distance and displacement covered of control and starved sea urchins were determined. These variables were then compared using Two-Way ANOVA.
On the other hand, to analyze the directionality of the sea urchin’s movement, several circular statistical tests were used. Rayleigh test of non-uniformity is used to determine whether there is directionality in the movement of sea urchins. Meanwhile, Watson test was used to determine whether the orientations of each group are significantly different.

Results and Discussion

*Diadema setosum* are omnivorous grazers and detritus feeders hence they influence the interaction between algae and coral. They are one of the most abundant sea urchins in the Indo-Pacific reefs yet the least studied, therefore this study aims to address the lack of available data on their movement patterns.

In the experiment, distance (Figure 1) and displacement travelled by control sea urchins (4.68 ± 1.75 m and 2.62 ± 0.78 m, respectively) did not differ from that of starved sea urchins (4.57 ± 0.96 m and 2.48 ± 0.70 m, respectively). This could be due to the circadian rhythm of sea urchins since *Diadema*, like many other sea urchin species, displays high nocturnal activity (Tuya, 2004). Nocturnal feeding behavior may reduce or avoid predation by fish. Hence, during the day, activity of sea urchins is limited. It is therefore recommended that further studies concerning movement patterns of *Diadema* should be conducted during the night in order to observe maximum activity especially in terms of feeding.

![Figure 1. Mean distance (± SD) travelled by adult (n = 10) *Diadema setosum* under control and starved conditions.](image)

On the other hand, Rayleigh test of uniformity showed that both control (p = 0.0069) and starved (p = 0.0089) sea urchins tend to travel towards the shore (east) where the water is shallower (Figure 2). Furthermore, Watson test showed that the direction of movement of both starved and well-fed sea urchins was the same (p > 0.10).
The Rayleigh test result is consistent with the findings of Dumont et al. (2004), where a significant directionality was observed in the movement of adult *Strongylocentrotus droebachiensis* in five out of six different plots, but orientation was random for each plot. However, another study by Lauzon-Guay et al. (2006) only showed directionality of *S. droebachiensis* movement in three out of nine trials. The differences of Rayleigh test results of the two studies mentioned and this study could be attributed to differences in local conditions (e.g. food, predators, weather, current), observational time scale, and number of trials with which the studies were conducted. In this study, the eastward direction of adult sea urchin movement corresponded to where the abundance of seagrass is located in the test site. Studies have shown that sea urchins could move in response to chemical stimuli resulting from the presence of food or predators (Dumont et al., 2004; Garnick, 1978). The general eastward movement could also be attributed to the tidal cycle when the test was conducted. It was found that the currents affect sea urchin displacement and directionality. Sea urchins would move towards downstream or upstream currents depending on the velocity of the current (Morse & Hunt, 2013).

**Conclusion**

Distance travelled by the sea urchins was the same for the two treatments since the time of the experiment may not have been the most ideal to detect any differences in their activity. However, the clear directionality of their movements differs from previous reports of random dispersal of other echinoids and suggests the possible influence of local environmental factors on *D. setosum* movements. Distribution of sea urchins is essential since it dictates the grazing pressure of individual species, which in turn, affects the other function of the reef such as its morphology, ecology, and diversity.

**Acknowledgements**

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Literature Cited


The status of groupers in the Philippines

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Introduction

One third of the world’s grouper species can be found in the Philippines. Functioning as apex predators, they are crucial in maintaining the balance of coral reef systems. However, most stocks have declined due to severe exploitation and habitat degradation. Yet, groupers are actively pursued more than ever since they have the highest market price among all reef fishes, with the Philippines being the top exporter in the global grouper trade. Because of the trade’s complexity and overfished state of the grouper stocks, no attempt has recently been done to update the state of the grouper stocks on a national level. This study identified spatial patterns on grouper assemblage, density and biomass, to capture the current status of the grouper stocks in the Philippines. This study also included protected sites to assess whether they have been effective as a management tool in facilitating recovery of the grouper stocks in the Philippines.

Materials and Methods

Forty-nine coastal municipalities in the Philippines were included in the study. A total of 537 transects were surveyed using underwater fish visual census in reef crests of 48 fished sites and 27 protected sites. Census included species, count and size, which was then converted to biomass.

Results and Discussion

A total of 1,972 grouper individuals comprised of 13 target species and 15 non-target species were recorded. However, only five non-target species comprise the bulk of the population. All target species contributed less than 2% of the population and have extremely discrete locations, mostly being seen in one to two sites only. The severe lack of other species, especially the naturally large, target species (> 60cm max TL), indicates losses in ecological function. Being left with few non-target species means limited competition and predation towards the small, cryptic fauna only. Consequently, they cannot impose these functions on relatively bigger fishes or those found in the water column, including lower trophic predators.

Mean grouper density of the Philippines is 2.62 ind/500m², with more than 50% of the sites having less than 2 ind/500m², including protected areas (Figure 1). Bulk of the grouper density were from the populations of the naturally small and non-target grouper species. Mean biomass of the Philippines is 181 g/500m², with 88% of the sites, including protected areas, having less than 300g/500m² (Figure 2). Biomass was flat and nearly indiscernible in all sites across the fishing pressure gradient, emphasizing that the current grouper stocks are not enough to provide sustainable incomes, let alone to be sufficient for daily consumption.
Protection through MPAs were proven to increase total grouper densities but for the small, non-target species only. Protection was also able to increase total grouper biomass of the small, non-target species and seem to increase the biomass of one large species, the peacock hind, *Cephalopholis argus*. However, promoting growth to *C. argus* is actually detrimental since it is extremely voracious and predates on fish larvae, juveniles and adult fishes including other grouper species. Therefore, it may actually impede recruitment of not just the groupers but other faunal species inside the MPAs as well. Protected sites were not able to increase species richness nor serve as sanctuary for IUCN Red listed grouper species, since they these species were actually seen in fished sites. These results towards protection were mostly due to the fact that MPAs surveyed were small in size, ineffectively managed, and have young ages to show immediate signs of benefits.

A principal component analysis showed that all sites clustered at the middle towards the negative axes of species richness, density and biomass, indicating that regardless of protection or fishing pressure, the Philippine generally has a disrupted grouper community, and therefore, disrupted stocks (Figure 3). Compared to the Great Barrier Reef, Seychelles and nations in the Caribbean, all resulting density and biomass values of the Philippines were excessively low. However, compared to Hong Kong which is the center and largest player in the global live grouper trade, the grouper richness, density and biomass of the Philippines remains relatively higher.

Conclusion

In conclusion, grouper stocks in the Philippines are already disrupted. However, the Philippines still have the propensity to maintain and facilitate recovery of its stocks, since there are still occurrences of many target species being present in selected sites. We strongly advise the sites engaging in the live grouper trade and grouper seed fisheries be identified and monitored to ensure that all activities are sustainable. Stock assessments should also be done for the target species so that catch regulations and control measures can be put in place. These can include size catch limits, fishery closures and protection of critical habitats such as mangrove nurseries. Management of MPAs should also be strengthened so that MPAs are ensured to function well. But to make recovery faster, developing technology for restocking and aquaculture of groupers should be prioritized in the Philippines.

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Figure 1. Mean grouper density ± SE (ind/500m²) per site, arranged according to increasing fishing pressure. Patterns indicate portion of each size category ( - small-sized, □ - medium-sized, - large-sized). Colors indicate status relative to the national mean (● – above, (●) – within or (●) – below). Mean total density for the Philippines marked as gray bar.
Figure 2. Mean grouper biomass ± SE (g/500m²) per site, arranged according to increasing fishing pressure. Patterns indicate size category (□ - small-sized, □ - medium-sized, □ - large-sized). Colors indicate status relative to the national mean (● – above, ● – within or ● – below). Mean total biomass for the Philippines marked as gray bar.
Figure 3. PCA plot showing ordination of sites based on grouper species richness, density and biomass. Sites are coded based on fishing pressure level and protections status. (A) without site labels, (B) with site labels
First report of highly branched isoprenoids produced by marine diatoms in tropical waters

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Introduction

Highly branched isoprenoids (HBIs) are unsaturated hydrocarbons ubiquitous in marine waters, hence, are used as geochemical markers [10]. They occur as either 25- or 30-carbon isomers (C\textsubscript{25} and C\textsubscript{30}, respectively). Aside from their possible use as biofuels, some C\textsubscript{25} HBI isomers were reported to have cytostatic effects on lung cancer cells, \textit{in vitro} [9], indicating its potential use in the field of medicine. Although C\textsubscript{25} and C\textsubscript{30} HBIs are widely distributed, studies about the occurrence of HBIs produced by diatoms were limited to temperate regions [8] [7] [5] [11] [9] [1] [2].

Even though these compounds are ubiquitously present in marine sediments, only a few species of diatoms have been documented to synthesize these. To date, the only diatom genera known to be producers of HBIs are \textit{Haslea}, \textit{Pleurosigma}, and \textit{Rhizosolenia} [12] [1] [6] [3] [2].

Materials and Methods

Water sampling and storage

Water samples were collected from three different sampling sites- Ajuy, Fort San Pedro, and Ortiz Port in Iloilo. The sampling was done during high tide using a plankton net (30 \textmu M mesh). The net was towed 7-10 times over approximately 2 meters. In each sampling site, collected sediments and plankton where concentrated to 500 ml. The water samples were stored in a refrigerator at 11°C prior to analysis.

Identification of different diatom species

Water samples were assessed under a compound microscope using a plankton counting chamber. Different diatoms observed were photographically documented and identification was done down to the genus level.

Hydrocarbon Analysis of water samples

Analysis of hydrocarbon composition and identification of tentative HBI isomers were done following the methods of Ferriols et al. (2016, 2017).

Hydrocarbon extraction

The crude lipid fractions were obtained from the filtered samples of the different water samples collected on GF/C filters by extracting with 10 ml of acetone three times. The crude extracts (~30 ml) were combined and evaporated to dryness under reduced pressure. The residue was re-dissolved in 1 ml of n-hexane and subjected to silica gel open column chromatography (1.5 cm ID x 3 cm L) and eluted with three column volumes of n-hexane as the mobile phase to separate hydrocarbons from other lipid components in the crude lipid extract. The resulting hydrocarbon fraction was
subsequently concentrated to ~200 μl under pressure and a 2.5 μl portion was subjected to GC/MS analysis.

**GC/MS analysis of hydrocarbon extracts**

Hydrocarbon extracts were analyzed by gas chromatography/mass spectrometry on a Shimadzu QP-2010 Ultra GC/MS system with a 60-m x 0.25-mm x 0.25 μm 1MS column. The temperature program for analysis followed that detailed by Ferriols (2016). The temperature of the injection port was set at 260°C and injection volume was 2.5 μl for hydrocarbon extracts.

Identification of algal hydrocarbons was based on Kovat’s retention indices and mass spectra of previously characterized HBIs (Ferriols, 2016).

**Result and Discussion**

The gas chromatograms exhibited a range of peaks indicating the possible presence of hydrocarbons of interest, namely HBIs. The peaks at retention times (RT) of 23.415 and 24.25 minutes showed presence of parent ions at m/z 346, indicating that two C<sub>25</sub> trienes (C<sub>25:3</sub>) were potentially present. Peaks at RT of 24.01 minutes showed presence of parent ions at m/z 344, suggested the occurrence of a C<sub>25</sub> tetraene (C<sub>25:4</sub>) isomer. Finally, a peak at RT of 25.63 minutes exhibited a parent ion at m/z 342 suggesting the presence of C<sub>25</sub> pentaene (C<sub>25:5</sub>). These alkenes were detected in all samples.

To identify their corresponding structures, the mass spectral data of the C<sub>25</sub> HBIs were compared to previously reported data [3] [1]. Two acyclic C<sub>25:3</sub> were detected with retention indices (RI) of 2044 and 2092 in all water samples. The HBI isomer with RI 2044 was similar to the RI of a C<sub>25:3</sub> isomer from *R. setigera* [3] with a RI of 2043 and to the RI of a similar C<sub>25:3</sub> isomer from *P. intermedium* [1], with a RI of 2042. Despite slight differences in the ion frequency of the HBIs from the water samples to the HBIs from the *R. setigera* and *P. intermedium*, the overall ion fragmentation pattern suggests the HBI structure identified for this isomer was the same, which was an acyclic C<sub>25:3</sub> containing double bonds at C<sub>7</sub>-C<sub>20</sub>, C<sub>9</sub>-C<sub>10</sub>, and C<sub>23</sub>-C<sub>24</sub>.

Another C<sub>25:3</sub> detected has a RI of 2092. Currently, there are no studies that have documented a similar RI that can be used as basis in identifying the possible structure of this HBI. Despite the difference in the RI, characteristic parent ions at m/z 346 were still present in the mass spectra, indicating that the HBI could still be tentatively assigned as a C<sub>25:3</sub> HBI.

Another HBI was a C<sub>25:4</sub> with a RI of 2081. Previous studies [3] [1] detected a C<sub>25:4</sub> with a RI of 2074, which was the nearest RI to the putative C<sub>25:4</sub> detected in the current water samples. The putative C<sub>25:4</sub> appears to be an undocumented HBI tetraene given that no studies have reported a HBI with similar RI.

The C<sub>25</sub> pentaene observed in this study with a RI of 2162 was compared to one of the C<sub>25:5</sub> HBIs detected in previous experiments with RIs of 2160 [3] and 2159 [1]. The studies confirmed the presence of an acyclic C<sub>25:5</sub> containing double bonds at C<sub>2</sub>-C<sub>3</sub>, C<sub>7</sub>-C<sub>20</sub>, C<sub>9</sub>-C<sub>10</sub>, C<sub>13</sub>-C<sub>14</sub> and C<sub>23</sub>-C<sub>24</sub>. Similar mass spectral patterns strongly suggest
that the $\text{C}_{25:5}$ detected is the same as those identified in the previous studies mentioned.

Previous studies demonstrated that diatoms are the biological source of HBIs, however, only a few species are capable of synthesizing $\text{C}_{25}$ and $\text{C}_{30}$ alkenes. *Haslea* spp, *Pleurosigma* spp., and *Rhizosolenia* spp.\textsuperscript{[12] [1] [6] [3] [2]} are currently the only diatoms identified as HBI producers. Since $\text{C}_{25}$ alkenes were present in all water samples, their most probable source could be the species of diatoms that were common in all samples. Given that *Pleurosigma* and *Rhizosolenia* were HBI synthesizing diatoms common in all the water samples, the presence of the four $\text{C}_{25}$ alkenes could be attributed to the occurrence of these genera.

Conclusion

Four $\text{C}_{25}$ HBIs were detected in the water samples. Out of the four HBIs, two are believed to be unidentified HBI isomers. With this, it indicates that diatoms that produce HBIs thrive not only in temperate waters but in tropical waters as well. The presence of the HBIs in the water samples are likely due to the presence of *Rhizosolenia* and other species of diatoms that could be new sources of HBIs that have not yet been documented. Other than *Rhizosolenia*, *Pleurosigma normanii* which was observed in all the water samples could be a potential source of HBIs.
Figure 1. Mass Spectra of HBIs from Ajuy water sample.
Figure 2. Mass Spectra of HBIs from Ortiz Port water sample.
Figure 3. Mass Spectra of HBIs from San Pedro water sample.
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References


**Sponge holobionts: Not all winners?**

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Introduction

The ocean has taken up about 30% of the total emitted anthropogenic carbon dioxide since the industrial revolution, leading to an increase in marine inorganic carbon concentration, reduced pH, and decreased CaCO$_3$ saturation state through the process termed as ocean acidification (Veron, 2011; Le Quéré et al., 2015). This global phenomenon is exacerbated by other emerging global and local stressors, such as the anomalous rise of sea surface temperature and eutrophication (Lapointe and Mallin, 2011; Pandolfi et al., 2011). The synergistic impact of these perturbations has been shown to induce major changes in community composition and has affected a multitude of organismal processes in reefs (Kroeker et al., 2010; Gatuso and Hansson, 2011; Veron, 2011).

Under future ocean conditions, sponges (Porifera) are predicted to be winners on the reef because of their diverse symbiotic microbiomes and rich gene repertoire, which confer exceptional ecological adaptability and plasticity (Bell et al. 2018; Pita et al. 2018). Studies to date have shown that some sponges are able to tolerate ocean acidification, others are susceptible to elevated seawater temperature, and some exhibit a positive response to the combined effects of acidification and warming (Goodwin et al. 2014; Bennett et al. 2017; Bell et al. 2018; Ramsby et al. 2018). However, these studies have been done on a limited set of sponge species and little is known about how different sponge types and their associated microbiomes may be affected by environmental perturbations. This study aims to understand the potential role of the associated sponge microbial community on the stress response of calcareous or siliceous sponge holobionts under ocean warming and acidification scenarios. The findings of this study suggest that not all Poriferans may be able to tolerate future ocean conditions.

Materials and Methods

Sample collection

Six *Leucetta chagosensis* (calcareous) and six *Petrosia* sp. (siliceous) individuals were collected from Bolinao-Anda Reef Complex, Pangasinan. Each individual was fragmented to 13 clones, and allowed to heal for 30 days. Identities of sponges were determined based on morphology (Hooper and Van Soest, 2002; Zea et al., 2009) and 28S rDNA analysis (Chombard et al., 1998).

Stress response experiments

Stress response experiments were conducted in independently aerated 10L aquaria with flow-through seawater. Temperatures were regulated using submersible heaters, levels of injected CO$_2$ were manipulated using a mass flow controller, and illumination
was provided by LED lamps following a 12:12 light:dark photoperiod. After seven days of acclimation, seawater temperature in the tanks was raised by 1.0°C/day and pH was lowered until the target temperatures and pH were achieved (Fig. 2). Conditions were designed to simulate the present day and predicted 2100 RCP 6.0 and 8.5 scenarios. Treatment conditions include (1) pH 8.0, 28°C (Present Day), (2) pH 7.6, 28°C (RCP 8.5 pH), (3) pH 8.0, 30°C (RCP 6.0 temp), (4) pH 8.0, 32°C (RCP 8.5 temp), (5) pH 8.0, 32°C (RCP 8.5 temp), (6) pH 7.8, 30°C (RCP 6.0 pH + temp), and (7) pH 7.6, 32°C (RCP 8.5 pH + temp). Each treatment was represented by four independent replicate aquaria containing three calcareous and three siliceous sponge clones. During the experiment, water parameters were monitored using light and temperature loggers, pH meter, and multiparameter meter.

Morphological responses, bacterial community shifts and survivorship

Sponges were subjected to experimental conditions for three days. Morphological changes and survival at the different treatments were observed. At the end of the experiment, all surviving sponges were flash frozen in liquid nitrogen for transport and stored in ultralow freezer until use. Total DNA was extracted from sponge tissues using DNeasy PowerSoil kit (Qiagen). The V3 hypervariable region of the 16S rRNA gene was amplified using 357F with GC clamp and 518R primers. Amplicons were resolved on a 30-60% denaturing gradient gel run at 60 V for 16 hrs. Shifts in bacterial communities were visualized in an NMDS map generated from binary values of presence or absence of ribotypes based on DGGE profiles.

Results and Discussion

Elevated temperature and combinations of acidification and warming caused minimal morphological changes in the siliceous sponge, *Petrosia* sp. (Fig. 1A). The sponge also exhibited high tolerance to stress conditions, with 97% of the colonies surviving 3 days of sustained exposure to pH 7.6 in combination with 32°C (Fig. 2C).

The calcareous sponge, *L. chagosensis*, also showed no apparent tissue changes under the treatment combinations of pH 7.6 and 28°C or pH 8.0 and 30°C (Fig. 1B). Survival was 100% under these conditions (Fig. 2D). However, exposure to pH 7.6 in combination with 30°C, or 32°C in combination with either pH 7.6 or 8.0, resulted in visible tissue necrosis, disintegration, and mortality (Fig. 1B). In the 32°C treatments, only 25% of the colonies survived after three days of exposure (Fig. 2D). Both sponges exhibited detrimental effects of high temperature, although this was more apparent in the calcareous species. The calcareous species was also more vulnerable to lowered pH levels. This may be due to its reduced capacity for acid-base regulation and the reduced integrity of calcified structures under acidified seawater conditions (Goodwin et al., 2013; Smith et al., 2013; Bell et al., 2013; Enochs et al., 2015).
Fig. 1. Response of sponges to stress. Siliceous (A) and calcareous (B) sponge fragments exhibit different responses to pH and temperature combinations after three days of exposure. Scale bars indicate 0.5 cm.

The two sponge species are associated with very different microbial communities (Fig. 3A, B). This marked disparity in the bacterial assemblage of may contribute to the differential survival of the two sponge types. Prokaryotes with GC-rich ribotypes, which are found in the *Petrosia* microbiome, have been shown to correlate with a broader tolerance range and higher temperature optimum (Musto et al., 2006; Mann and Chen, 2010). On the other hand, the calcareous sponge community appears to consist of less GC-rich ribotypes (Fig. 3A, B). The microbial community in the calcareous sponge exhibits a shift under elevated temperature conditions (Fig. 3C), resulting in a very different community than in the normal sponge (Fig. 3D). This disruption may be an indication that host health is compromised. Under these conditions, proliferation of opportunistic microorganisms may cause tissue necrosis and mortality in the sponge.

Conclusion

We have demonstrated that different sponge groups are differentially affected by warming and acidification. Although, temperature appeared to have a greater detrimental effect to both species. In the calcareous sponge, elevated temperature resulted in tissue necrosis and death, accompanied by an obvious change in the sponge microbial community. Stability of bacterial community structure may be one of the contributing factors to the maintenance of holobiont homeostasis and functioning. However, additional analysis, such as evaluation of taxonomic diversity and functional contributions of the microbial community, will provide better insights into their roles in the holobiont stress response. The findings of this study suggest that not all sponges may be able to tolerate future ocean conditions, emphasizing the need for more studies on this diverse group of organisms.
Fig. 2. Survival of sponge fragments subjected to different conditions. Temperature (A) and pH (B) profiles measured during experimental ramping and exposure. Survival
of siliceous (C) and calcareous (D) sponges differ after 3 days of sustained exposure to stress conditions.

**Fig. 3.** Sponge associated microbial communities. The siliceous sponge, *Petrosia* sp. (orange) and the calcareous sponge, *L. chagosensis*, exhibit different microbial communities as revealed by 16S DGGE profiles (A) and NMDS analysis (B). Microbial community changes observed in *L. chagosensis* subjected to 28°C (black), 30°C (blue), and 32°C (red) (C-D).

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Major references


**Size at the onset of sexual maturity and fecundity of Favites abdita**

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Introduction

Scleractinian corals are framework species of reef systems (Harrison 2011; Graham and Nash 2013). These marine invertebrates enhance structural complexity of marine ecosystems, often leading to higher diversity and abundance of reef-associated organisms (Sheppard et al. 2009). One way to ensure its maintenance and survival is through having enough gametes for successful reproduction (Szmant 1986; Hall and Hughes 1996; Sakai 1998a; Sakai 1998b).

Corals have polyps that reproduce either asexually through propagation of fragments, or sexually through broadcast spawning or brooding (Harrison 2011). However, prior to sexual maturation of corals is the juvenile stage. Juveniles are coral colonies with a longest diameter of less than 4 cm and are sexually immature (Bak and Engel 1979; Soong 1991; Edmunds 2007). Therefore, colony size is a factor affecting corals’ reproductive ability, as growth consumes greater energy during the early life stage of a coral.

Here, we examined the presence of gametes and its corresponding fecundity at maturity of *Favites abdita* across different size classes found in the reef. The results of this study will be useful in understanding their population dynamics, their ability to help restore and maintain their populations in the reefs (Hughes and Jackson 1980, 1985).

Materials and Methods

Sample collection

Encrusting and sub-massive source colonies across different size classes were chosen haphazardly at 2-5 m depth in Anda, Pangasinan. Fragments (1-5 cm) were collected from the center of the colony last April 2018 prior to the spawning of the *F. abdita* (May) and were stored separately in a pre-labeled resealable plastic bag with seawater.

Fixation and decalcification

Processes for fixation and decalcification were based on the procedures of Glynn et al. (1991) and Szmant-Froelich et al. (1980). Each of the coral samples were placed in separate jars fixed with Zenker’s solution for 24 hours. Samples were then rinsed with running seawater for an hour and were preserved with 70% ethanol.

Dissection and histological examination

Decalcified samples were dissected on a petri dish using fine needles under a dissecting microscope. Total oocytes per polyp was noted, 10 of which were measured of their maximum diameter (*D*1) and the maximum perpendicular diameter (*D*2) to solve for the geometric mean diameter (GMD = \(\sqrt{D1 \times D2}\)) using the Motic software version 3.0 (Vicentuan 2009; Maboloc et al. 2016). Since most of the oocytes are
nearly spherical in shape, oocyte volume (V) was estimated using the formula
\[ V = \frac{4}{3} \pi r^3 \] where \( r = \frac{1}{2} GMD \). The total volume of oocyte per polyp was computed by multiplying the mean oocyte number per polyp to the mean oocyte volume (Vicentuan 2009). Total egg count and total egg volume per polyp are the values used to quantify coral fecundity.

The remaining samples were processed, and histological slides were prepared. Samples were examined using a compound light microscope to determine stage of the oocytes based on the description of Szmant-Froelich et al. (1980).

Results and Discussion

*Favites abdita* colony with <2 cm diameter was found to be the smallest recorded sexually mature colony with mean oocyte count of 17 eggs per polyp and mean oocyte GMD of 468 µm. In the previous years, *F. abdita* colonies with 4 cm diameter were found gravid (Baria et al. unpublished). With this, previous definition of coral juvenile characteristics and size might be an over-estimate.

Thirty-nine percent (39%) of the total samples (n=31) have oocytes with highest mean count of 267 eggs per polyp found at size classes between 4 and 6 cm. Mean oocyte GMD of 381 µm across all size classes was observed. Effects of colony size to its fecundity varies among different species. Generally, small colonies have lower relative volume of gametes (Sakai 1998; Kai and Sakai 2008). Moreover, larger colonies have and could allocate more energy to reproduction since eggs are lipid-rich and are energetically costly. Although smaller colonies (<2 cm) can already add to the reef’s larval pool, bigger colonies (>4 cm) can contribute better. Peak oocyte count observed from *F. abdita* colonies >4 cm was less than those observed from much bigger colonies (23 cm) with 478 eggs per polyp (Maboloc et al. 2015). In addition, mean oocyte GMD across different size classes was also smaller than previously reported size of 428 µm (Maboloc et al. 2015). Although mean oocyte GMD differs from the previous study, stage III (Figure 1) were both observed for April samples.

![Figure 1. Stage III oocytes sampled in April. O; oocyte, scale bar; 500 µm.](image)

*Favites abdita* is a broadcasting encrusting, sub-massive to massive coral. Species having massive life form and slower growth rate conveys a greater chance of long-
term survival (Szmant 1986; Hall and Hughes 1996; Sakai 1998). However, corals with faster growth rates such as Acropora hyacinthus and Acropora nana have bigger eggs as the colonies grow (Hall and Hughes 1996). While this was not true for $S$. pistillata (brooder), planulae count per polyp increased proportionally with colony size instead (Hall and Hughes 1996). In addition, smaller eggs produced by brooders were found to be advantageous as it enhances the safe internal fertilization and the succeeding developmental processes. In contrast, smaller eggs produced by broadcasters have lower chances of surviving (Hall and Hughes 1996). With these, size at the onset of sexual maturity of $F$. abdita is worth looking into as they may guide in determining when do colonies start to help reproduce and restore the population.

Conclusion

In conclusion, $F$. abdita starts to reproduce at <2 cm with lesser oocyte count and GMD. This supports previous knowledge that smaller colonies have lower fecundities (Kojis 1982). However, it is recommended to add more samples in future works to have further insights on the oocyte count and GMD across different size classes. Results of this study is useful in understanding their population dynamics and their ability to help restore and maintain their populations in the reefs as small colonies can already contribute to the larval supply. Ultimately, these findings showed that coral juvenile size of ≤ 4 cm is an underestimate.

Acknowledgements

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Clonal structure and genetic connectivity of the scleractinian Pocillopora acuta in the Bolinao-Anda reef system

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Introduction

The Pocillopora damicornis species complex is an ecologically important reef-building coral that distinctively employs mixed sexual and asexual modes of reproduction (e.g., colony fragmentation, broadcast spawning, parthenogenetic and sexual planula larvae), which are hypothesized to contribute to its dispersal ranges, adaptive capacity, and resilience. Throughout its geographic distribution, P. damicornis exhibits marked variability in reproductive strategies and population structuring, leading us to explore reproductive patterns and their potential influence on genetic differentiation in Philippine populations. This study examined the clonal richness and genetic structure of P. acuta (P. damicornis Type β) populations in the Bolinao-Anda reef system, an ecologically critical and economically important site in the northwestern Philippines.

Materials and Methods

Using 14 polymorphic microsatellite loci (Magalon et al. 2004, Starger et al. 2008, Torda et al. 2013), this study characterized clonal richness, genetic structure, and connectivity of P. acuta (n = 392) populations near-exhaustively sampled from four 10 m x 40 m quadrats in the Bolinao-Anda reef system, with each site 5–10 km apart. An outgroup population from Gonzaga, Cagayan (n = 33) was also evaluated. Fine-scale (quadrat scale) clonal structure was assessed using GenClone 2.0 (Arnaud-Haond and Belkhir 2007). Genetic differentiation among the four Bolinao-Anda and one outgroup population was estimated using three approaches: summary statistics (Fst; Weir and Cockerham 1984) and principal analysis of coordinates, Bayesian model-based individual assignment tests (STRUCTURE, Geneland; Pritchard et al. 2000, Evanno 2005, Guillot et al. 2005), and multivariate analysis through discriminant analysis of principal components (DAPC, Jombart et al. 2010). Hypotheses of population structuring were tested using analysis of molecular variance (AMOVA; Excoffier et al. 1992). Directional gene flow between sampled populations was explored in DivMigrate online using a GST-based relative migration network (Sundqvist et al. 2016).

Results and Discussion

Fine-scale observations show differential quantities of clonal colonies, several multi-locus genotypes (MLGs) shared across the reef system, and the abundance of singly represented MLGs within each site, corroborating the contribution of both parthenogenetic and probably sexual P. acuta larvae to Bolinao-Anda recruits. Site variability in genotypic heterogeneity (clonal richness, Shannon diversity) in correlation with colony sizes and a presumed gradient of wave energy across the four sites supports the progressive ontogenetic shift towards asexual reproduction in Pocillopora spp and the potential role of disturbance to genetic diversity.
Hierarchical tests of model-based individual assignment and other statistical tools (PCoA, DAPC, AMOVA) consistently and significantly differentiated the outgroup and Bolinao-Anda populations with lower genotypic heterogeneity. The levels and spatial patterns of population differentiation support the evolutionary paradigm of organisms with mixed reproductive strategies that asexual propagules (here more detected in mature populations) tend to recruit locally and favor the expansion of successful genotypes while genetic mixing is observed among younger populations found in naturally disturbed reefs, probably to produce more genetic novelty and ecological adaptability.

Directional connectivity showed high albeit asymmetric levels of connectivity within Bolinao-Anda, with the distal and differentiated populations serving more as likely demographic and genetic sources to the medial and mixed cluster.

Conclusion

In a relatively small domain such as the Bolinao-Anda reef system, this study characterized patterns of diversity, population differentiation, and gene flow, which serve as the basis for resilience-based spatial planning of coastal resource management. By assessing genetically identified *P. acuta* samples, this study provides insights on reproduction and larval dispersal not confounded by incorrect species identification (Torres and Ravago-Gotanco 2018). The gene flow and variability in genetic diversity observed among the reef sites of this study are speculated to have contributed to the resilience of the highly disturbed Bolinao-Anda region: differentiated sites offer demographic supply, mixed sites provide genetic diversity, and all sites are linked through interconnectivity. These patterns of functional genetic diversity, if maintained with protection, could serve as a good model resilient metapopulation and provide substantiation for implementing more integrative and comprehensive management approaches.

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Major references


Characterizing the vertical phytoplankton distribution in the Philippine Sea
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Introduction

Tropical waters are generally stable with quasi-permanent stratification. The typical tropical structure profile consists of a subsurface chlorophyll maximum (SCM) that coincides with the thermocline and nutricline where the balance of light and nutrients are ideal (Herbland and Voituirez 1979, Mann & Lazier 2013, Cullen and Eppley 1981). At the SCM, chlorophyll fluorescence is at the maximum, with primary production reaching its peak generally above the SCM. While there is a multitude of papers that describe the SCM structure, there is limited contributions describing their mechanisms within tropical regions. In the Philippines, intricate bathymetry coupled with a monsoon climate and high exposure to tropical cyclones creates a complex pelagic ecosystem. Gordon et al. (2014) conducted two in-depth oceanographic cruises in 2011 and 2012 and recorded the nascent Kuroshio Current enclosed by an anticyclonic eddy in the northeast and a cyclonic eddy to its southwest. Moreover, they observed a shift from subtropical to tropical stratification regimes between the two cruises. Several studies have examined phytoplankton distributions in Philippines seas (Penaflor et al 2007, Alabia 2009, Villanoy et al 2011, Cabrera et al. 2015), but mechanistic understanding of phytoplankton distributions remains rudimentary. The main objectives of this study were to (1) identify characteristic chlorophyll profiles in the Philippine Sea, (2) identify phytoplankton assemblages in relation to the chlorophyll distribution and (3) determine the physico-chemical parameters that may influence the observed profiles.

Methods

This study examines the SCM in the Philippine Sea, utilizing empirical phytoplankton data from two oceanographic cruises conducted northeast of the island of Luzon in May/June 2011 and April/May 2012. Physical parameters (temperature [Temp], salinity [Sal], dissolved oxygen [DO], beam attenuation [BAT]) and chlorophyll [Chl] profiles were acquired using a Seabird 19-CTD during two cruise while water samples were collected separately for phytoplankton identification and enumeration, and for nutrient analysis. We followed Fortuna and Maturo’s approach (2018) on functional k-means clustering based on the semi-metric distance between functional components to scrutinize the chlorophyll profiles taking into consideration individual profiles that can be represented as functional data with reference to depth. Phytoplankton data were averaged to derive the mean abundances of the clusters and community structure was calculated in terms of species richness for comparisons of the clusters. A correlation analysis between the standardized Chl concentrations at the surface and the SCM and physico-chemical parameters, including derived values of the Brunt-Vaisala Frequency (BVF) was done to help explain the observed distributions.

Results and Discussion
In 2011, the mean SCM depth was 100 m with mean SCM concentration of 0.3 μg/L while in 2012, mean SCM was deeper at 120 m and mean SCM concentration of 0.2 μg/L. Functional principal component analysis showed that the first principal component (PC) explained variability in the SCM depth, the second PC showed variability in the magnitude of the SCM concentration while the third PC accounted for the presence of multiple peaks. K-means clustering using the principal components resulted in three clusters which represented the offshore stations with the deepest SCM, stations within an observed cyclonic eddy with intermediate SCM and stations with shelf or coastal upwelling showing shallow SCM (Fig. 1). Diatoms were dominant in all clusters at both the surface and SCM depth, except at the SCM of the offshore cluster in 2011 which was dominated by the cyanobacteria, *Trichodesmium*. This N2-fixing organism is considered to be representative of the intrusion of the Kuroshio recirculation gyre. Correlation analyses between Chl and physico-chemical parameters showed that Chl was negatively correlated to beam attenuation, a bio-optical property that has been used as an alternative proxy for phytoplankton. This suggests that the observed SCMs represent actual increase in phytoplankton biomass. When the influence of the Kuroshio recirculation gyre was dominant in 2011, temperature was found to be a driving factor for chlorophyll in surface waters. In 2012, highly saline waters from the tropical North Equatorial Current (NEC) waters appeared to influence the Chl distribution, particularly at the SCM. These results corroborate the findings of Gordon et al. (2014) and Cabrera et al. (2015) where they observed changes in the oceanic circulation from subtropical North Pacific water in 2011 to tropical NEC water in 2012.

Conclusion

Our paper provides the first report on the phytoplankton communities from offshore to nearshore of the Philippine Sea located northeast of Luzon in two different years. Vertical phytoplankton profiles and community structure can be explained by the variations in oceanographic features and conditions across space within a year as well as the changes between 2011 and 2012.

Acknowledgments

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Fig. 1 Clusters formed from k-means clustering using principal components in (a) 2011 and (c) 2012 with mean Chl profiles of each cluster for (b) 2011 and (d) 2012.
Qualitative Assessment of Microplastics in Cultured Oysters in Anda, Pangasinan

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Introduction

Plastics are popular due to several properties such as weight, strength and cost and use of plastics is in near inexhaustible applications. Plastic production has continuously increased from the time it was discovered until this day. However, due to the durability of plastics, they persist and accumulate in marine habitats, accounting for up to 90% of all marine debris. Suffocation, entanglement in nets, ingestion and death of marine mammals, sea birds and turtles have been well documented. Plastic pollution is a global problem because of the improper waste disposal and degradation of this compounds takes several years. Negative impacts of plastics in marine environment are being recognized and require further mitigation to solve the problem. In recent years, research have been focused on microplastic contamination because of its alarming increase in marine biota. Microplastics are the products of the degradation of larger plastic items into smaller fragments. Sources of microplastics include, but not limited to, cosmetics, clothing, and industrial processes.

This study aims to investigate the presence of microplastics in cultured oysters in Anda, Pangasinan where aquaculture production is intensified. Bivalves such as oysters have been good marine pollution indicators because of their ability to filter water and their presence or absence can be an indication of imbalance in the aquatic environment.

Materials and Methods

This study used 1M sodium hydroxide (NaOH) as a digesting agent. Three oyster tissues were cut in small pieces and placed in Erlenmeyer flask with 100 ml NaOH and a magnetic bar was placed to ensure mechanical mixing. This procedure was replicated four times. Then, it was placed in a hot plate at 60°C for 4 hours in the laboratory hood. Then it was left in the refrigerator for 24 hours for further digestion. Digested samples were then filtered using a vacuum pump and 0.2 µm nylon filter paper. However, during filtration some samples were difficult to digest so a Whatman Filter Paper Grade 1 (11-micron pore size) was used. Filters were placed in a petri plate then oven dried for 2h at 40°C while filtrate or liquid was discarded. Filters were inspected for the presence of microplastics using an Olympus Stereomicroscope (S761 model).

Results and Discussion

Microplastic fiber and fragment were detected in cultured Crassostrea iredalei from Anda, Pangasinan. However, no microplastic pellet were detected. Microplastic fiber were colored blue and black while fragments were brownish and bluish. Due to the rigorous precautions adopted while handling and processing the samples, contamination with (airborne) microplastics was successfully prevented. Indeed, the procedural blanks were completely free of any form of contamination, both fiber- and
Particle-shaped. Particles were identified as microplastics based on their size (<5mm), lack of organic or cellular structures, lack of mineral or glass-like characteristics, homogenous color, presence of fraying and equal thickness throughout their length for fiber-like particles.

Conclusion

This preliminary study confirms microplastic fiber and pellets may be present in cultured oysters, suggesting potential plastic pollution problem in Anda, Pangasinan.

Marine biofilm development under different reef conditions and effects on coral larval settlement

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INTRODUCTION

Settlement and metamorphosis are tightly coupled processes in which the planktonic coral larva attaches to the substratum and undergoes developmental changes wherein it loses its larval structures and becomes a sessile polyp (Hadfield, 2011; Tran and Hadfield 2011; Thompson et al., 2015). It is generally accepted that invertebrate larvae, including corals, do not settle randomly (Hadfield, 2011; Heyward and Negri, 1999; Tran and Hadfield, 2011; Ritson-Williams et al., 2010). Instead, they actively probe surfaces for suitable substrates (Heyward and Negri, 1999; Ricardo et al., 2017). The major sources of chemical morphogens that can induce settlement and metamorphosis of invertebrate species, including corals, are crustose coralline algae (CCA) and bacteria in marine biofilms (Webster et al., 2004; Tebben et al., 2015; Hadfield, 2011).

Variation in biofilm community composition and structure is associated with changes in water quality (Witt et al., 2012; Sawall et al., 2012), depth and age (Webster et al., 2004), niches (Tout et al., 2014), and thermal stress (Webster et al., 2011; Mahmoud, 2015). Thus, these changes may have implications on the functional role of the biofilm. In the event that the biofilm community structure changes, the emitted cues may also differ, thereby influencing larval settlement (Kegler et al., 2017; Witt et al., 2011; Doropoulos et al., 2012).

An emergent environmental problem in coastal areas, where most of the productive ecosystems are found, is eutrophication from anthropogenic sources, including mariculture activities (Cai et al., 2011: Lagumen, 2017; Bonsdorff et al., 1997; San Diego-McGlone et al., 2008; Bouwman et al., 2013; Ferrera et al., 2016). Mariculture increases organic loading in the environment, which can result to water quality deterioration (Wu, 2001; San Diego-McGlone et al., 2008) harmful algal blooms, and hypoxic conditions (San Diego- McGlone et al., 2008; Escobar et al., 2013). The
environmental changes brought about by mariculture impacts are also anticipated to have an effect on the biofilm community on nearby reefs.

As biofilms are crucial for the induction of both settlement and metamorphosis of coral larvae, understanding the influence and impacts of mariculture activity on biofilm microbial communities will also provide insight into the dynamics of coral settlement on impacted sites. Relative to this theoretical framework, the general objectives of this study are to investigate the effects of a nutrient gradient associated with mariculture on marine biofilm community composition and biofilm-mediated induction of coral larvae settlement. Mariculture not only affects the surrounding water quality, but it may indirectly impact invertebrate recruitment that rely on microbial cues for settlement. This will bridge the gap in our understanding of the mechanisms at play between microbially-induced invertebrate settlement and eutrophication.

MATERIALS AND METHODS

Biofilm development. Marine biofilm were developed on glass slides (2.5 cm x 7.5 cm) deployed for 15, 11, 7, and 4 days at three sites with varying distance from the mariculture zone in Bolinao, Pangasinan (Fish Cage, 0 km; Tomasa, 2 km; Lucero, 5 km; Malilnep, 12 km). Water parameters (dissolved oxygen, salinity, temperature, pH, and light intensity) were monitored and recorded at each site on the deployment dates.

Microbial community analysis. Genomic DNA was extracted from the developed biofilm material using a modified CTAB method (Winnepenninckx et al., 1993). The V3-V4 hypervariable region of the 16S rRNA gene was sequenced on the Illumina MiSeq platform. Microbial community analysis was conducted using the QIIME 2.0 pipeline (Caporaso et al. 2010).

Coral larvae settlement. Gravid Acropora tenuis colonies were collected from reef sites where they are most abundant. The colonies were reared in the Bolinao Marine Laboratory hatchery prior to the anticipated spawning event. Larval rearing methods followed techniques detailed in previous studies (Edwards, 2010; Villanueva et al. 2008). Settlement assays were conducted in 1L rectangular plastic containers containing 500 ml of UV-filtered seawater. Two glass slides from the same age and site were placed in each container, providing a total biofilm-covered settlement area of 15.24 sq. cm. Competent coral larvae were added to the containers at a density of 1 larvae/mL. The number of larvae that had settled on the slides were enumerated after 24 hours using a dissecting microscope (Motic), following the endpoint time scoring method of Heyward and Negri (1999) and Webster et al. (2004).

Statistical analysis. Statistical analyses were performed in R (The R Core Team, 2018) with packages vegan ver. 2.5-4 (Oksanen et al., 2019), ggplot2 (H. Wickham, 2016), MASS (Venables, W. N. & Ripley, B. D., 2002), plyr (Wickham H., 2011), and ggpubr (Kassambara A., 2018).

RESULTS AND DISCUSSION
Environmental Parameters. pH, salinity, dissolved oxygen, and light intensity (except for temperature) were significantly different among sites. Multiple pairwise comparisons showed that primary differences were between the farthest site (Malilnep) and the site in the mariculture zone (Fish Cage). pH was lowest at the Fish Cage area (7.60 ± 0.0427) and revealed an increasing trend with increasing distance. Salinity was significantly different between Fish Cage (29.6 ± 0.256 ppt) and Tomasa (30.3 ± 0.1 ppt), despite their close proximity while there was no difference between Lucero (30.8 ± 0.32 ppt) and Malilnep (30.9 ± 0.220 ppt). Dissolved oxygen was significantly higher in both Lucero and Malilnep. Light intensity was highest in Malilnep (2676 ± 277 lux), Tomasa (571 ± 94.5 lux) and Lucero (772 ± 131 lux) had similar levels, and the Fish Cage had significantly lower light (350 ± 28.7 lux).

Coral Settlement. Coral larval settlement was highest on slides developed farther away from the Fish Cage site. Malilnep biofilm induced greater settlement compared to the other sites (Figure 1). Older biofilm at 15 days was able to induce more settlement than younger biofilm. Interestingly, 11 and 15-day old biofilm from Tomasa also elicited larval settlement despite its proximity to the Fish Cage site, although this was not statistically supported. No coral larvae settled on the negative control slides.

Figure 1. Mean coral larval settlement after 24 hours on glass slides with 4, 7, 11, or 15-day old biofilm from the Fish Cage (FC), Tomasa (TM), Lucero (LC) and Malilnep (ML). Lower case letters show results from Tukey's posthoc testing of pairwise comparison.

Bacterial Community. 16S rRNA profiling revealed the composition of the microbial community attached to the glass slides that had been deployed at the different sites. The most abundant bacterial groups were Alphaproteobacteria, Bacteriodia, and Gammaproteobacteria (Figure 2). The dominance of these groups has also been
reported in biofilm developed from artificial substrates across sites affected by different levels of anthropogenic impact (Kegler et al., 2017), in surfaces of crustose coralline algae (Sneed et al., 2015; Webster et al., 2011), and in estuarine biofilm (Moss et al., 2006). There were no significant differences in the alpha diversity of the bacterial communities based on Faith’s phylogenetic diversity and Pielou’s Evenness. However, there was a significant difference in the beta diversity of different biofilm ages among sites.

Gammaproteobacteria had a greater prevalence in ML and LC as compared to FC and TM. This group encompasses genera, including Alteromonas, Vibrio, Colwellia, and Pseudoalteromonas, that have been reported to mediate or possibly induce settlement of invertebrate larvae (Hüsseneruck et al., 2017; Kegler et al., 2017).

The relative abundance of Alphaproteobacteria decreased in FC and TM as the biofilm matured, whereas it increased in mature biofilm from ML. Alphaproteobacteria are often found in oligotrophic systems (Kegler et al., 2017) and in CCA surfaces and is linked to higher larval settlement (Webster et al., 2011). Bacteroidia of phylum Bacteroidetes, had higher prevalence in FC and TM compared to LC and ML. An increase in the abundance of Bacteroidetes has also been observed in marine organisms exposed to stressors, such as elevated temperatures or disease (Webster et al., 2011).

Oxyphotobacteria, of the Phylum Cyanobacteria, was found to be relatively more abundant in mature biofilms, especially at sites FC and TM, which are closer to the mariculture area. Cyanobacteria often indicate poor water quality and eutrophic conditions (Kegler et al., 2017). Members of this group can limit coral recruitment and form pathogenic consortia that can infect host corals (Charpy et al., 2012).
Figure 2. Class level taxonomic composition of the biofilm bacterial community from Fish Cage (FC), Tomasa (TM), Lucero (LC), and Malilnep (ML) at 7 and 15 days.
CONCLUSIONS

The study underlines the important role that the bacterial biofilm community plays in successful settlement of coral larvae. Higher larval settlement rate was observed on biofilm developed at sites farther away from a mariculture area. These biofilms were characterized by a higher prevalence of Gammaproteobacteria and lower prevalence of Cyanobacteria. The growth of different bacteria may reflect differences in environmental parameters and water quality across sites. This suggests that mariculture not only impacts seawater and sediment quality but can also influence the bacterial community composition of biofilm on the surfaces of nearby reefs, with downstream impacts on the settlement and recruitment of coral larvae.

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MAJOR REFERENCES


Evaluating the effects of Marine Protected Areas (MPAS) and fishing pressure on fish parasitic gnathiid isopods in the central Philippines

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Introduction

Parasitic organisms dominate biodiversity on coral reefs and can have significant impacts on community dynamics. However, the effects of fishing pressure on their hosts and loss of live coral due to anthropogenic and climate-induced stressors on parasites remains unclear.

Our goal was to compare the abundance of gnathiid isopods (the most common external parasites of coral reef fishes) in marine protected areas (MPAs) and fished areas in the central Philippines.

Our objectives were:

Test the hypothesis that fishing results in an overall higher number of gnathiids per host fish;
Investigate the role of benthic habitat on gnathiid abundance

Materials and Methods

This study was conducted on shallow fringing coral reefs (<10m) in 3 sites in Negros and 3 sites in Siquijor (Fig. 1). Gnathiids are most active at night and at dawn and their presence on fish hosts is temporary. Gnathiids were sampled using light traps, which are an effective sampling method for these parasites (Fig. 2). Light traps were deployed in paired MPAs and fished areas at 6 sites (n = 20-25 traps per MPA and fished area) (Fig. 2). Traps were deployed before sunset and retrieved the next morning after dawn. Reef fish species were counted and their total lengths estimated within a 2-m radius around each trap in order to estimate fish biomass and density. Percent cover of different benthic variables at MPAs and fished areas was also estimated using a 1 m² quadrat (Fig. 2A). After deployment, the contents of each trap was filtered into individual containers and the number of gnathiids were counted.
Results and Discussion

Our data thus far suggests that overall there was no significant difference in fish density between MPAs and non-MPAs ($p=0.06$) in the 6 sites. This may be due to an increase in abundance of non-targeted fish in response to their competitors or predators being removed by fishing. Fish biomass and the number of targeted fish families were significantly greater inside the MPA than outside ($p=0.028$), which is consistent with the possible effects of protection for larger targeted species. Percent cover of live hard corals ($p=0.03$) and abundance of cleaner wrasses ($p=0.04$) (both known predators of gnathiids) were greater within than outside MPAs for all sites.
No relationships have been found so far between benthic composition and gnathiid abundance in this study. This may be due to the low hard coral cover of the sites, which would enable gnathiids to easily avoid coral. Sites with higher coral cover are needed to investigate this further.

![Fig. 3 A) Larval stage gnathiid Isopod, B) Female adult gnathiid, C) Male adult gnathiid](image)

Preliminary findings of gnathiid abundance showed a trend of being higher in MPAs than in non-MPAs (0.24). Due to biomass being lower outside the MPAs and the relatively high numbers of gnathiids in 4 of the sites the average calculated gnathiid to host ratio was up to 6.2 times higher outside MPAs. The highest ratio was found in a low fish biomass site. This suggests that in fished areas, reef fish would have higher levels of gnathiid infestation and consequent burden. These findings support the hypothesis that fishing results in an overall higher number of gnathiids per host fish.

Conclusion

This is the first study on how gnathiids respond to secondary effects of MPA protection and fishing that used appropriate sampling methodology to obtain more accurate estimates of gnathiid abundance. The results so far suggest that while human-induced stressors may reduce both predators of gnathiids and host biomass, the reduction is not sufficient to reduce the impacts of gnathiids on the remaining fish hosts, constituting a secondary effect on fish populations in fished areas. However to gain a more comprehensive understanding of these effects, a greater number of sites should be studied with varying coral cover and fish assemblage structure.

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The offishore segment of the east Zambales fault and its implications to coastal geohazard in Lingayen Gulf
INTRODUCTION

The Philippines is one of the most tectonically active regions in the world. Majority of the faults that have been mapped and characterized are located on land and it is expected that these faults may extend offshore and there may also be offshore faults that do not have onshore traces. The East Zambales Fault is a ~78 km active left-lateral strike slip fault that borders the eastern side of the Zambales Mountains and the western side of the Luzon Central Basin (Figure 1). The offshore extension of the EZF was delineated by Salas et al. (1991) but no characteristics of the fault were reported. The lack of knowledge about the EZF would likely underestimate the level of seismic hazard in the region. Thus, there is an urgent need to study this fault. The study aimed to characterize the offshore EZF in terms of its overall type of movement and magnitudes of past vertical motions and determine possible implications to currently available coastal geohazard maps in Lingayen Gulf.

MATERIALS AND METHODS

Database

High resolution seismic reflection profiles acquired during three separate research cruises were used in this study. The Mines and Geosciences Bureau in coordination with the Committee for Coordination of Joint Prospecting for Asian Offshore Areas (MGB-CCOP) acquired ~750 line-km of sparker profiles with a grid spacing of ~ 5 km. A total of 110 line-km of Parasound profiles were acquired during the 1999 R/V Sonne cruise 140. The authors also acquired ~15-line km of chirp profiles in the northeastern coast of Anda, Pangasinan (Figure 2).
Figure 1. A Digital Elevation Model of the study area showing the major tectonic structures. The epicenters of earthquakes that occurred from 1900 to 2018 are also plotted. The distinct linearity of shallow earthquakes inside Lingayen Gulf is most likely due to the activity of the East Zambales Fault.

Seismological data retrieved from the Philippine Institute of Volcanology and Seismology (PHIVOLCS) and the United States Geological Survey (USGS) earthquake catalog were also used to provide insights on the occurrence of earthquakes in the area.

Fault characterization

Faults were identified on seismic reflection profiles based on the abrupt truncation or warping of reflectors (Johnson and Watt, 2012). The identified faults were marked and for seismic profiles showing multiple faulting everts, the main trace was determined on the bases of continuity with the onshore trace and age. Faults grow over long time periods (Taylor et al., 2004) and therefore the main trace was determined to be the oldest fault in the profile.

Seismic profiles were converted to depth using a conversion factor of 1500 m/s and the magnitudes of vertical displacements between distinct reflectors were then measured. The overall type of movement of the fault was then determined by the associated deformations shown in the seismic profiles. Radiocarbon dates for certain
sediment layers from a core acquired during the 1999 R/V Sonne cruise complemented by sequence stratigraphic principles provided age control for reconstructing past movements of the offshore EZF.

RESULTS AND DISCUSSION

Fault characteristics

The EZF continues ~57 km into the gulf following a north-northeast trend with an eastward bending that starts at the far eastern coast of Anda, Pangasinan. The fault is not a single linear traceable feature but appears as a fault zone with the main trace located at the boundary between the karstic terrane to the west and the fluvio-deltaic deposits to the east (Figure 3). The karstic terrane is indicated by an irregular surface with the absence of internal reflectors and it represents coral reefs that were buried through time. The protruding tips from the seafloor represents the present-day corals. On the other hand, the fluvio-deltaic deposits to the east are sediments deposited by the rivers that drain into the gulf. Sound can penetrate these sediments, which allowed the subsurface features of the possible splays of the EZF to be imaged.

For the main trace, only the surface displacement can be measured which range from 2.3 to 5.4 m. Possible splays show that there were at least four (4) movements since the end of the Last Glacial Maximum (18 kya). The maximum defined vertical motion is ~16 m and the incremental vertical displacements range from 1.5 to 10 m. The overall movement of the EZF is strike slip as indicated by the presence of (1) synthetic and antithetic faults that form extensional and contractional features, (2) normal and reverse drag geometries along the fault trace and (3) reversals in the sense of throw with depth.

Coastal geohazard implications

Current estimates by PHIVOLCS show that the onshore trace of the EZF can generate a magnitude 7.3 earthquake that can induce violent ground-shaking in Central Luzon. The added fault length from the offshore trace would imply that it can generate a stronger earthquake based on the empirical equation for strike slip faults developed by Wells and Coppersmith (1994):

\[ M = 5.16 + 1.12 \log (L) \]

Where M is the possible magnitude and L is the fault length. Tsunamis can also be generated by an earthquake. There are five (5) confirmed tsunami events that occurred in northwest Luzon and two (2) of these events were generated from earthquakes generated onshore (PHIVOLCS, 2017). The eastward bending of the fault may be an important factor in determining if the EZF can generate a tsunamigenic earthquake.
CONCLUSION

The EZF is a strike-slip fault that extends ~57 km into the gulf. The main trace appears as a boundary between the karstic terrane to the west and the fluvio-deltaic deposits to the east. The past movements of the main trace could not be determined because the continuity of reflectors from the fluvio-deltaic deposits could not be traced to the
west side of the fault. However, possible splays show that there may have been at least four movements during the past 18,000 years. The large vertical displacements that range from 1.5 to 10 m, and the combined fault length of the onshore and offshore segment indicate that the EZF can generate a strong earthquake that may be tsunamigenic.

References


Figure 3. A sample of an interpreted sparker profile from the 1987 MGB-CCOP cruise. Red arrow indicates the identified main trace of the offshore East Zambales Fault. In this figure, it is seen that the fault is not a single linear traceable feature but appears as a fault zone.
Brittle stars (Echinodermata: Ophiuroidea) in the coastal areas of Lian and Calatagan, Batangas

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Introduction

Brittle stars (Echinodermata: Ophiuroidea) encompass the most diverse and abundant group among extant echinoderms. Although with over 2,000 species recorded (World Ophiuroidea Database, 2019 obtained from the World Register of Marine Species, 2019), shallow-water ophiuroidean studies in the Philippines remain scarce, which includes Koehler (1922), Domantay (1931 & 1971) and the most recent monograph on Indo-Pacific echinoderms by Clark & Rowe (1971). Ophiuroid faunal records remain less well-known in the Eastern Pacific (O’Hara & Stohr, 2006) while patchy knowledge is still recorded along the Indo-West Pacific (Stohr, Sautya & Ingole, 2012). Limited information in these organisms may be attributed to their cryptic habits, little economic importance and difficulty in identification and reconstructing phylogeny (Stohr, Thuy & O’Hara, 2012). However, given the advents of biodiversity loss and insufficient taxonomic records, continuous efforts in updating information should be carried out in order to assess species diversity. This study aims to identify the species located in the coastal areas of Calatagan and Lian, Batangas, as well as to compare past literature records with the results of Koehler (1922), Domantay (1937 & 1971) and Clark & Rowe (1971) using Sorensen Index.

Materials and Methods

Brittle stars were collected along 50-m² transects in rocky areas and seagrass beds in Bgy. Gulod, Calatagan, Batangas on October 2018 and Bgy. Luyahan, Lian, Batangas on March 2019 during low tides for two days each. A 50-m line transect was also laid on each of the seagrass and rocky areas in Lian, Batangas for species accumulation curve to assess completeness of survey. Specimens were relaxed in 4% magnesium chloride before preserving in 70% ethanol. The collected brittle stars were identified using several publications and artificial keys of Koehler (1922), Devaney (1970), Clark & Rowe (1971), Guille (1976), Pomory (2007), Olbers & Samyn (2012) and Boissin, et al. (2016), which bases mainly on the ossicular compartments at the central disc and
arms. Sorensen Index was used to compare similarities in species occurrence of brittle stars from this study with those documented in early surveys conducted in the Philippines specifically in the littoral zones of Batangas and Mindoro areas.

Results and Discussion

Results show a total of 13 species in Calatagan and Lian under the families Ophiotrichidae (*Macrophiothrix*), Ophiodermitidae (*Ophioplocus* and *Ophiarachnella*) and Ophiocomidae (*Breviturma*, *Ophiomastix* and *Ophiocoma*) with cryptic species occurrence observed under *Ophiocoma*. In contrast, only 4 species in total were found in Lian which were *Ophiocoma cynthiae* Benavides-Serrano & O’Hara 2008, *O. schoenleinii* Muller & Troschel 1842, *O. scolopendrina* Lamarck 1816 and *Macrophiothrix longipeda* Lamarck 1816. Sorensen Index showed that the Calatagan assemblage showed greatest similarity towards the monograph records of Clark & Rowe in 1971 (82%). The updated taxonomic revisions of the *O. erinaceus* complex into three separate species: *O. cynthiae*, *O. schoenleinii* and *O. erinaceus* (Benavides-Serrato & O’Hara, 2008) show incongruities regarding records from the past literatures that no *O. erinaceus*, mainly characterized by their red tube feet, was found along the study sites. The elevation of the Brevipes-group (Devaney, 1970), formerly considering *Breviturma* as a subgenus of *Ophiocoma* (Stohr, Horeau & Boissin, 2013), is now recorded as a separate genus (O’Hara, et al. 2018). Several revisions based on molecular and morphological diagnoses were also made within Family Ophiocomidae including several *Ophiocoma* species moved into genera *Ophiocomella* and *Ophiomastix*, species under *Ophiarthrum* were now included under *Ophiomastix*, and *Ophiomastix elegans* renamed as *O. brocki* (O’Hara, et al. 2019). This requires further studies due to the resulting polyphyletic group within the *Ophiocoma* species.

Conclusion

Given the massive taxonomic revisions of ophiuroids over the last 50 years, reassessment of Philippine ophiuroid diversity should be undertaken and updated. This study could provide a preliminary updated checklist which can aid for biodiversity assessment and taxonomic identification for future researches.

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Rarity of the “common” coral Pocillopora damicornis in the Philippines

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Introduction

The cauliflower coral Pocillopora damicornis (Linnaeus, 1758) is considered a cosmopolitan species, widely distributed across the shallow waters of the tropical Indo-Pacific. However, extensive phenotypic plasticity generally confounds identification of this common reef-building species complex. With the recognition of P. damicornis genetic lineages as taxonomic species (Schmidt-Roach et al. 2014), this study surveyed genetic lineages within P. damicornis sensu lato (Veron and Pichon 1976) in the Philippines.

Materials and Methods

We examined P. damicornis s.l. colonies (n = 1,002) from 25 locations across the Philippine archipelago to characterize the distribution of Pocillopora spp. in the region. Coral fragments were exhaustively sampled from four sites in the Bolinao-Anda reef system, Pangasinan and haphazardly from 21 other sites: six sites within the West Philippine Sea, eight along the Verde Island Passage, three covering the Sulu Sea, one in Celebes Sea, and three sites along the northeastern coast of Luzon. A PCR-RFLP assay of the mitochondrial control region (CR; Torda et al. 2013) and sequencing of the mitochondrial open reading frame (ORF; Flot et al. 2008, Johnston et al. 2018) were employed for lineage identification. A minimum-spanning network was constructed to examine the global distribution of Pocillopora spp. haplotypes.

Results and Discussion

Results confirm the occurrence of P. acuta populations in the Philippines and reveal the rarity of P. damicornis s.s. in this region. Of the colonies assayed, 73% (n = 726) were reclassified as P. acuta while no P. damicornis sensu stricto (Schmidt-Roach et al. 2014) was detected among the samples. Sequencing the ORF for a subset of the samples (n = 152) corroborates these findings and further reveals the presence of at least three Pocillopora spp. (P. verrucosa, P. meandrina, and P. brevicornis) among the samples unresolved by the PCR-RFLP assay. The minimum-spanning haplotype network of Pocillopora ORF (n = 57 unique DNA sequences; 854 bp length) suggests the limited distribution of P. damicornis to colder water environments of higher latitudes.

Conclusion

By characterizing cryptic genetic variability within populations of P. damicornis s.l., this study addresses the problem of identifying species where morphology is unreliable. This study highlights the need to revisit the distributional ranges of this extensively studied species complex which, ultimately, will benefit studies on ecology, biodiversity, population genetics, and evolution within this group.
Acknowledgements

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Comparison of Zooplankton Diversity and Abundance in “HAB”- Coastal Waters of Carigara Bay and “Non-HAB” Coastal Waters of San Pedro Bay, Leyte, Philippines

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Introduction

Algal blooms are the main causes of red tides, and these become harmful to the public as some species such as Pyrodinium bahamense secrete toxins which bioaccumulates in shellfish. In August 2017 until April 2018, bans on the consumption of shellfishes has been made in Carigara, Leyte and its neighboring municipalities. While there were no such bans in that period in San Pedro Bay, just opposite to Carigara Bay. As zooplankton are highly sensitive to changes in aquatic ecosystems, they may serve as a measure of biological conditions of coastal waters, including conditions of Harmful Algal Bloom (HAB)-infected waters. Furthermore, HABs have the potential to dominate the phytoplankton community and eliminate non-toxic phytoplankton species (Paerl et al. 2001). This can lead to a decline in zooplankton diversity as zooplankton rely on non-toxic phytoplankton species. In a study conducted by Moses and Barker in 2014, a significant decline in zooplankton species diversity was found in a lake with HAB compared to a lake with no HAB. In this study, the zooplankton diversity and abundance of HAB affected bay, Carigara Bay was compared to a bay not affected by HAB, during the same period, the San Pedro Bay.

Methodology

Simultaneous assessments were performed in two bays in Leyte: Carigara (CB) and San Pedro (SPB) bays. Qualitative and quantitative samples were collected using a plankton net and a bucket, respectively. Using a Sedgewick-rafter counting chamber, all samples were viewed under an electric compound microscope and all zooplankton individuals were counted in each concentrated sample.

Results and Discussion

Statistically, physico-chemical parameters and nutrient analysis data between the two bays showed no significant differences between the two datasets (t test, α=0.05) implying that these datasets may not have much impact on the decline in zooplankton count in CB compared in SPB.

Other results on the physico-chemical parameters in CB showed Station 1 with the lowest transparency (5.57 m) and the highest nitrate concentration (2.70 μM ± 1.24) as it was near a sea port. Anthropological impacts and human activities may have affected the conditions of the coastal water. Whereas Station 3 showed the opposite as it was far from residential areas. Similarly, Station 3 of SPB showed the lowest transparency (3.56 m) and high values of nitrates and phosphates (1.88 ± 1.06 and 0.39 ± 0.04 μM, respectively) as the presence of fishing nets within the area indicate active human activity. In both CB and SPB, increase in pH (8.05 and 8.29) and
A decrease in salinity (28.89 ppt and 31.33 ppt) were observed in December as Typhoon Urduja occurred in Leyte prior to sampling.

Initial results on zooplankton data showed a total of 27 zooplankton groups (22 and 26 in CB and SPB, respectively), amounting to 3,818 individuals (634 and 3,184 individuals in CB and SPB). Of the 27 groups, 25 families were identified from two kingdoms and seven phyla, five from kingdom Animalia and two from kingdom Chromista. The other two zooplankton groups are Ascidian tadpoles and copepod eggs. Most abundant zooplankton groups in CB were found to be copepod eggs and Cyclopidae, while Cyclopidae and Calanidae were the most abundant in SPB. 

*P. bahamense* count amounted to 3,519 cells (average cell density of 1.76x10^4 ± 4.11x10^3 cells/L) in CB alone and 121 cells (6.05x10^2 ± 1.05x10^3 cells/L) in SPB. *P. bahamense* count in CB showed highest in Station 1 (7.30x10^3 ± 2.20x10^3 cells/L) and in November (7.18x10^3 ± 1.83x10^3 cells per liter). Both in Station 1 and in November, nitrate concentrations were at their highest (2.70 ± 1.24 and 3.56 ± 0.78 μM, respectively) which indicate a positive relationship between nitrate concentration and *P. bahamense* count. Moreover, correlations were done per station and per month between the two datasets and results show positive correlations with r^2 = 0.97 and r^2 = 0.51, respectively. In SPB on the other hand, showed *P. bahamense* count only in the month of December (6.05x10^2 ± 9.46x10^2). *P. bahamense* cells may have been washed inwards towards SPB, by Typhoon Urduja, from Matarinao Bay in Eastern Samar as HAB was also present in the area at the time. Moreover, nutrient data in SPB also showed December with the highest nitrate concentration (2.54 ± 0.50 μM) thus may contribute to the presence of *P. bahamense*. Statistically, CB showed a significantly lesser zooplankton number (z-test, α=0.05) with an average of 4.36x10^3 ± 5.45x10^2 (± 3.50x10^2 per station and ± 5.45x10^2 per month) indiv./L, compared in San Pedro bay with an average of 1.95x10^4 ± 1.79x10^4 (± 2.42x10^3 per station and ± 1.79x10^4 per month) indiv./L. Shannon-Weiner Diversity and Pielou’s Evenness index values were lower in CB (2.52 ± 0.11 and 0.51 ± 0.03, respectively) than in SPB (2.86 ± 0.07 and 0.58 ± 0.01) while Menhinick’s Richness Index value showed higher in CB (3.17 ± 0.21) than in SPB (1.86 ± 0.72).

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PLIO-PLEISTOCENE MOLLUSCS FROM ILOCOS SUR AND ILOCOS NORTE, NORTHERN PHILIPPINES
Policarpio D, Ambid A, Doyongan Y, Uy M, Guballa J, Hermo M, Fernando A, Kase T,

The molluscan assemblages of Plio-Pleistocene lithologic units in Ilocos Sur and Ilocos Norte are reported in the present study. The lithologic units represent the shallow marine deposits of the Ilocos-Central Luzon Basin. The age of the units were obtained by calcareous nannofossil and planktonic foraminifera analyses. Distinct differences were noted between the two units in terms of lithology and molluscan assemblage. The units in Ilocos Norte (mapped as part of the Laoag Formation) consist of tuffaceous very fine-grained sandstones with common occurrence of Dentalium spp. On the other hand, the units in Ilocos Sur (mapped as part of the proposed Santo Domingo Formation) are composed of medium to fine-grained lithic sandstones with a more diverse molluscan assemblage compared to Ilocos Norte. An investigated section in Brgy. Laoingen, Santo Domingo exhibits what appears to be a change in mollusc assemblage towards the top of the section. The lower units contain several species of the pelecypod Trisidos, while the upper unit is characterized by the dominance of the genera Oliva and Conus.

Both units are believed to have been deposited in the shallow marine shelfal environment, but the dominance of planktonic foraminifera in the units in Ilocos Norte indicates that it is relatively deeper than the units in Ilocos Sur, which contain more abundant reef-derived benthic foraminifera. The shifts in the molluscan assemblages in Ilocos Sur could possibly be due to a shift/change in the water depth of the depositional environment.

QUANTITATIVE CHARACTERIZATION AND SPECIES-LEVEL IDENTIFICATION OF HOLOCENE CORALS FROM AN UPLIFTED CORAL REEF PLATFORM IN SAN ESTEBAN, ILOCOS SUR
Cercado F, Leonida S, Anticamara J, Ramos N,

Holocene fossil corals serve as analogues of ancient reefs, provide information on coral characters and serve as proxies of paleoenvironmental conditions (e.g., sea level rise, tectonic activities, etc) (Shen et al., 2010; Brandano et al., 2016). However, fossil coral surfaces usually become difficult to identify by being obscured by encrusters or due to breakage and erosion (Humblet et al., 2015). Coral-based paleoclimate reconstructions may also be affected by diagenesis and dissolution, and impede the accurate identification of corals (Sayani et al., 2011). Therefore, the careful identification corals by observation of internal structures and surface morphology becomes important. In this study, emergent Holocene fossil corals were identified up to species level through analysis of coral morphology, cross sections, and thin sections. Coral characters were also measured to provide standard quantitative values for said coral species characters.
Holocene coral samples were taken from an emergent coral reef terrace along the coasts of San Esteban, Ilocos Sur (Ramos et al., 2016). The Favides, Galaxea, Goniastrea, Platygyra, and Porites genera were initially identified. Coral samples were photographed at hand sample scale and were cut into thin sections for microscopic analysis. The tpsdig2 program was used to measure coral characteristics such as corallite diameter, septal length, and distance of columella. Resulting measurements will then be compared with present values in literature. Results from this study provide standard quantitative values for coral characters and would be useful in understanding the distribution and variation of coral species in northwest Luzon during the Late Quaternary.

SHADOWS OF PAST REFUGIA FROM THE MURKY SEA: GENETIC SIGNATURES OF PLEISTOCENE LOW SEA-LEVEL STANDS IN TWO REEF FISH SPECIES FROM THE PHILIPPINES
Matias A, Riginos C,

Habitat changes associated with past glacial cycles are known to influence spatial distributions of intraspecific genetic diversity. For shallow water tropical marine organisms, low sea-level stands may have caused habitat extirpations leading to population bottlenecks followed by expansions when habitat area increased during interglacial periods. Additionally, low sea-level stands would have caused the emergence of landmass barriers that presumably generated genetic divergence between populations of marine organisms. While previous phylogeographic studies have provided evidence for the above scenarios, most conclusions are based on mitochondrial DNA markers and summary statistics, e.g., FST, that might be poor at resolving the relative contributions of past divergence and recent gene flow to present-day genetic diversity. Here we examine the demographic histories of two reef fish species showing weak genetic structuring across the Philippines archipelago. Using genome-wide data and Approximate Bayesian Computation approach, we test the effect of low sea-level stands on past effective population sizes (Ne) and gene flow of the cardinalfish Cheilodipterus quinquelineatus and the grouper Epinephelus merra. Specifically, we explicitly examine the support for competing demographic models representing different genetic effects of low sea-level stands on past Ne and gene flow. We find strong support for population expansions from our two study species affirming previous suggestions from mtDNA data. Although we do not explicitly find strong support for bottlenecks preceding the expansions, cross-validation of our approach indicates that the lack of support is due to the signals of genetic bottlenecks being overridden by expansions. In terms of past connectivity, we find strong support for secondary contact model indicating past population divergence followed by on-going gene flow. This result corroborates suggestions of past divergence based on divergent haplotypes that are homogenously distributed across space, while also offering an alternative view of past isolation and recent high gene flow to previous association of low genetic differentiation to minimal effect of low sea-level stands. Overall, we found consistent evidence for the effect of low sea-level stand on past and gene flow highlighting the pervasive signatures of Pleistocene glacial cycles on genetic diversity of shallow water tropical marine organisms.
PHYLOGENETIC RELATIONSHIPS AND THE DIVERSIFICATION OF FLASHER WRASSES (LABRIDAe: PARACHEILINUS) IN THE INDO-PACIFIC: PRELIMINARY RESULTS

Sorgon K, Carpenter K,

The genus Paracheilinus includes 20 currently described wrasses occurring on coral reefs of the Indo-Pacific. Commonly referred to as Flasher Wrasses, they are known for their display behavior, where males flare their elaborate dorsal fins and intensify body colorations to attract potential mates and delineate their territory. We used the mitochondrial gene cytochrome oxidase subunit I (COI) to investigate phylogenetic relationships of 16 Paracheilinus species. Maximum likelihood and fossil-calibrated Bayesian inference analyses yielded a monophyletic Paracheilinus with four strongly supported species groups within the genus. Construction of a chronogram using fossil-calibrated Bayesian inference suggests that Paracheilinus arose from its putative sister taxon Cirrhilabrus in the Miocene and subsequently diversified throughout the early Pliocene. Evolutionary relationships coupled with temporal and spatial concordances within endemics suggest that alternative diversification models of successive division and colonization may have contributed to the speciation of Paracheilinus throughout its current distribution range. We seek to extend this study to include additional species, genes and morphological evidence.

BUCKETFULS OF BIODIVERSITY: THE CRUSTACEANS AND ECHINODERMS OF TAKLONG ISLAND, GUIMARAS, PHILIPPINES

Malay M, Rañises D,

The Philippines is located within the “Coral Triangle” hotspot of marine biodiversity, and yet so much of this biological wealth remains unknown, undescribed, and unappreciated. Focused and intensive sampling, databasing, and taxonomic studies are needed to address this knowledge gap. When planned and executed correctly, modern biodiversity surveys can serve as a vehicle for baseline inventories and species discovery, an aid to educational initiatives, and a basis for conservation and management policies. We report ongoing work to document and database the crustacean and echinoderm species diversity in the Taklong Island National Marine Reserve in Guimaras, Western Visayas, Philippines. About 130 species have been identified so far, mainly from hand-collecting in the intertidal zone; and species accumulation curves show that the rate of discovery is far from asymptoting. The initial checklist includes new geographic records for the Philippines as well as potential new species. DNA barcoding will be used to delineate problematic species-complexes and to study the Indo-Pacific phylogeographic patterns of one focal genus. Much more work needs to be done to fully describe this biodiversity fully.
COMPARATIVE STUDY OF ECHINOMETRA MATHAEI SPECIES COMPLEX (ECHINOIDEA: CAMARODONTA) FROM TAKLONG ISLAND, GUIMARAS AND NABAS, AKLAN

Tamayo J, Malay M,

Echinometra mathaei is a species complex with its constituent reproductively-isolated species informally called A, B, C and D based on studies done in Okinawa. Little research has been done on this genus, especially in the Philippines. To clarify species delineations in the Echinometra mathaei species complex, a comparative study is being undertaken between the Taklong Island National Marine Reserve, Guimaras and Barangay Unidos in the municipality of Nabas, Aklan. This study aims to (i) identify the species or species complex composition of Echinometra in the two sites based on external morphology and gonad spicules, (ii) determine the abundance of Echinometra populations in the two sites, and (iii) find out if there are microhabitat differences among different E. mathaei species-complex members between the two sites. Collection is ongoing for Echinometra spp. from the two sites. Morphological characters observed include spine color, color of skin around the peristome, presence of basal rings, and shape of gonad spicules. The specimens will then be classified as Echinometra sp. A, B, C, or D based on their character states. To study their abundance and distribution, 50-meter transects were surveyed: two parallel transects (at 0 ft and 3 ft) and one perpendicular transect, each transect type having three replicates per site. The results indicate that there may be three species-complex present in both sites (A, B, and C). Echinometra sp. A has a distinct feature by possessing white-tipped spines. Echinometra sp. B has a dark skin around peristome and a faded basal ring, while Echinometra sp. C has pale skin around peristome and clear basal ring. Apparent differences in microhabitat are observed among the species-complex: Echinometra sp. A was rare and found on coral reef burrows while Echinometra sp. B and C co-occurred and predominantly inhabited the rocky shore. Initial results indicate that Echinometra spp. are more abundant at 3 ft than at 0 ft.

BRITTLE STAR (ECHINODERMATA: OPHIUROIDEA) DIVERSITY AND SPECIES COMPLEXES AT TAKLONG ISLAND, GUIMARAS, PHILIPPINES

Delgado L, Malay M,

The study of ophiuroids has been important in biogeography, studies on trophic relationships among species, and in other fields like aquaculture. However, it has received little attention in the past 50 years, and ophiuroid taxonomy remains problematic because of poorly delimited species and numerous species complexes. Moreover, there are no published checklists of ophiuroid species from Taklong Island National Marine Reserve (TINMR), Guimaras, Philippines since its proclamation in 1990. To address this gap, we are conducting focused sampling of brittle stars in specific habitats of TINMR. The collected specimens are photographed, preserved in ethanol, tissue-subsampled, and entered into a collections database. Morphological identifications are on-going based on relevant taxonomic literature. Species complexes will be subjected to DNA barcoding to aid species delineation. At present, 16 species belonging to the genera Ophiocoma, Ophiothrix, Ophiomastix, Ophiarachnella and Ophiarthrum have been identified, with morphologically variable putative species complexes observed in Ophiocoma.
This study is a preliminary assessment of ophiuroids in the area and further studies involving exploration of deeper waters will likely increase the number of species recorded.

SOFT CORALS IN THE PHILIPPINES: WHAT DO WE KNOW ABOUT THEM?

**Cabasan J**, Lalas J, Arceo H, Rodriguez M,

Soft corals are among the most diverse macrobenthic group in coral reefs - a refuge for other marine fauna such as fish, mollusks, and arthropods. Outside of the marine realm, soft corals are of high interest to humans due to their putative natural products which have high potential for drug discovery. Despite increasingly being recognized as a key taxa, little is known about their distribution, abundance, and diversity in the Philippines. Hence, this study was done to provide baseline information on soft corals. The survey of soft coral communities was done by haphazardly laying transect lines in selected reefs and by adapting the photoquadrat method in capturing images of the substrate. The extent of soft coral cover and the generic abundance were estimated using area-length analysis of Coral Point Cover with Excel Extension (CPCe). Voucher specimens were also collected for taxonomic identification using sclerites, and later, by using molecular markers. Preliminary assessment in Northeastern Philippines tallied a total of 18 genera from 5 families of soft corals, slightly higher than existing records in Taiwan. The most dominant family is Xeniidae which constitute to about 70% of the population, with *Xenia* and *Eflatounaria* contributing to 27.3% and 26.2%, respectively. Generic richness ranged from 2 to 11 genera/50m², with highest alpha diversity observed in Bicol Shelf. In terms of live cover, the highest was at 6.1% in Bicol Shelf, comparable to that of the Red Sea but is way below than 70% - the highest living coverage in Taiwan. This study is one of the few to provide comprehensive assessment of soft corals in the Philippines. It is our ultimate goal to map soft coral communities in the entire archipelago in the future. Keywords: soft corals, diversity, northeastern Philippines

COASTAL FISH ASSEMBLAGE STRUCTURE FROM SHALLOW TO MESOPHOTIC DEPTHS IN THE CENTRAL PHILIPPINES

**Abesamis R**, Utzurrum J, Raterta L,

The central Philippines is the global center of marine shore fish biodiversity. However, little is known about how the taxonomic and trophic structuring of fish assemblages varies in this region from shallow to mesophotic depths. Ecological studies of fish assemblages in the central Philippines have focused mostly on shallow environments (<20 m deep). Studies of deeper Philippine coastal shelves, on the other hand, have been limited mainly to trawl surveys. Here, we used baited remote underwater video (BRUV) to describe fish assemblage structure from 10 to 90 m at two mainland coast locations in southeast Negros. BRUVs were deployed at more than 50 replicate stations per site and left to record on the seafloor for at least 30 minutes per station. MaxN, the number of individuals per species at any given time, was used to estimate fish abundance. Fish species were classified according to trophic groups. Non-metric multidimensional scaling was used to visualize fish assemblage structure. The data was also compared to fish
assemblage structuring at a nearby offshore site (Apo Island) covering a similar depth range. This work will significantly contribute to understanding the ecology of Philippine coastal shelves and elucidate potential implications for biodiversity conservation and fisheries management.

LONG-TERM PATTERN OF TEMPORAL AND SPATIAL VARIABILITY OF CHAETODONTIDAE ASSEMBLAGES IN THE BOLINAO-ANDA REEF COMPLEX, NORTHWESTERN PHILIPPINES


An important determinant of reef fish assemblages in a location is changes in benthic reef structure which may be brought about by environmental disturbances. The relationship between coral cover and butterflyfish (Chaetodontidae) assemblages has been a focus of many studies as this association is particularly sensitive to significant changes in benthic cover due to their dietary dependence on scleractinian corals. However, relatively few studies have examined the long-term changes in Chaetodontidae assemblages with changes in reef benthos. For this study, community data on butterflyfish species was collected via underwater visual census in eight sites within the Bolinao-Anda Reef Complex (BARC), northwestern Philippines from 2010 to 2018, along with photoquadrats of the reef benthic community. Results show temporal differences in Chaetodontidae abundance, with peak abundance recorded in 2015, then a succeeding sharp decline for majority of the sites in 2016 which may be attributed to the bleaching event that reduced availability of corals. However, an increase was then observed in the following year, perhaps due to factors such as recruitment or a rise of species less dependent on coral. Differences in Chaetodontidae assemblages were also observed among sites, with the highest species richness, abundance and biomass values recorded at sites situated in the South China Sea (Lucero and Balingasay) compared to those in the Lingayen Gulf (Cangaluyan, Cory, and Malwest), with among-site differences likely associated with differences in hard coral cover. Results show that Chaetodontidae assemblages are sensitive to changes in hard coral cover in the BARC, highlighting the vulnerability of this family to changes in reef habitat conditions due to their reliance on scleractinian corals.

FARMER DAMSELFISH POPULATION DYNAMICS IN BOLINAO-ANDA REEF COMPLEX (BARC)


Farming damselfishes are territorial grazers that can alter the benthic composition on coral reefs although their effects on the substrate may vary depending on the species. Some farmers intensely defend and maintain algal monocultures whereas some maintain multi-species farms. Thus, turnover of farming damselfish species can result in changes in the heterogeneity of the reef substrate across temporal scales. However, it is not well understood how farmer damselfish assemblages change through time. In this study, we examined the spatial variability in abundances and sizes of the different farmer damselfish species from 2010 to 2019, at two
depths in Bolinao-Anda Reef Complex (BARC). Farmer damselfish composition were examined along three 25 m transects that were laid in eight sites. The structure of the benthic community was also examined at the same time. Abundance, sizes, and species composition of farmer damselfishes varied across the eight sites. Dominant farmer species on each site varies depending on the general condition of the benthic community, thus seasonal variation in the farmer damselfish assemblage was observed. The farmer damselfish assemblage varied depending on the structural complexity and benthic composition, as well as the dominant farmer damselfish species in each site.

**DISTRIBUTION OF SOFT CORALS (OCTOCORALLIA: ALCYONACEAE) IN THE BOLINAO-ANDA REEF COMPLEX, PANGASINAN, NORTHWESTERN PHILIPPINES**

Lalas J, Baria-Rodriguez M,

One of the most conspicuous organisms in coral reefs are soft corals. These organisms are ecologically and economically valuable. Soft corals are also potential to be indicators of changes in environmental conditions. In this study, distribution of soft corals in the Bolinao-Anda Reef Complex (BARC), Pangasinan, northwestern Philippines was assessed. In addition, taxonomic richness, cover and abundance of each genus, identified using sclerites, were analyzed. To our knowledge, this is the first detailed soft coral assemblage study in the Philippines. Hierarchical sampling was done in 10 selected sites in BARC. Two stations were established in each site, each having a 25m x 75m area. In each station, 5 transects were randomly laid at depths of 3-5m. Photoquadrats were then taken following the transects. This design was utilized to compare soft coral assemblages at different scales - sites, stations, and transects. Physico-chemical parameters, such as nutrient levels, temperature, sedimentation rate, and exposure of the different sites were measured. A total of 9 genera from 6 families were observed. Preliminary results show that soft coral cover, abundance, and generic richness were lowest in Trenchera. Among the sites, Trenchera, nearest site to a mariculture area, had the highest nitrate level and sedimentation rate. Soft coral assemblages in BARC were dominated by the genus *Lobophytum* in terms of abundance and cover. Compared to other sites in other studies, the Bolinao-Anda Reef Complex has a very low soft coral generic richness. Abundance of smaller colonies were relatively low in most of the sites. The absence of many octocoral groups and the dominance of Lobophytum is indicative of low water quality and/or areas with high sedimentation. Absence of small colonies in most of the sites is indicative of unfavorable conditions for new recruits. Thus, soft coral assemblage of BARC is a result of poor water quality. It is important to monitor soft coral in more detail than just pooling them as group, as done traditionally. Therefore, we propose to include this in national coral reef monitoring programs.
COMPARISON OF MACROFAUNAL ASSOCIATES OF THE SPONGE MELOPHLUS SARASINORUM FROM TWO REEF AREAS
Piloton R, Campos W,

Sponges (Phylum Porifera) are important components of the marine benthic fauna. They are responsible for reef bio-erosion and consolidation, transfer of energy through bentho-pelagic coupling, food for some vertebrates and invertebrates, and they serve as microhabitats for both macrofauna and microbiota. Little is known about the macrofaunal associate with sponges in the Philippines. In this study, we describe and compare the macrofauna associated with the sponge Melophas sarasinorum from two reef areas: Quinapondan Eastern Samar and Tubigon, Bohol. A total of 4,946 individuals representing four animal phyla were found in association with the host sponge collected at depths between 15 - 20m. Ophiuroids were the most abundant group, followed by crabs, barnacles and polychaetes. Sponges represent a biodiversity reservoir that contributes to the maintenance of reef biodiversity by providing refuge for a variety of other invertebrates. Sponges should be seriously considered in conservation programmes.

DECADAL CHANGES IN REEF FISH DIVERSITY IN THE CENTRAL VISAYAS
Whalen J, Baldisimo J, Garcia E, Bucol A, Williams J, Catania D, Alcala A, Carpenter K,

The central Visayan region of the Philippines is a global epicenter of marine fish biodiversity. Hypotheses attribute this peak of species richness within the Coral Triangle to processes that occur at the geological time scale. However, changes in biodiversity may occur on ecological time scales, allowing for the assessment of the potential impact of anthropogenic activity. Low species richness in the central Visayas, where a majority of coastal communities rely on marine resources for their livelihoods, has previously been associated with stressors such as habitat degradation, overfishing, and harvesting individuals for the aquarium trade. Many marine protected areas (MPAs) have been established throughout the Philippines in order to mitigate the cumulative negative effect of these stressors. While a majority of the country’s MPAs lie within the central Visayas, this region has been termed the “epicenter of conservation adversity” within the Philippines, in part due to the lack of proper enforcement that prevents the benefits of MPAs from being fully realized. This study examines patterns of diversity in selected reef fish communities within the Visayan region that were sampled in two distinct time periods: 1970s and 2010s. These two surveys used similar sampling methods and were conducted by the United States Smithsonian Institution and the California Academy of Sciences, respectively. Species accumulation curves, rarefaction curves, and other indices were utilized to create snapshots of species diversity from these distinct periods, thereby providing insight on how various factors may have impacted species diversity in the Visayan region over the past four decades.
CHANGES IN TROPHIC STRUCTURE OF FISH COMMUNITIES IN THE CENTRAL VISAYAS OVER A 40-YEAR PERIOD

**Baldisimo J,** Whalen J, Garcia E, Bucol A, Williams J, Catania D, Alcala A, Carpenter K,

Knowledge of baseline environmental and biodiversity data and long-term monitoring can improve conservation and management of marine resources. This enables effective marine protected area placement and management, and ecosystem-based management to help ensure the services and benefits natural systems provide. The Visayan region of the Philippines is a global epicenter of marine fish biodiversity that continues to incur impacts from anthropogenic activity and poor coastal resource management. Examining the trophic structure of fish communities can provide information on how fishing pressure and other factors are affecting this region. This study analyzes differences in the trophic structure of fish communities surveyed at various sites in the central Visayas by the United States Smithsonian Institution in the 1970s and the California Academy of Sciences in the 2010s. Fishes were classified according to their trophic ecology and abundances of each level were contrasted between the two time periods. Results reveal how trophic structure of fish communities has changed over four decades, and provides a useful framework to improve resource management.

EFFECTS OF LIGHT ON BEHAVIOR, GROWTH AND SURVIVAL OF *STICHOPUS CF. HORRENS* JUVENILES

**Rioja R,** Abesamis N, Meñez M,

*Stichopus c.f. horrens* are high value sea cucumber species known to be nocturnal, negatively phototactic and positively thigmotactic, but only observed at short periods. We examined these behaviors in relation to light using on 6-month old juveniles (4.27 g to 19.41 g) and younger post-settled juveniles (4-10 mm; 0 g; 62 days after fertilization) for 30 days. Six month-old juveniles were subjected to different light treatments (i.e., covered, exposed, half-covered) under natural light-dark cycle in aquaria with sediment, while post-settled juveniles were exposed to 3 photoperiods (i.e., 24L, 24D, and 12L:12D cycle) in glass jars coupled with either presence or absence of an artificial seagrass unit (ASU) as shelter. Absolute growth rate (AGR) and survival were calculated. Older juveniles in the half-exposed treatment hid at the corners of the shaded portion and usually with a conspecific, suggesting negative phototaxis and positive thigmotaxis. Positive thigmotaxis was also observed in the covered and exposed treatments. Contrasting results were obtained in the covered and exposed treatments, with the former having low AGR (-0.07 ± 0.03 g/day) and 100% survival, while the latter had high AGR (13.44 mg/g ± 4.57 SD) but low survival (50%). The difference might be due to varying food abundance in the sediment. The older juveniles were predominantly feeding at night throughout the experiment. In contrast, younger juveniles fed predominantly during the day (days 1 and 11), which then shifted to an average nighttime feeding (days 19 and 29). This shift is an indication of endogenous and developmentally determined nocturnal feeding. Although juvenile fed equally on the jar surface and the ASU, higher growth was observed in treatments with ASU. ASU could have provided additional substratum for the biofilm to grow and also minimized interaction among conspecifics. Further, the younger juveniles in 24D treatment with ASU had
the highest AGR (0.46 cm/day ± 0.04 SD) and survival (90%). Our results suggest that it is best to rear the both age groups at lowest light intensities to ensure survival. Addition of substrates for benthic algal growth, or other means of enrichment, can be explored to boost growth.

IN VITRO EGG LIBERATION AND FERTILIZATION OF SARGASSUM POLYCYSTUM IN RESPONSE TO DIFFERENT ENVIRONMENTAL CONDITIONS
Magcanta M, Uy W, Leopardas V, Dagapioso D, Cabactulan F,

The brown seaweed Sargassum spp. locally known as “samo” is subject to increasing overexploitation in the natural environment, thus culturing the species for mass production is recommended. Fertile fronds of Sargassum polycystum, were collected from selected sites of Iligan Bay in Southern Philippines. Approximately 20 reproductive receptacles were cut and placed in every petri dish and were administered in four different environmental conditions such as temperature, salinity, nutrients and desiccation under laboratory conditions. The dishes were arranged in a randomized complete block design in three replicates. Percent egg liberation and egg fertilization were observed and recorded daily at each treatment in every experiment for a maximum of two weeks.

All measured variables did not show significant difference (p>0.05) across temperature ranges of 20°C to 30°C and with desiccation up to 1 hour. However, salinity experiment showed significant difference across 20-45ppt with highest values obtained at ambient seawater (30-32ppt). *S. polycystum* also showed negative response towards the addition of AGP fertilizer, while the control (no fertilizer) obtained the highest values. This study suggested that the optimum condition for the release of eggs and subsequent fertilization can be achieved using ambient seawater (30-32ppt) with no added fertilizer.

INDUCTION OF PRECOCIOUS MOLTING IN MANGROVE CRABS *Scylla spp.*
Arteta A, Ferriols V,

Mangrove crab farming is a well-established aquaculture venture, with the production of soft-shell crabs presenting itself as a lucrative aspect of crab culture. Molting is a prerequisite for soft-shell crab production and several methods have already been studied to induce molting in a variety of crustaceans. To date, the effects of melatonin in relation to precocious molting have not yet been investigated in the edible crabs of the genus *Scylla*. It is therefore intuitive to determine the effectiveness of melatonin in inducing precocious molting in order to support efforts in soft-shell crab production.

In the present study, *Scylla* spp. with internal carapace width of 6.0-6.9 cm and body weight of 30.0-80.0 g were administered with melatonin at a dose of 10⁻⁷ mol/crab and saline solution (as control). The molt stages, survival rates, and mean internal carapace widths (ICW) of mud crabs in both treatments were determined and analyzed at the end of a 40-day period. Melatonin-injected crabs were observed to undergo precocious molting with a 48.15% molting rate whereas
saline-injected crabs remained in the intermolt stage. Increase in the mean ICW (7.53 ± 0.42) was observed in melatonin injected crabs. The survival rates of melatonin-injected crabs and saline-injected crabs were 100% and 82.61%, respectively. The results suggest that melatonin induced precocious molting in mangrove crabs of the genus *Scylla*, thus presenting melatonin administration as a potential strategy for soft-shell crab production.

EFFECTS OF FARNESOL AND GERANIOL AGAINST BACTERIA ASSOCIATED WITH ICE-ICE DISEASE FROM THE SEAWEED *Kappaphycus alvarezii* (DOTY)

**Miranda D**, Ferriols V,

Bacteria are said to play a role in the occurrence of ice-ice disease in commercially important seaweeds such as *Kappaphycus alvarezii*. Two bacterial isolates presumed to be Vibrio species were obtained from the thalli of *K. alvarezii* exhibiting signs of ice-ice disease as differentiated by colony morphology on TCBS agar. The antibacterial and anti-motility activity of the terpenoids farnesol and geraniol were evaluated against the isolates. Antibiotic disc diffusion assay on nutrient agar revealed that farnesol and geraniol were able to inhibit bacterial growth but at very high concentrations (800 mM). At 800 mM concentration, no significant differences were noted between the antibacterial effect of farnesol and geraniol on isolate 1 (12.50 ± 0.58 and 12.25 ± 1.50 respectively); however, geraniol (11.25 ± 0.50) exhibited significantly greater antibacterial activity than farnesol (8.75 ± 0.50) on isolate 2. Lower concentrations of farnesol and geraniol (80 mM and 8 mM) were only slightly effective in inhibiting growth of the isolates. In the motility inhibition test, both farnesol and geraniol significantly inhibited motility of the isolates at a low concentration of 1.5 mM, with geraniol exhibiting a greater inhibitory effect.

Ice-ice disease still poses as a considerable challenge for the seaweed industry but to date, effective strategies in managing the disease still lack detailed scientific solutions. The results of the current study point to the potential of natural products such as phenyl alcohols in controlling factors related to the infectiousness of bacteria associated with the disease. This research will therefore be useful to those who wish to address ice-ice disease in seaweeds by means of future biotechnology strategies involving the use of natural products.

PRELIMINARY EVALUATION ON THE EFFECT OF DIFFERENT SUPPLEMENTAL FEEDS ON THE GROWTH AND SURVIVAL OF JUVENILE SANDFISH *Holothuria scabra*

**Noran R**, Altamirano J,

The global demand for sea cucumber particularly sandfish *Holothuria scabra* continues to escalate because of its high economic value. Because of this, there is a spurring interest in massive artificial production of this certain commodity. Several nursery rearing and grow out techniques was developed and modified in order to enhance growth performance and survival, however growing them intensively in a tank-based aquaculture systems has not yet develop thus become one of the major bottleneck. This study evaluated the effects of various locally-available food sources on the growth and survivorship of juvenile (1.21 ± 0.05) sandfish reared in laboratory
in plastic bins (0.24 m$^2$) for 60 days with average stocking biomass of 250g m$^2$. Three supplemental feeding treatments were tested: dried Sargassum powder, Shrimp PL feed, and Milkfish fry feed. A control tank consisted of juveniles with same biomass and without any supplement. After 30 days, results showed that Milkfish fry feed and Shrimp PL feed gave the best growth rate (0.10 ± 0.02g d$^{-1}$; 0.08 ± 0.02g d$^{-1}$) while Sargassum powder did not support sandfish growth where they shrunk (-0.01 ± 0.00g d$^{-1}$). Meanwhile, sandfish relying only on natural biofilm with no supplemental feeding shrunk even more (-0.03 ± 0.01g d$^{-1}$). Survival rates were excellent for all feeding treatments (> 96%) except for sandfish that received no supplement or food supply (66%). Preliminary results gained in this experiment may provide viability options to intensify and augment production performance of sandfish in a tank-based system.

EVALUATING FACTORS RELEVANT TO THE REARING AND GROW-OUT OF JUVENILE Stichopus cf. horrens SEA CUCUMBERS
Abesamis N,

Effective culture and restocking of sea cucumbers is dependent on understanding the biology and ecology of a species throughout its life history. Inherent differences between species require distinct strategies in larval culture and juvenile rearing. This study evaluated the influence of food and shelter on the growth and survival of cultured Stichopus cf. horrens juveniles (0.8-15 g) during nursery rearing and grow-out. Specifically, it (1) examined the influence of macrophyte detritus as additional food on juvenile growth, behavior and biochemical composition and (2) determined the effect of experimental bottom-set trays, with or without artificial shelter, on juvenile growth and survival in the wild. The addition of macroalgal and seagrass detritus to sediments did not significantly influence juvenile growth rate and body composition, but significantly affected size variability, feeding rate and sheltering behavior. Juveniles provided with macroalgal detritus had the highest coefficient of variation in weight (40-51%) over time and a propensity to avoid sheltering near the sediments. This avoidance behavior was likely due to anoxic sediment conditions that developed in the sediments over time. Juveniles fed detritus had lower fecal production rates without any significant differences in growth, suggesting the availability of high quality food in the treatment aquaria. Experiments in the field demonstrated the viability of fully enclosed, bottom-set trays as a grow-out system for juveniles of this species. Average juvenile weight increased significantly over time and was not significantly different between trays with or without additional shelter. Juvenile survival was also high (94-100%) in all treatments. Positive growth rates throughout the experiment suggest that the bottom-set tray provided adequate food, shelter and shade for the juveniles during grow-out in the field. However, the significant decline in growth rates and increase in size variability over time imply that competition for food and space may be the limiting factors for juvenile growth in this system over a period of 60 days. These results provide valuable insights on the conditions relevant to and necessary for the optimal production of S. cf. horrens juveniles.
Variability on somatic growth of an organism suggests a mechanism that triggers this variation. To address this hypothesis, this paper describes the growth changes on shell length (SL), total weight (TW), adductor weight (AW) and gonad weight (GW) of the Noble Scallop *Chlamys nobilis* Gmelin 1791 before and after sexual maturity. For this study, 230 individuals of *C. nobilis* were sampled and subjected to various laboratory examination and biometrical analysis. Results revealed that SL, TW, AW and GW show different growth pattern before and after attaining sexual maturity at 57-60 mm SL. SL-TW and SL-AW show isometric growth (*b*=3, *P* < 0.05) before the scallop becomes sexually mature. After the sexual maturity period, SL-TW and SL-AW show negative allometry indicating that SL grows faster than the TW and AW (*b*<3, *P* < 0.05). SL and GW show allometric growth (*b* ≠ 3) in both cases. GW increases relatively faster than SL (*b*>3, *P* < 0.05) before sexual maturity was attained, but the reverse occurs after maturation whereby SL grows faster than the GW (*b*<3, *P* < 0.05). The simple allometric growth coefficient (exponent of *x*) reveals faster growth in the immature individuals compared with the sexually matured *C. nobilis*. Gonad weight increases at a greater rate in respect to shell height than that of the total weight and adductor weight both before and after sexual maturity. Condition index (K) shows significant differences before and after sexual maturity. Higher value of K was observed in the immature individuals compared to sexually matured *C. nobilis*. In general, the biometric traits grow at the same rate (i.e., isometrically) before maturity while the same traits grow at different rate (i.e., allometrically) after maturity. With the allometric growth after maturity, the length measures grow faster than the weight measures. Physiological growth mechanism is faster in the calcareous than the soft or flesh part of the organism. It is typical in animal growth trajectories that growth asymptote is reached faster in the shell portion than in the tissues under a given period.

**EFFECT OF INITIAL SIZE AT STOCKING ON THE GROWTH AND SURVIVAL OF SANDFISH (*Holothuria scabra*) JUVENILES REARED IN FLOATING HAPAS**

**Jontila J**, Gonzales R, Llavan N, Villanueva R, Junio-Mene M,

This study determined the growth and survival of sandfish juveniles reared in the oceannursery system using hapa nets in Rasa Island in Narra, Palawan. Early sandfish juveniles categorized as small (~3 mm ±1.3) and medium (~3.5±1.1 mm) were the Treatments (T1 and T2) for this study. Each treatment had three replicates with an initial stocking density of 1000 ind.hapa⁻¹. Rearing started in February 2018 and was done in two cycles, each cycle having a 30-day rearing period. For the 2nd cycle† stocking density was lowered to 250 ind. Hapa⁻¹ and monitoring for the Average Growth Rate (AGR) was done every 15 days. Nets were changed during each monitoring period to allow optimum growth. Individuals were counted and measured using CPCe. Results showed that survival during the 1st cycle was 75% and 56% with AGR of 0.42 mm and 0.44 mm for T1 and T2, respectively. Survival was significantly higher during the 2nd cycle at 96% for T1 and 94% for T2 (*p*<0.05). During the 2nd cycle, the AGR was higher after 15 days of rearing at 1.23±0.20 mm for T1 but only 0.009±0.26 mm for T2. After 30 days, the AGR dropped to 0.32±0.26
mm for T1 while it was down to -0.24±0.28 mm for T2. Such indicates that stocking density should be lowered after 15 days of rearing during the 2nd cycle to allow optimum growth of individuals† Overall, the results showed that rearing of juveniles measuring around 3mm in floating hapas is viable to grow them to a larger size (~30 mm or ~3 g) for 60 days that can be used for the grow out culture

THE MARINE RESEARCH CENTER OF THE BATANGAS STATE UNIVERSITY: THE VERDE ISLAND PASSAGE CENTER FOR OCEANOGRAPHIC RESEARCH AND AQUATIC LIFE SCIENCES
Saco J, Ronquillo T,

The Verde Island Passage (VIP) was dubbed as the world’s center of the center of marine shore fish biodiversity which is located on the southwestern part of the Luzon Island bordered by five provinces i.e., Batangas, Occidental, and Oriental Mindoro, Marinduque, and Romblon. With the popularization of the VIP, a number of researches already confirmed the vast biodiversity of the different marine organisms. However, the current situation in the VIP revealed continuous and increasing industrialization, tourism and human activities and even threatened by the global climate change. This poses a serious and detrimental effect to the VIP. Unfortunately, continuous monitoring of the different marine ecosystems and research on the different marine resources in the VIP is very scant due to the lack of immediate government agency prioritizing these tasks. To answer this call, the Batangas State University established the Verde Island Passage Center for Oceanographic Research and Aquatic Life Sciences or VIP CORALS. The center was approved on the 14th February 2018 by the University’s Board of Regents Resolution No. 004, Series of 2018. The center aims at providing research, teaching, and extension services of the Batangas State University on the marine resources and its marine environment in the VIP. At present, the almost one-year-old center have on-going institutional research on the biodiversity assessment and documentation of the different marine organisms in Verde Island; a number of seminar series and training courses among different stakeholders i.e., academe, local government units, non-government organizations; and extension services i.e., coastal clean-up, mangrove planting and capacity building. In the future, we envisioned to be the pioneer, leading, pro-active, and world-class research center on the field of oceanographic research and aquatic life sciences in the VIP. In addition, the center advocates collaborative works with institutions having shared vision and commitments on conserving the VIP.

PATING, SAAN KA PARARATING? -- UNDERSTANDING POLICY NEEDS FOR SHARK AND RAY CONSERVATION IN THE PHILIPPINES
Utzurrum J, Maguyon M, Cinches V, Oposa A, Yaptinchay A,

Conservation of sharks and rays in the Philippines is a trending topic among marine conservationists. A total of 116 species of sharks, rays, and chimaeras - collectively referred henceforth as “sharks” - are confirmed in Philippine waters while ~89 other species are unconfirmed or undescribed. Of these species nominally listed in the 2017 NPOA-Sharks, 57 species were considered IUCN Threatened Species and yet, to date, only 18 species are protected nationally from fisheries and trade through
the Philippine Fisheries Code as amended by R.A. 10654, which prohibits any trade of species listed in CITES Appendices. A few provincial and municipal governments have passed local legislation, through fishing bans of all shark species or species that are locally important or listed as IUCN Threatened species. Advocates have called for national government to protect more, if not all, sharks despite the current challenges to policy implementation and enforcement. A three-year roadmap for shark conservation was developed in 2017 to help policy-makers, key government agencies, researchers, and advocates navigate complex issues surrounding shark conservation in the Philippines. It takes into consideration existing and proposed policies and aims to provide a model for collaborative efforts to conserve Philippine sharks through their sustainable use and resource management, using best available information. This paper highlights some crucial issues and policy gaps identified, and activities undertaken to address these.

TOP-DOWN OR BOTTOM-UP? COMPARING DECISION-MAKING APPROACHES WHEN PROVISIONING WHALE SHARKS

Bottom-up resource management approach is becoming more popular as locals have started being a big part in decision-making on resource use. However, this study recommends that high-level government involvement (top-down approach) is needed for direct improvement of management in a whale shark tourism site in Cebu, Philippines. Oslob whale shark tourism is the world’s biggest non-captive whale shark tourist attraction, receiving >400,000 guests annually. Sharks here are provisioned daily, year-round, with unknown long-term consequences. The tourism began in 2012 by Tan-awan Oslob Sea Warden and Fishermen Association (TOSWFA), the local tour operator accredited by the Oslob’s local government. Since then, only minimal action has been done to aim for best practices despite >400 million PHP gained from sales every year. In 2018, Cebu’s provincial government advised TOSWFA in 2018 to improve tourism management, or that it might face closure. A technical working group (TWG) was formed to assess the issues and guide TOSWFA on to better regulate and control their tourist activities. LAMAVE has shared results from >6 years of research, including daily in-water work and visitor and community surveys in Tan-awan, with TWG. Recommendations were given based on the inputs from past studies and best international practices. This includes reduction of crowding, boat-shark contact, and limiting the amount of food and length of the provisioning. TOSWFA, provincial and local government has compromised to a decision of limiting tourists to 800/day, approximately 50% of current daily tourist visits (as of October 2018), based on social norm and tourist satisfaction results. This study notes events that leads to the current situation of Oslob’s tourism management and compares the outcomes of top-down versus bottom-up approaches. A bottom-up approach of self-regulation failed to move towards best practices at Oslob despite the weight of research evidence presented. The success of the top-down approach is not yet clear as stakeholders have yet to implement the changes and assess its sustainability. This case study illustrates some of the challenges with whale shark tourism management and the need to combine top-down and bottom-up management strategies to achieve conservation goals.
Numerous private groups and government agencies are pushing to reclaim much of coastal and nearshore Manila Bay. Their primary motivation is to create additional urban space for the expansion of Metro Manila, a megacity of 12 million people. These spaces are mainly envisioned for commercial and industrial use and to create more urban villages. But at what cost?

Manila Bay was once a productive fishing ground. Unfortunately, destructive fishing practices, massive pollution, and unabated land conversion of wetlands and coastal environments have contributed to the destruction of Manila Bay’s marine ecosystem.

Much of coastal Manila Bay used to be covered by extensive mangrove forests and lush seagrass beds. These biodiversity hotspots are home to many species of aquatic and terrestrial wildlife; additionally, these also serve as habitat and spawning areas for many economically-important marine species. Government data show that many pelagic species can still be found within the waters of the Bay. Destruction of these ecosystems have disrupted the food chain causing the reduction of fishery populations. This has resulted in the loss of an important food source and income for many of the coastal communities of Manila Bay.

Urban expansion, the goal of the proposed land reclamation projects will displace thousands of communities whose food and livelihood greatly rely on the health of Manila Bay, thereby increasing their vulnerability. They are already exposed to numerous natural hazards, particularly those related to earthquakes and hydro-meteorological events. The effects of these hazards are exacerbated by climate change and accelerated land subsidence due to over-extraction of groundwater. The confluence of natural hazards and increasingly vulnerable populations with limited resilience will result in a much higher disaster risk. The Philippine government has a clear directive to rehabilitate and preserve Manila Bay through the writ of continuing mandamus issued by the Supreme Court. Scientific evidence clearly shows the adverse environmental and socio-economic effects of reclamation. Land reclamation directly contradicts that mandate. Therefore, any rehabilitation and preservation policies for Manila Bay should be clear and unambiguous: reclamation activities must stop.

Recently, the policy on redefining units of managing fisheries in the country was enacted - Fisheries Administrative Order 233, “Establishment of Fisheries Management Areas (FMA) for the Conservation and Management of Fisheries in
Philippine Waters. “The policy emphasized the use of ecologically right scale units rather than political boundaries and could be a catalyst to meaningful changes in the fisheries sector. Among the long-standing contentious issues this policy could help resolve is the conflict between the commercial and the municipal fishing sector. It is also seen as a platform wherein: preferential rights; appropriate management actions specific to the fisheries and other natural resources; harmonized governance of mandated government agencies (LGUs and BFAR); and science-based decisions, will be fully realized. All these nuances will be discussed here.

COLLABORATIVE EFFORTS: SUPPORTING SEA TURTLE MONITORING AND CONSERVATION IN MYANMAR

Ong S, Myint K, Zaw Oo P, Howard R,

Historical data from Myanmar’s delta region reported nesting populations of 3,750 Lepidochelys olivacea and 5,000 Chelonia mydas, with 1.5 and 1.6 million eggs harvested annually respectively in late 19th century (Maxwell, 1911). Presently, Myanmar sea turtle nesting and foraging ground populations are in decline (Maung Maung Lwin, 2009; Ko Myint et al., 2017) with unregulated harvesting of turtle eggs for local consumption playing a major role coupled with bycatch in Myanmar’s trawling fleet. In October 2016, a Sea Turtle Technical Working Group (TWG) was formed to address these issues and developed a national sea turtle conservation program. The TWG works aim to enhance survey methodologies, identify and mitigate existing major threats for sea turtle populations in Myanmar, build local capacity and awareness. Since 2017, a series of turtle identification and survey workshops were conducted for members of the TWG, beach patrollers and Myanmar fisheries officers. Capacity building was extended internationally by engaging in collaborations with regional partners in Southeast Asia including a fellowship with Large Marine Vertebrates Research Institute Philippines, providing technical support to Myanmar sea turtle practitioners in field surveys and data management. The preliminary results of nesting distribution among 6 sites showed occurrence of three (3) species Chelonia mydas, Eretmochelys imbricata and Lepidochelys olivacea, with a minimum of 145 nesting in less than a year between the fall of 2017 and 2018. This collaborative effort is a step forward in supporting sea turtle monitoring and conservation in Myanmar, building potential partnerships, and an experience in enhancing plans for sea turtle research and conservation in the Philippines.

THE PLIGHT OF BLACK NODDY Anous minutus worcesteri in Tubbataha Reefs

Pagliawan M, Songco A, Jensen A,

The subspecies of Black Noddy Anous minutus worcesteri is endemic to the Philippines and has been found to breed only in the Cagayan Ridge. Tubbataha Reefs Natural Park (TRNP) in the Sulu Sea is the last known intact breeding ground for this species. This study looked into the population development of A. minutus worcesteri in TRNP from 2004 to 2018, the threats they face and the management interventions to conserve the species. Data was obtained from the TRNP seabird monitoring. From 2004 to 2013, the adult population of the species was increasing, with the highest number of breeders in 2013. A decline in the population was
observed in 2017 and 2018. This coincided with the loss of vegetation, specifically of mature trees, in the two islets of TRNP. *A. minutus worcesteri* nests on trees; thus, the deterioration of vegetation, coupled with habitat competition with Red-footed Booby *Sula sula*, posed a threat to the remaining population of this endemic sub-species. Other threats to the population include marine debris and erosion of the islets. Park management implemented measures to provide breeding habitats for the species. Temporary structures using bamboo sticks and poles were built to serve as nesting areas. This experiment explored different designs of the structures to ensure maximum nesting turn-out of the *A. minutus worcesteri*. Our initial observations suggest that *A. minutus worcesteri*, in the absence of options, utilized the man-made nesting structures but appeared to have a preference on the configuration of the structures.

INITIATING ADAPTIVE FISHERIES MANAGEMENT IN TINAMBAC, CAMARINES SUR, PHILIPPINES


The main focus of fishery management is to manage fishing mortality at a desired level. However, due to the dynamic fishery systems, fluctuating environmental conditions, variable fishing behaviors and economic conditions, achieving the multiple biological, ecological and socio-economic objectives simultaneously is often difficult to attain. Moreover, available data is often incomplete, uncertain, and accompanied by biases. Nevertheless, the Municipality of Tinambac initiated an adaptive fisheries management strategy using data-limited assessment methods that allow managers to use available data to make more informed estimates of how their fishery population is doing. A combination of catch, CPUE, underwater visual survey and violation data were used to initially evaluate the fisheries in the locality. Introducing the concept of harvest control rules, target and limit reference points were initiated and integrated into workplan and management plan of Lamit Bay, and as a discussion point of the management body. By combining the results of several assessment types, a broader view of the condition on their fishery is observed of which provided management guidance for managers to adaptively manage their resources moving forward. The adaptive fishery management process and results are presented in this paper.

ASSESSMENT OF FISHING ACTIVITIES IN THE SEAGRASS BEDS OF CONCEPCION, ILOILO

*Beniga K*, Regalado J, Campos W, Bagarinao A,

Seagrass beds are crucial habitats that serve as a habitat, nursing ground, and food source for many different marine species. However, despite of its wide array of ecosystem services that it offers, the role of the seagrass beds as a coastal fishing ground is mostly overlooked and unrecognized compared to coral reefs. The limited information for proper management and regulation of fishing in seagrass beds can lead to an increased risk of overfishing in coastal waters. In the Philippines, the municipality of Concepcion is one of the coastal municipalities in the province of Iloilo known for its high fish production. In this study, we assessed fishing practices
that utilize the seagrass habitats in four barangay of Concepcion, Iloilo. A focus group discussion was conducted with local government officials and fisherfolks from barangays Bacjawan Sur, Polopinia, Maliogliog, and Talotu-an. Twelve to eighteen fishing gears and practices were identified from the four barangays. Fishing gears like the bottomset gillnets (palubog), fish traps, multiple handlines, encircling gill nets equipped with fishfinders (likos), and ring nets (kubkuban) was estimated to have the highest annual catch. Results from the fishing gear mapping activity revealed that gleaning, push nets using fine meshed nets, beach seines, and gillnets operate on the seagrass beds. Conches, oysters, and cockles were commonly caught during gleaning in seagrass areas. Fine meshed nets and seines catch a wide variety of fish and invertebrates such as mullets, ponyfish, shrimp, squids, cuttlefish and other juvenile fish. Systematic assessments of coastal habitats, fishery resources and practices from this study can be used to for coastal resource planning and management for the local government of Concepcion.

MANAGING A BAY FOR BETTER FISHERIES: THE CASE OF BRGY. SAN ANTONIO NUEVA VALENCIA, GUIMARAS
Novilla C, Bañas J, Eslopor J, Gatilogo K, Ombrog K,

Environmental degradation continue despite efforts taken on a global scale to mitigate impacts of climate change and anthropogenic activities. Worldwide trends point towards declining air and water quality, depleting resources that are otherwise renewable, and loss of habitats and endemic species. As a result, development is impeded and quality of life diminishes (PEMSEA, 2003). To contribute to growing body of literature on inclusive and multi-sector approaches to coastal management as well as inform future development of the study site, Brgy. San Antonio, Guimaras, this study was anchored on three (3) objectives. The study took stock of the biogeophysical, socio-economic, and institutional profile of the community; identified ridge to reef issues and concerns of the community; and provided recommendations to inform future interventions, laws, and policies in benefit of the community. The study utilized the rapid appraisal of fisheries management systems (RAFMS) approach to gather primary and secondary information using the following tools - simple biophysical assessment, semi-structured interviews, group interviews, participatory resource mapping, and gear matrix. This study also used the SWOT tool and the logical framework to analyze the data gathered guided by the sustainable development principles and integrated coastal management (ICM) framework. This study identified various factors to the rapid degradation of the San Antonio Bay and its resources; to name - overpopulation, illiteracy rate, weak institutions, siltation, unsustainable fisheries, congestion, quarrying, and lack of solid waste management infrastructure, among others. Thus, this research acknowledged the diverse threats to the community, hence the researchers aimed to address these issues through a community-based crafted development plan to further guide interventions, laws, and policies in benefit of the community.
Milkfish, *Chanos chanos* Forsskal, continue to contribute towards sustaining the fish food needs of the country in the midst of emerging food security issues, increasing food prices and environmental problems in the Philippines. The consumption of milkfish in the country increased from 4kg to 7kg/capita/year over the past two decades in spite of fluctuations in production volume during this period. Hence, one of the key targets of the country's Comprehensive National Fishery Industry Development Plan (CNFIDP) is to increase the annual production of milkfish by four percent and to improve processing and value-adding options for milkfish.

Milkfish, being euryhaline species, has been successfully cultured throughout the country in brackishwater, freshwater and marine water environment using a variety of culture systems or enclosures such as ponds, pens, cages, tanks and raceways. However, farming of milkfish in these environment types is often confronted by economic and environmental challenges. The adoption of IMTA by many small-holder mariculture operators is envisioned to help mitigate pollution of coastal areas while making milkfish available to consumers, and address the “price squeeze” confronting milkfish farmers due to increasing feed cost vs. stagnant market prices. This paper emanates from a study on “Community-Based Small-Holder IMTA (Integrated Multi-Trophic Aquaculture) Milkfish Mariculture in Guimaras, Philippines” under the JIRCAS research project “Development of technologies for sustainable aquatic production in harmony with tropical ecosystems”. The SLA as applied to IMTA project stakeholders involving fisher folks, local government and women in fish value-adding showed that there were some increments, but variable, in the acquisition and development of all five livelihood assets (i.e. human, physical, financial, environmental and social) during the three evaluation periods considered in the series of socioeconomics studies implemented under the abovementioned project from 2015 to 2018. Results of SLA application as an impact assessment framework in promoting and evaluating the adoption potentials of IMTA in milkfish mariculture showed an array of long-standing limitations. Research, industry, governance and policy recommendations all require collective public attention and action to secure benefits from IMTA in milkfish mariculture.

**MONITORING BOAT ACTIVITY OF A SMALL-COMMERCIAL GILL NET BASED IN AJUY, ILOILO**

*Regalado J, Monteclaro H, Ferrer A, de Guzman A, Napata R,*

Small-commercial gillnets contribute significantly to sardine catch in the southwestern portion of the Visayan Sea in central Philippines. Catches and boat activities of these fishing vessels are however not often monitored. This study aimed to monitor boat activity of a small-commercial gill net based on Ajuy, Iloilo. The monitoring was done for 10 days using a GPS logger. Total fishing time (search time and actual fishing time) lasted on average for 3.4 hours and started at 3:30AM and ended at around 7:00 AM. Boat tracks indicate that the fishing operations took place in the municipal waters of Ajuy reaching to waters of neighboring municipalities E.B.
Magalona, Sagay City, and Manapla. Circular patterns in boat tracks determined the location where deployment of the gillnet took place. Water depth where deployment was conducted was on average 17.7m. Annual catch for sardines based on the records of the captain monitored small-commercial gillnet was 14,560 kg. The boat tracks from GPS loggers can help in refining catch and effort data and provide more accurate data of the spatial extent of fishing operations. These data could complement methods in collecting fisheries information such as interviews, catch logbooks and seaborne surveillance.

Small-commercial gillnets contribute significantly to sardine catch in the southwestern portion of the Visayan Sea in central Philippines. Catches and boat activities of these fishing vessels are however not monitored and accounted for by government agencies. This study aimed to monitor boat activity of a small-commercial gill net based on Ajuy, Iloilo. The monitoring was done for 10 days using a GPS logger. Total fishing time (search time and actual fishing time) lasted on average for 3.4 hours and started at 3:30AM and ended at around 7:00 AM. Boat tracks indicate that the fishing operations extended from municipal waters of Ajuy reaching to those of neighboring municipalities E.B. Magalona, Sagay City, and Manapla. Circular patterns in boat tracks determined the location where deployment of the gillnet took place. Water depth where deployment was conducted was on average 17.7m. Annual catch for sardines based on the records of the captain monitored small-commercial gillnet was 14,560 kg. The boat tracks from GPS loggers can help in refining catch and effort data and provide more accurate data of the spatial extent of fishing operations. These data could complement methods in collecting fisheries information such as interviews, catch logbooks and seaborne surveillance.

VALUE CHAIN ANALYSIS OF THE SEAWEED INDUSTRY IN TAWI-TAWI
Amil F, Halun S, Burias D, Jumaide N,

Seaweed farming is a major economic activity in Tawi-Tawi. Unfortunately, the seaweed industry has been beset with various issues and problems such as declining production and poor quality of raw dried seaweeds. This study assessed the seaweed value chain in Tawi-Tawi using structured questionnaires and focus group discussions. Farmers cultivate several varieties of *Kappaphycus* and *Eucheuma* using the fixed off-bottomand floating methods. Seedlings are provided by fellow farmers or seaweed traders (bodega owners) or from their previous harvest. Some farmers get their initial capital from traders with the understanding that the farmers will sell their harvest to them. A common problem in seaweed farming is ice-ice disease and epiphytes. Ice-ice disease is observed during abrupt changes in temperature. Epiphyte growth occurs when there is no wind and water becomes stagnant. There is also widespread use of fertilizers to increase production. Seaweeds are dried using stilts dryers or hanging method and packed in sacks prior to being sold to local traders. Local traders or consolidator ship raw dried seaweeds to Zamboanga or Cebu because there is no seaweed processing plant in Tawi-Tawi. These results suggest that the quality and volume of raw dried seaweeds are influenced by seedling quality, farming method, environmental conditions and drying method. The results of the value chain analysis of the seaweed industry will
provide inputs to stakeholders, policymakers and decision makers and promote the sustainable development of the seaweed industry in Tawi-Tawi.

INITIAL EXPERIENCE ON REGULATING ACCESS OF IN MUNICIPAL WATERS
Amolo R,

Municipal water is critical to effectively manage fisheries in the country. These highly productive waters along with vital nearshore ecosystems are a common fishing grounds of most municipal fishers. City / municipal government units have the primary jurisdiction over these areas play a significant role in managing its uses and users, protection of essential habitats. Despite the regulatory, protection and direct manage mandate to local government units, open access regime persist. Managing access and regulation fishing activities are among the critical program by local government units (LGUs) to sustain fisheries in the nearshore areas. This paper presents initial output, process and challenges of 20 LGUs in the managing access in the respective municipal waters. These regulations include various control such as fishers and gears registrations, establishment of closed seasons, effective protection of marine protected areas, water use zoning, establishment of manage access areas. It will also present important learnings, challenges and initial output in the implementation of these regulations.

VALUE CHAIN ANALYSIS OF THE SEA CUCUMBER INDUSTRY IN TAWI-TAWI
Jumaide N, Sakilan A, Burias D, Bara A, Mohammad K, Tarabasa R, Amil F, Muksin H, Halun S,

Sea cucumbers are of high demand and command high prices in Asian markets. Sea cucumbers are an important source of livelihood in Tawi-Tawi. This study analyzed the sea cucumber value chain in Tawi-Tawi using questionnaires, focus group discussions and semi structured interviews. The initial results show that 26 species of sea cucumber are harvested commercially. The municipalities of Bongao, Languyan, Sitangkai and Simunul are the main suppliers of sea cucumbers in the province. Holothuria scabra, Bohadschia marmorata, Actinopyga lecanora and Actinopyga echinites were collected in high volumes. Holothuria fuscogilva commands the highest price at 5,000/kg followed by H. scabra and at 4000/kg. Low value species such as B. marmorata are also collected suggesting that the supply of high value species cannot meet the demand for sea cucumbers. Dried sea cucumbers are sold to traders in Bongao, Tawi-Tawi which are then shipped to Zamboanga. Dried sea cucumbers from Sitangkai are sold to local traders and the traders either sell them to Zamboanga or Sabah, Malaysia.
KNOWLEDGE, PERCEIVED THREAT, CUES TO ACTION, AND SELF-EFFICACY: IMPLICATIONS FOR SAN JOAQUIN, ILOILO MARINE RESERVE AND SANCTUARIES’ PROTECTION AND REHABILITATION PROGRAM

Ylayron M, Sansait J, Sansait M,

One response to global resources depletion in the coastal areas is the setting up of marine sanctuaries at various local sites and 24 of which are found in the municipality of San Joaquin, Iloilo, Philippines. With the need to continuously engage communities, this research was conducted to describe how likely the stakeholders in the southern town of Iloilo will support programs that would greatly benefit both their marine resources and the fishing livelihood of the municipality. Results revealed that of 38 respondents (M=28.6, SD=18.96), majority are young (68.4%); majority scored high on broad level of knowledge (60.5%) but low on specific knowledge (28.9%): on the percentage occupied by ocean on earth; on the number of marine reserves in San Joaquin, Iloilo; on the nature of open and close season fishing; and on mangroves’ as well as of the corals’ importance to coastal habitat. Majority have high perceived seriousness (86.8%) on the likelihood to suffer tragedy if pertinent laws and policies were not consistently implemented as well as if their communities remained uncooperative to coastal protection program, but have moderate perceived susceptibility (60.00%) to the likelihood that the destruction of mangroves and corals will have negative effects to their community and livelihood. Majority have expressed a fair level of self-efficacy (67.1%) and cues to action (71.9%): observed someone perform damaging acts to the coastal environment; have encountered reading materials related to managing coastal resources; and, have received advices from someone in their neighborhood regarding coastal protection. Strong perceived correlation was observed between perceived threat and “Lack of cooperation...” (r(38)=.83, p=.001); and there was a positive but weak correlation between perceived susceptibility and “Lack of cooperation” (r(38)=.35, p=.03). Research implications point to the need to improve the stakeholders’ understanding of the interrelated concepts that define coastal ecology. Similarly, educational inputs and workshops should include and highlight the precariousness of coastal resources and their real immediate effect to coastal resources and livelihood in order to increase levels of sensitivity and cooperation of the municipality’s stakeholders.

PERFORMANCE OF CORAL REEF MARINE RESERVES IN PANAY ISLAND, WESTERN VISAYAS, PHILIPPINES

Maliao R,

The performance of coral reef marine reserves in Panay Island in Western Visayas, Philippines was surveyed using Ostrom’s Institutional Analyses and Development (IAD) Framework as an analytical paradigm. A total of 32 marine reserves were surveyed covering the provinces of Iloilo, Antique, Aklan, and Capiz with a total of 2,208 respondents. I evaluated the perceived performance of marine reserves using 9 performance indicators categorized in 3 performance criteria (economics, environment, and sustainability). The respondents viewed a ladder-like diagram with 10 steps, where step 1 represented the worst possible scenario and step 10 the best possible scenario for each indicator in 3-time frames: before marine reserve, present (2016-2017) and 5 years into the future. Overall, marine reserves in Panay Island were perceived to have a significant positive performance. However, the
performance of each of the indicators was mixed across reserves. In general, although marine reserves were perceived to be effective in empowering the local fishing communities, their perceived impact on improving the state of the local fisheries resources remained limited. This highlights the importance of incorporating ecological and socio-economic considerations in setting reef fisheries management regimes.

ESTABLISHING A MUDCRAB SANCTUARY IN GUBAT, SORSOGON: INITIAL PHASE
Faburada A,

Coastal and fisheries resources’ contribution to the local economy is always undervalued. This is either due to the fact that data collection and analysis is not seriously invested or there is no capacity to implement monitoring, evaluation, and feedback program. In the Philippines for instance, around 1,800 protected areas are already established (Cabral, et.al. 2014) with varying levels of effectiveness and achievements in terms of the goal/s of its establishment. Most of these marine protected areas are coral reef based, though few MPAs for special purposes are now beginning to be legally declared and supported by communities. With the popularity of MPAs as a habitat and fish stock recovery strategy more Local Government Units in the Philippines are adopting and establishing such.

The municipality of Gubat, Sorsogon is among Local Government Units that is seriously implementing coastal fisheries reforms. Aside from establishing and managing three marine protected areas the municipality ventures into another first in the region - a mudcrab sanctuary. This paper presents the initial phase of establishing the Gubat Mudcrab Sanctuary. Mudcrab as a very important fishery commodity in the Philippines is abundant in the coastal area of Gubat as evidenced by the existing trade of crablets and its earlier stage and the economic derived from the business, and the claim that the area is considered to be a mud crab critical habitat, breeding and hatching ground in the Pacific region.

Under its Fish Forever program, a total of 72 hectares was declared composed of old growth mangroves, seagrass and coral reefs. Supported by science in terms of determining the right species and a campaign to inform the community to support the program as well as government investments, the pilot project hopes to succeed and become a model mudcrab sanctuary for the country, aside from its regard as an aquaculture commodity only. The study also presents an innovative way of determining baselines on the mudcrab population in the area that will be the basis on the impact of protected in the years to come.

STATUS OF THE CORAL REEF CONDITIONS OF THE MARINE PROTECTED AREAS IN LANUZA BAY, SURIGAO DEL SUR
Seronay R, Calagui L, Masangcay S,
Regular monitoring of the coral reef condition of the Marine Protected Areas (MPAs) in Lanuza Bay can provide evidence on effective MPA management. This study aims to determine the current condition of benthic coral cover and reef fishes richness, abundance and biomass in the MPAs of Carrascal, Cantilan, Lanuza, Cortes and Tandag City, Surigao del Sur. Detailed assessment of the benthic and reef fish community were made using a photo transect method and fish visual census, respectively. Of the 36 sampling sites (19 sites inside MPA and 19 sites outside MPAs), 12 sites were considered as excellent and eight sites as fair. Twelve out of 19 MPAs coral condition inside the MPAs in Lanuza Bay classified as excellent. Poor coral condition however, were observed inside Caglayag MPA, outside Ayoke Island MPA and inside Tag-anongan MPA. Good and excellent coral reef conditions in many of the MPA are indications that proper and strict implementation of policies and management on MPAs were effective. For the reef fishes, eight MPAs were scaled very high for species richness and moderate densities. In terms of biomass, 12 MPAs scaled very high attributed by the deep bodied target fishes. Ayoke (outside MPA), San Pedro (inside and outside MPA) and Caglayag (outside MPA) have similar patterns of having poor species richness, with very poor density and very low to low biomass levels. Generally, the survey reflects that reef fishes within Lanuza Bay are diverse and abundant particularly those from Lanuza and Cortes, Surigao del Sur indicating efficient MPA management.

COMPETENCE ASSESSMENT OF MANAGERS AND PRACTITIONERS TOWARDS IMPROVED MANAGEMENT OF SELECTED MARINE PROTECTED AREAS IN LANUZA BAY, SURIGAO DEL SUR, PHILIPPINES

Guirjen J,

Marine protected areas (MPAs) have been significant interventions in coastal and fisheries management and its success is brought about by several factors typically aligned to the principles of good governance with human resource and budget capacity as the strongest predictors of its conservation impact. In Lanuza Bay, which is considered as one of the key marine biodiversity areas in the Philippines stretching 121 kilometers and covering an aggregated municipal water of 127,325 hectares are 18 Marine Protected Areas that vary in size, age and management effectiveness level. Utilizing the Competence Assessment Tool developed under the SmartSeas program, the study assessed the competence of individuals involved in the management of Marine Protected Areas in selected areas from executives down to the skilled workers with the aim of providing a set of building blocks that can guide and open opportunities for better protected area management. Moreover, results of the study determined the significance of competency scores and its relationship to the MPA management effectiveness based on MPA MEAT results.

MPA EFFECTIVENESS EVALUATION: EVALUATING THE RELATIONSHIP BETWEEN THE MEAT AND BIOPHYSICAL INDICATORS OF EFFECTIVENESS

Schram L,

The organisational aim of MCP is to assess the effectiveness of MPAs by identifying key indicators of productivity, resilience, and criteria for site selection to enhance the likelihood of success from that initial point of selection. The data is analysed to
contribute toward goal-oriented management coordinated by the full range of stakeholders.

The methodology is intensive, representing the MPA ecosystem to the highest degree feasible. Stratified random sampling is used to monitor reef fish (belt transect), substrate (PIT), and invertebrates (belt transect) employing the use of 30m transect lines over continuous reef. Monitoring is conducted across twelve sites at depth ranges of 3-7m, 9-13m, and 15-19m. Approximately 36 replicates/site are completed seasonally (every 3 months) resulting in a minimum of 2,000 surveys/year. The number of replicates required to collect statistically viable information was determined by assessing inherent variability within the highest diversity site.

MPA effectiveness indicator species were identified using the legal context of the MPA (food security) and social data from fishermen and fish markets. Commercial reef fish biomass was selected as a primary indicator of effectiveness since it is a direct indicator of commercial productivity. Substrate composition and resilience were considered indirect indicators of effectiveness, being essential for maintaining a source of food security over the long-term. Invertebrate indicators are those determined to be commercially important and those that play an essential part of the food web, contributing toward productivity, and maintaining the stable state of the coral-dominated ecosystem.

Here we present our findings, exploring the relationship between the MEAT score for these MPAs and evaluating their relative effectiveness from biophysical indicators. This assessment is designed to assess how well the MEAT measures MPA effectiveness from the legal and social context, and where deficits lie. Defining these deficits can help to improve the management of MPA ecosystems, highlighting how monitoring and evaluation should be used to build an iterative process toward a management effectiveness that generates the social and ecological goals outlined in the management plan.

ASSESSING THE ROLE OF SEASONAL VARIANCE IN THE EVALUATION OF COMMON INDICATORS OF MPA EFFECTIVENESS

Kavanagh A,

Coral reef and mixed habitat MPAs are dynamic ecosystems that require intensive monitoring and evaluation to accurately represent the ecosystem and detect changes over time. Marine Conservation Philippines has been collecting seasonal data from six MPAs in Southern Negros, Philippines, over the past two years to assess the role of natural seasonal variance in the fluctuation of MPA effectiveness indicators. By doing so, monitoring and evaluation techniques can be refined to accurately account for that natural variation, and develop a greater interpretative capacity for MPA management.

Data were collected from six MPAs employing randomly stratified 30m transects at 3 separate depth ranges (3-7, 9-13, 15-19). Point intercept transects were used to determine substrate cover with belt transects used for fish and invertebrate. Sample size was determined using a Bayesian approach, assessing the likelihood of precise
information being collected with minimal replicates from the highest diversity MPA ecosystem. Using this approach, a minimum of 36 replicates were collected at each site per season. Seasons were defined according to PAGASA standards.

Coral cover and fish biomass are commonly chosen in the Philippines as the primary indicators of MPA effectiveness. As such, these indicators, as a part of the broader substrate composition and fish community, were calculated and assessed against seasonal rainfall and temperature variations. The relationship between cover coral and fish biomass was explored, together with contributions made by other substrate organisms such as algae and sponges.

The outcome of this analysis can provide useful insights into the use of coral cover as an indicator of MPA effectiveness; and has the potential to provide similarly useful insights into the role of fish biomass, and species abundance, in the maintenance of the coral-dominated stable state.

MANAGEMENT EFFECTIVENESS OF MARINE PROTECTED AREAS IN TAWI-TAWI, PHILIPPINES

Irilis R, Harun N, Muallil R,

Tawi-Tawi is the southernmost province of the Philippines composed of more than 300 islands/islets. It has huge coral reefs that are among the most pristine in the country, but unfortunately also among the most threatened due to the increasing demand for high-value reef fish and the prevalence of destructive coral reef fishing practices. Establishment of no-take marine protected areas (MPAs) is a common initiative implemented for coral reef conservation in the Tawi-Tawi. Currently, there are already more than 20 MPAs established in Tawi-Tawi, with assistance from Non-Government Organizations (NGOs), and about half of these MPAs are more than ten years old already. In this study, we assessed the management effectiveness of these MPAs using the MPA Management Effectiveness Assessment Tool (MPA MEAT). Results showed that the MPAs could hardly pass level 2 (Strengthened) of the MPA MEAT. Management effectiveness was highest in terms of “community participation” and “legal instrument” but weak in all other areas especially in “enforcement”, “financing” and “monitoring and evaluation (MandE)”. The strengths indicate the strong support of both the LGUs and the local community for MPAs. On the other hand, the weaknesses indicate challenges for the LGUs to enforce the laws against violators, the lack of opportunity for tourism development and other income-generated activities for MPAs, and simply the lack of technical skills or outside assistance to conduct regular MandE activities. Recommendations to improve and sustain MPAs effectiveness and other initiatives for coral reef conservation that are culturally-sensitive will be presented.

SYSTEMATICS OF THE FAMILY SCYTOSIPHONACEAE (ECTOCARPALES, PHAEOPHYCEAE): CURRENT PERSPECTIVES AND OUTLOOK

Santiañez W,

The complex systematic problems in the brown algal family Scytosiphonaceae presents an interesting case study on how molecular information is shaping our
understanding of global marine algal biodiversity and systematics. Herein, I provide a synthesis on the current taxonomy and classification of the Scytosiphonaceae in light of the taxonomic and nomenclatural revisions that were proposed recently based on integrated information from multi-gene phylogenies, morpho-anatomies, and life histories. Systematic changes included the proposal of three new genera (i.e., Planosiphon, Dactylosiphon, and Pseudochnoospora), the discovery of a monotypic genus Tronoella, as well as descriptions of new taxa under the genus Hydroclathrus and Rosevingea, all these, being made in a span of a year. These efforts to disentangle the intricacies within the Scytosiphonaceae point to the need for wide-scale efforts if we are to resolve the taxonomic, nomenclatural, and molecular phylogenetic issues in the group. Despite several new taxa being discovered among cold water representatives, I encourage a shift of focus on studying the Scytosiphonaceae of the tropics as they currently pose among the most pressing and challenging questions in the systematics and phylogenetic relationships within the family. It is expected that, upon closer inspection, several new taxa will be discovered at different phyletic levels and that such discoveries will, hopefully, resolve the problem in the Scytosiphonaceae.

INSIGHTS ON THE MICROBIAL COMMUNITY AND GEOCHEMISTRY OF HIGH TEMPERATURE SEDIMENTS AND MICROBIAL MATS IN A SHALLOW HYDROTHERMAL VENT IN MABINI, BATANGAS

Elegado A, Conaco C, Rodolfo R, Cardenas M, Lapus M, Jaraula C,

Geothermal activity along the coast of Mabini, Batangas manifests in the form of shallow hydrothermal vents with temperature and CO2 partial pressure measurements significantly higher and pH much lower than ambient levels. Sediments and flocculent microbial mats found at the localized vents are hypothesized to be geochemically distinct substrates for microorganisms participating in chemosynthetic and photosynthetic processes. Understanding the microbial ecology, as well as the carbon and energy dynamics of microbial communities in these systems provide another dimension into how these complex coastal environments are modelled. DNA and lipid biomarkers were extracted and analyzed from the microbial mats to provide insight into the microbial diversity and their potential roles in the biosynthesis of organic compounds, as well as the biosignatures that might be representative of the site geochemistry. Comparison of 16s rRNA gene PCR-DGGE band patterns between mats and nearby sediments reveals complex assemblages of bacterial groups with some ubiquitous to all matrices while others unique to each type of sample. Elevated concentrations of polyunsaturated fatty acids (PUFA) and markers for both chemosynthesis and photosynthesis were present in high temperature substrates with 16s rRNA gene sequence data identifying dominant groups related to Chloroflexi and Cyanobacteria. C19 and C20:1 fatty acids are corroborated with 16s rRNA gene sequences as putative markers for Aquificales and Zetaproteobacteria, respectively. The former group was shown to be distinctly abundant in mats, and have also been described in other hydrothermal environments. The unique setting in Mabini, Batangas with pCO2 and pH ranging from ambient seawater to relatively extreme provides novel opportunities for understanding biogeochemical and ecological processes associated with ocean acidification.
METAGENOMIC ANALYSIS OF THE ASSOCIATED MICROBIAL COMMUNITY OF THE LOW MICROBIAL ABUNDANCE (LMA) SPONGE, *Haliclona amboinensis*
Nada M, Conaco C,

The Philippines is a major hotspot for marine biodiversity but is frequently subjected to climate and anthropogenic stressors. On many coral reefs, marine sponges have emerged as the dominant organism after the decline in coral cover caused by mass bleaching events. Sponges are holobionts and form an intimate partnership with a plethora of microbial symbionts including bacteria, eukaryotes, viruses, and others. These symbionts are predicted to play important roles in the evolutionary success and ecological adaptation of sponges. However, the metabolic potential and molecular mechanisms mediating sponge-symbiont interactions are rarely explored due to the enormous diversity of microbes associated with sponges and the lack of available reference genomes. In this study, we sequenced the whole metagenome of the sponge, *Haliclona amboinensis*, in order to elucidate the functional features of the microbial community and reveal genomic signatures and adaptive features of the microbiome. The presence of genes encoding eukaryotic-like proteins (ELPs) in the metagenome of *H. amboinensis* suggests their potential role in mediating host-microbe interactions. This work expands our understanding of the metabolic potential and associated gene networks that are essential for holobiont functioning and provide target areas for future studies aiming to understand how host-microbe interactions may vary in response to changes in environmental conditions.

INTEGRATIVE APPROACH TO DISCRIMINATE *Sardinella lemuru* STOCKS ALONG THE NORTHERN COAST OF MINDANAO
Labrador K, Follante J, Agmata A, Palermo J, Pante M,

Previous reports suggest the presence of distinct stocks of Bali sardinella (*Sardinella lemuru*) between Northern Mindanao Region (NMR) and Northern Zamboanga Peninsula (NZP). We tested the hypothesis of regional structuring through an integrative approach using samples collected from 2014 to 2016. Phenotypic variation was assessed using Geometric Morphometrics (GM) with 25 landmarks defining the organism’s body shape. Meanwhile, genotypic variation was determined using mitochondrial DNA (mtDNA) control region and a panel of 2,589 genome-wide single nucleotide polymorphisms (SNPs). GM revealed (1) significant body shape variation over time underscored by the subtle contraction of the midsection; and (2) absence of such variation between the two regions. On the other hand, mtDNA showed little to no temporal ($\Phi_{ST} = 0.02$) and spatial ($\Phi_{ST} = 0.00$) genetic variation. Likewise, SNPs revealed little to no spatial genetic variation ($F_{ST} = 0.0005$) and an optimal genetic cluster ($K = 1$). Contrary to the previous reports, we find that *S. lemuru* between NMR and NZP belong to a single stock based on the absence of spatial variation in the phenotypic and genotypic data accounted for. This
is often the characteristic of small pelagic species which are highly migratory and thus, have high dispersal potential. Moreover, the discordance between temporal phenotypic and genotypic inferences may be due to plasticity in phenotype, and that the contraction of midsection may be attributed to various environmental and anthropogenic pressures. Other methods on stock delineation such as looking at biological tags (e.g., fish parasites), assessing otolith shapes, and taking into account life history traits, can be explored to corroborate our findings. Insights from this research can provide input in the improvement of sardine fishery management in the region.

FIRST REPORT OF TAKAYAMA SP. BLOOM DURING A FISH-KILL EVENT IN OBANDO, BULACAN, PHILIPPINES

Gernato E, Onda D,

In the Philippines, Harmful Algal Blooms (HABs) have been a national concern since the 1980s with its negative effects on aquatic ecosystems, public health, and economy. From 1983 to 2016, 41 areas or embayment in the country were reported to be already infested or at least had the presence of HABs-forming species. Year by year, species not reported to have bloomed before are occurring in new areas. Specifically, on May 6, 2018, a massive die-off of cultured fish (*Chanos chanos*) and shellfish was reported in the Bulacan area of Manila Bay preceded by an extreme heating event, affecting 100 ha of fishponds with nearly PhP30M loss. Water samples were collected, and the dominant phytoplankton was isolated, which was characterized morphologically and using molecular techniques. Here, we present the first report on the presence of the dinoflagellate Takayama spp. in the Philippines. So far, only 7 species have been identified within this genus, with most representatives coming from temperate regions. Growth responses of the isolate to different temperature conditions was also assessed to test possible scenarios in the field and gain insights on the consequences of warming waters on HABs. Implications of the study are further discussed.

WEDGEFISH ON THE EDGE: INTERDEPENDENCE OF TAXONOMY AND CONSERVATION

Alava M, Yaptinchay A, Utzurrum J, Torres F, Aca E, Mesa S,

The Bottlenose wedgefish (*Rhynchobatus australiae*) was previously considered to consist of a species complex inclusive of *R. djiddensis* (Whitespotted wedgefish) and *R. laevis* (Smoothnose wedgefish). Recent taxonomic confirmation by Last et al. (2016) showed at least eight distinct *Rhynchobatus* species globally; only two are reported present in the Philippines: *R. australiae* and *R. springeri* (Broadnose wedgefish). Nominal records of *R. laevis* and *R. cf. laevis* in the Philippines suggest the need to review species and specimen records from various sources (e.g., museum collections, NSAP databases).

Globally, *R. australiae* and its look-alikes (i.e., *R. djiddensis* and *R. laevis*) are listed by the IUCN as Vulnerable. Some populations are Endangered. Data on the biology and ecology of *R. australiae* and the “look-alikes” remain limited. Indirect evidence suggests that populations of some *Rhynchobatus* species likely undertake
transboundary migrations in several regions. The inclusion of *R. australiae* in CMS Appendix II and of the “look-alike” species in MOU Sharks Annex 1, as proposed by the Philippines and approved at COP12 in October 2017 and at MOS3 in December 2018, respectively, will strengthen international conservation action for the species and their population.

A wedgefish research project by Marine Wildlife Watch of the Philippines, funded by the Save Our Seas Foundation and Philippine Aquatic Red List Committee, will be looking at the historical and current distribution and abundance of wedgefishes in the Philippines, assessing its extinction risks using the IUCN Red List Criteria and Categories, with the end view for improved management and/or protection.

**BENTHIC MACROFAUNAL COMMUNITY WITHIN THE VICINITY OF A PIER STRUCTURE IN BATANGAS BAY**

**Afalla E**, Fetil J, Ticzon V

The ‘ocean sprawl’ phenomenon has shown clear effects on marine biodiversity. The establishment of piers over homogenous, loose coastal substrate in particular, has been shown to increase species count and abundance across faunal taxa. However in the Philippines, no studies have yet been conducted on the influence of subtidal pier structures on the diversity of soft bottom marine macrofauna. The study aims to address this data gap and determine small-scale fluctuations in benthic macrofaunal community structure within the vicinity of a long established pier structure. In the study, five stations were established; one control station located 300m away from the pier; two stations under the pier and to stations located 10m away from the pier structure. In each station, four 0.025m³ sediment samples were collected. All organisms found in the sediment were collected and identified to the lowest possible taxon. The results of the study showed marked difference in community structure between macroinvertebrates found in the control station and those near the pier columns. Furthermore, macrofaunal community found under the pier and those located 10 away from the pier also showed notable difference. In general, taxon count and macroinvertebrate abundance was higher in sediment samples collected under the pier and lowest in the control area. It is likely that the increased diversity of soft bottom macrofauna near the pier columns was driven by the higher accumulation of organic matter in the area, derived primarily from waste materials from organisms aggregating in the pier structure and from dislodged epibionts falling within the immediate vicinity of the columns.

**DIVERSITY AND ABUNDANCE OF CONE SNAILS IN VERDE ISLAND, BATANGAS CITY, PHILIPPINES**

**Infante R**, De Torres V, Perez K,
The data gathered is the first attempt to provide baseline information on the cone snail diversity and abundance in Verde Island, Batangas City, Philippines. Five 1m² quadrats with a distance of 10m apart were used to obtain specimens of cone snails. A total of 386 specimens of 34 species were collected, 14 Conus species in Barangay San Agustin West, 15 in San Andres, 25 in San Agustin East, 21 in San Antonio, 16 in Liponpon, and 18 Conus species in Barangay San Agapito. Conus coronatus obtained the highest values of abundance, density, frequency, and species importance value. The results of the diversity indices in six (6) barangays revealed a narrow range of species richness value, highest value of species evenness in San Agapito, and moderate species diversity in San Antonio using Shannon Winer Index. The Simpson’s diversity index has values early 1.0 in all barangays indicating that habitat was diversified resources with lower species diversity. The result of this study also revealed that most of the Conus species found in Verde Island were vermivorous.

PRELIMINARY ASSESSMENT OF SEAWEED-SEAGRASS COMMUNITIES AT THE SOUTHERN PART OF VERDE ISLAND, BATANGAS CITY, PHILIPPINES

Rula N, Arcega J, Tabuga A, Vacarizas J, Saco J,

Verde Island is situated approximately 6 km south of Batangas City and sits in the middle of the Verde Island Passage, which is known as a biodiversity hotspot. This study aims to provide baseline data for seaweed and seagrass in Verde Island. Abundance and composition of seaweed and seagrass in two sites in the southern part of the island were studied using the line transect / quadrat method during the northeast monsoon season (December 5-7, 2018). Site 1 is primarily composed of coral-rubble substrate, whereas Site 2 is characterized by sandy to silty substrate with few coral rubble. The two sites, approximately 700 m apart, differed in seaweed and seagrass composition. The dominant species in the first site were Halophila ovalis and Udotea orientalis. Thalassia hemprichii, Halodule pinifolia, Halophila ovalis, and Caulerpa verticillata dominated the second site. In total, 33 species of seaweed and 6 species of seagrass were present in the southern part of Verde Island. Interestingly, although the sites were seemingly diverse, seaweed species, in particular, were noted to be small in size, which may be ascribed to the exposure to high water movement.

SEAGRASS AND MACROINVERTEBRATE DIVERSITY IN OLOTAYAN ISLAND

Custodio I,

Seagrass and macroinvertebrates play a vital role in the coastal ecosystem. The first is recognize as one of the most economically valuable coastal resource but receives very little attention and the latter as an important bioindicator. Both are sensitive to fluctuations thus their diversity provides integral information on the health of the coastal waters. This study was conducted to determine the species diversity of seagrass and macroinvertebrates in Olotayan Island. Using transect and quadrat method, the result showed that there are 4 species of seagrass and 43 species of macroinvertebrate. Enhalus acoroides and Diadema setosum were found possessing the greatest species abundance. The data obtained also showed that
the average seagrass cover is poor and the diversity is very low. Contrastingly, a moderate diversity for macroinvertebrates was found.

FORAMINIFERA ATTACHED ON SEAGRASS BLADES IN TWO SITES IN SOUTHERN GUIMARAS, PHILIPPINES

**Nuñez K**, Campos W,

Foraminifera or “forams” are single-celled (unicellular) organisms characterized by their mineralized shells or test. There are abundant and living in aquatic environments including marine, brackish or freshwater. Forams are widely distributed in all latitudes especially in the tropics and they can also be found attached to seagrass blades. They are among the most abundant epiphytes in southern Guimaras, making up 60-80% of all organisms attached to seagrass blades. Due to their abundance, they are considered as a major contributor to meiofaunal biomass and a potential food source to predators including invertebrates and fishes. Herbivorous fishes (e.g. *Pomacentrus*, *Canthigaster*, and *Siganus*) that select and or accidentally ingest living foraminifera can contribute to the distribution of these assemblages. This study examines the distribution pattern of the assemblages of foraminifera in two grass bed sites; Sto. Nino (SN) and Nabinbinan (NB), Southern Guimaras surveyed in June and December 2011. Overall mean density of forams across sites and across months is 1218.27 ind/cm² x 100 (±1241.37) and 1218.27 ind/cm² x 100 (±1379.05) respectively. Nine families of foraminifera were identified (Calcarinidae, Soritidae, Peneroplidae, Rotaliidae, Elphidiidae, Hauerinidae, Globorotaliidae, Amphisteginidae and Textulariidae) and family Calcarinidae (66.0%) dominates the assemblages together with Family Soritidae (10.23%) and Peneroplidae (9.49%). The study further discusses spatial and temporal patterns in abundance and composition to gain a better understanding of the role of forams in seagrass ecosystems.

VARIATION IN ICHTHYOFANAUAL ASSEMBLAGES OF SEAGRASS HABITATS OFF ANG PULO, CALATAGAN, BATANGAS, PHILIPPINES


Seagrass meadows are among the most productive coastal habitats and leaf canopy cover is known to influence fish productivity. This study described the ichthyofaunal assemblages associated with dense and less dense seagrass-vegetated substrates in the shallow reef flat off Ang Pulo in Quilitisan, Calatagan, Batangas. The sampling stations were pre-determined from two colors (dark green vs. light green) rendered in Google Earth, which were subsequently validated and described in the field. Fish observations were based on 2-hour video records taken at low tide in the morning and high tide in the afternoon. Field validations confirmed that the dark green colored areas were inhabited by dense seagrass growth and were a mix of eight species (806 ± 60 shoots m⁻²), while light green colored areas were predominantly sand with at most two species and less shoots (324 ± 40 shoots m⁻²). There were 10 fish families found associated with the seagrass beds, of which eight and six families occurred in the dense and less dense seagrass stations, respectively. In both stations, higher ichthyofaunal diversity was found during the
low tide (morning) than the high tide (afternoon). Abundances were similar between stations but estimated biomass was higher in the less dense station.

COMPOSITION, ABUNDANCE, AND DISTRIBUTION OF MEIOFAUNAL ASSEMBLAGE IN BANATE BAY, ILOILO, PHILIPPINES

Taborda S, Campos A, Burgos L,

This study was conducted in Banate Bay, Iloilo, Philippines to evaluate the composition, abundance, and distribution of meiofauna present in the area. Field sampling was done during the months of June and September 2013. A total of 35 taxa were identified. The overall mean density across all surveys was 42.99 ind. cm$^{-2}$. The ten most abundant meiofaunal groups were nematodes comprising 87.4% of the average density followed by harpacticoid copepods (5.8%), bivalves (1.0%), paraonidpolychaetes (0.7%), ostracods and cyclopoids (each 0.6%), kinorhynchs (0.5%), crab zoea (0.4%), oligochaetaes and calanoids (each 0.3%). These groups constituted 97.53% of the total meiofauna while the remaining 2.47% was composed of other polychaetes, crustaceans, nemerteans, gastropods, sipunculids, tanaids, and others. Highest meiofaunal abundance was found in stations B3 (89.13 ind. cm$^{-2}$) in June and GN2 (101.22 ind. cm$^{-2}$) in September. Meanwhile, lowest densities were found in GN1 (1.59 ind. cm$^{-2}$) and B4 (18.14 ind. cm$^{-2}$) in June and September, respectively. Two-way ANOVA showed a significant variation in between months (F= 6.96, p= 0.03) but not among stations (F=1.75, P=0.22). The overall mean meiofaunal density was significantly negatively correlated with water depth (R= -0.672) and sediment types very coarse sand (R= -0.800), coarse sand (R= -0.683), and silt and clay (R= -0.800). Spearman’s correlation analysis also revealed a significant negative correlation between nematodes and sediment types very coarse sand (R= -0.733) and silt and clay (R= -0.700). In this study, water depth and sediment type were identified as the limiting factors that influenced meiofaunal density.

A SPATIO TEMPORAL COMPARISON OF NEMATODE COMPOSITION AND ABUNDANCE IN CALAPARAN, GUIMARAS FOR YEARS 2014 AND 2015

De la Rosa R, Campos A, Sanchez K,

Nematode studies are ecologically very important and yet there is a lack of information regarding their composition and abundance especially in areas found in the tropics. This study aims to compare the spatial and temporal differences on the distribution as well as occurrence of nematodes and other meiofauna in the seagrass beds of Calaparan, Southern Guimaras for the years 2014 and 2015. It is a part of the long-term monitoring effort of infaunal assemblages in the seagrass beds and rocky shores within the Taklong Island National Marine Reserve (TINMAR) beginning in 2005. Field sampling has been conducted on the same site once a year for the past 17 years following the standard NaGISA protocol for surveying various marine habitats. The results of the study showed that the meiofauna and nematode densities vary between transect points (P-value 0.021 for meiofauna, P-value 6.56e-20 for nematodes) but not between years (P-value 0.925 for meiofauna, P-value 0.639 for nematodes). Variations in the densities between transect points could be accounted to the poor sorting of sediments found in the seagrass beds. On the other
hand, the absence of temporal variations could be due to the fast recovery rates of meiofauna when exposed to sudden extreme environmental conditions. Aside from that, there was also no record of typhoons occurring on the days near or during the second sampling period. Nematodes dominated the overall meiofauna composition (59%). This is comparable to the results of most meiofauna studies conducted in seagrass areas worldwide. Of all the nematode families identified, the family Desmodoridae (83%) dominated the overall nematode composition. The specific adaptations of this nematode family in harsh environments as well as its feeding habits may have been the factors which allowed its dominance. Due to the limitations of using only ten nematodes per transect point, the conclusion that the habitat characteristics in the seagrass beds directly reflect the composition and abundance of nematodes may require further verification. Thus, it is highly recommended to use larger sample sizes in conducting future nematode or meiofauna studies.

DIVERSITY AND SPECIES COMPOSITION OF ANCHIALINE MACROBENTHIC INFANNA COLLECTED FROM TINIGUIBAN ISLET, GUIMARAS, PHILIPPINES

Pepino M, Felix Jr. L, Campos W, Malay M,

Anchialine pools are coastal landlocked bodies of water displaying tidal fluctuations due to their subterranean connection to the ocean. Several studies revealed that anchialine pools house different organisms, such as fishes, shrimps and crabs. These higher trophic organisms feed on smaller benthic organisms, such as macroinfauna. In Tiniguiban Islet, Guimaras, Philippines, an anchialine pool has been also identified, separated from the open sea by a white coral sand bar about 40 meters wide and 6 meters in height. The pool is quite popular because it is home to the red shrimp, *Parhippolyte uvaea* Borradaile, 1900, existing exclusively in that area. Wear and Holthius (1997) studied this shrimp species, but among other organisms mentioned to exist in the pool were infaunal polychaetes, nematodes and amphipods, which serve as available prey items for the omnivorous red shrimps. Because of their important ecological function and the unique nature of the environment where they are living, the macrobenthic infauna existing in the anchialine pool of Tiniguiban were studied, specifically their diversity and species composition. Since the pool is relatively small (146 square meters), the number of replicates for sediment samples collected was limited. Only 4 replicates were collected on July 2018, using a PVC corer with 7.5 cm inner diameter, pushed to a depth of 10 cm. Physio-chemical parameters were also recorded, such as temperature, salinity, dissolved oxygen, pH and water depth. Additional sets of sediment samples were also collected for organic matter content analysis. The relationship of the macrobenthic infauna with the environmental and physical parameters were also examined. The present study is the first attempt to document the diversity and species composition of macroinfauna in an anchialine environment in the Philippines, since most benthic studies in the country have been conducted in coastal areas, rivers, and estuaries.

COMMUNITY STRUCTURE OF GASTROPODS FOUND IN THE INTERTIDAL ZONE OF ISLAND GARDEN CITY OF SAMAL, DAVAO DEL NORTE

Aquino F, Nañola C,
Given the ecological role of gastropods in the tropical intertidal communities and their possible role as bioindicators, this study aimed to investigate their community structure in the southern portion of Mindanao, Philippines. Reef walks in the intertidal zones (i.e. high, middle, and low) in six sampling sites around Samal Island have been done throughout the year, covering the northeast and southwest monsoons. A total of 123 species representing 39 families have been recorded, with 83 species observed during Amihan and 82 species during Habagat. Three species were observed to be common in all sampling sites during the different monsoons, *Morula musiva*, *Conus coronatus*, and *Strigatella pica*. Abundance values were analyzed using ANOVA and standard error using a non-parametric test. Community analyses reflected the varied and patchy nature of substrates on different sites which ranged from rocks, pebbles, sand, rubble, corals, and seagrass. The variation in habitats influenced the distribution and abundance of different species across the intertidal zones of different sites. High species richness was observed to be common across the bare rocky substrate located at the high intertidal zone. It is noteworthy to mention that an uncommon tusk shell from family Dentaliidae was observed in Camudmud. Furthermore, this study provides baseline information about gastropod diversity influenced by monsoonal conditions. Follow-up species inventories and assessment of individual species are suggested to be done as reference for future studies.

COMMUNITY STRUCTURE OF BIVALVES ALONG THE SHALLOW COAST OF THE ISLAND GARDEN CITY OF SAMAL, DAVAO DEL NORTE
Ang G, Nañola C.

Bivalves are known to be the dominant filter feeders along the shallow intertidal zones. This study focused on the community structure of bivalves in six sites of the shallow coastal areas surrounding Samal island. Species inventory was conducted from February 2018 to January 2019, covering the northeast and southeast monsoons. All bivalves were collected within two-meter observation along the 50 m belt transect laid in low intertidal and shallow water zones. Presently, a total of 69 species representing 19 families were identified. Species such as *Septifer bilocularis*, and *Trachycardium rugosum* were found to be the most abundant in Camudmud and Catagman. Furthermore, fossilized species under Tridacnidae were also found in Catagman, Camudmud and Aundanao, with Catagman having the most fossilized records of *Tridacna gigas*. Diversity and spatial analysis using PRIMER software indicated that diversity is high for areas exposed during the northeast monsoon.

ASIN'S OYSTER HATCHERY: CULTIVATING SUSTAINABILITY THROUGH SCIENCE AND TECHNOLOGY, COMMUNITY INVOLVEMENT AND INSTITUTIONAL COLLABORATION AND PARTNERSHIP
Rodolfo R, Lapus M, Cabria H, Rosell II N, Ubial E, Ruado R,
Agriculture Sustainability Initiatives for Nature (ASIN), Inc. is a small startup company whose mission is to provide high quality, traceable and sustainable agricultural produce using environmental friendly sound practices. At present, its focus is on the oyster industry in the Philippines which has a huge potential due to the archipelagic nature of the country, providing numerous suitable sites for oyster farming. ASIN's Project TALABA-TALABEST was conceptualized to respond to the Philippine oyster industry gaps to sustainably produce the best high quality and safe oysters as identified during the Processed Bivalves Road Map Formulation Workshop held in Tacloban City in 2016 and the 2016 EU-Philippines Trade Related Technical Assistance Project 3 Mission Report on the Road Mapping of Processed Bivalve Molluscs. At the center of project TALABA-TALABEST is the development and operation of an oyster hatchery in San Juan, Batangas in order to regularly supply oyster seeds to partner communities of oyster growers and reduce their dependence on the natural spat fall cycle which determines the frequency of harvest seasons. These communities are usually composed of fisher folks and informal settlers that are among the vulnerable sectors of the country. In the end, this project hopes to contribute their livelihood and to a sustainable oyster industry by making the necessary interventions throughout the supply/value chain anchored on science and technology, community involvement and collaboration among the various stakeholders and institutions.

LOCOMOTOR ACTIVITY AND SURVIVAL OF GLASS EEL Anguilla marmorata (ANGUILLIFORMES: ANGUILLIDAE) EXPOSED TO DIFFERENT SALINITY LEVELS
Aquino G, Cabaitan P, Tsukamoto K,

Eels are catadromous fish that undergo stepwise migration from marine to estuarine, then to freshwater habitats. A few species are able to stop their migration and settle in marine habitats, while some can migrate between seawater and freshwater habitats throughout their life. However, little is known on the link between salinity preference, habitat selection and growth of tropical eels, especially in the most biodiverse region, the Philippines. In this study, glass eels of *Anguilla marmorata*, an economically important eel, were collected from an estuary near Cagayan River, Cagayan Province, northern Philippines and were observed for behavioral experiments to investigate their salinity preference in connection to their locomotor activity and survival. For the choice experiment, glass eels were initially placed in brackish water with connections to compartments with different salinity levels (freshwater and seawater). Salinity preference was based on the locomotor activity of glass eels (i.e., glass eels swimming toward freshwater or saltwater). Subsequently, the survival rate of glass eels was determined after seven days of rearing in different salinity levels. Inactive response or high preference for brackish water can be due to the role of pigmentation from glass eel to elver stage. Highest survival rate was observed in glass eels reared in freshwater, followed by those reared in brackish water. Examining the habitat preference and its influence on survival are essential in improving the culture techniques of eels and important in understanding its spatial distribution in the northern Philippines especially that many parts of the country are impacted by land-based runoff that drastically reduces water salinity.
Literature on age-structured studies of reef fishes in Davao Gulf is lacking. This study presents the age-growth parameters and maturity of *Lutjanus vitta*, a dominant catch in coastal areas of the Davao Gulf. A total of 330 samples were collected in wet markets and landing sites around Davao gulf from the months of May 2018 to December 2018. Fish standard length ranged from 9 cm to 27 cm. Length-weight relationship of *L. vitta* was found to have high correlation (SL-weight: $R^2=0.96$). Linear regression values between fish standard length and otolith length, and fish standard length and otolith weight were $R^2=0.86$ and $R^2=0.80$, respectively. The LWR of *L. vitta* is comparable to another study carried out in the Davao gulf ($R^2=0.99$). Male and female *L. vitta* reached sexual maturity at 19 cm SL and 14 cm SL, respectively. Results of FiSAT showed the von Bertalanffy growth parameters as $L_\infty= 28.35$; $K= 0.440$. Further, estimated exploitation rate of *L. vitta* is $E= 0.14$. This study provides life history information on *L. vitta* at a local scale.

Otolith growth increment vis-a-vis with length-weight relationship are valuable and straight-forward tools that unlock life history of reef fishes. None so far have investigated the age-growth parameters of *L. fulviflamma* in Davao Gulf using otolith microstructure. This study investigated a total of 238 individuals of *L. fulviflamma* (8-25 cm, SL) collected from wet markets and landing sites around Davao Gulf. Length-Weight relationship for *L. fulviflamma* is denoted by the equation $W= 0.1939SL^{2.3977}$ with an $R^2$ value of 0.89. $R^2$ values of standard length and otolith length, standard length and otolith width, and standard length and otolith mass are 0.81, 0.79 and 0.75, respectively. Size at sexual maturity for female is at 16 cm, SL while male at 17 cm, SL. Age-growth parameters of *L. fulviflamma* are $K= 0.8$, $L_\infty= 27.3$ and $E= 0.62$. The growth parameters differed from other areas indicating that local conditions greatly influenced the growth of this species such as water temperature, fishing pressure, and food availability.
were used to analyze length-length, length-weight, and weight-weight relationship using regression analysis. Shell height (SH) and shell width (SWD) has the strongest functional relationship ($R^2=0.96$) as expected for a length-length type of relationship. It was revealed that between these two-length metrics, SWD shows to be a better predictor for both total weight (TW) ($R^2=0.89$ and 0.92) and the adductor muscle weight (AMW) ($R^2>=0.76$ and 0.80) as compared to SH. Strong functional relationship was also observed for TW and AMW ($R^2=0.78$ and 0.81) in both months. The patterns of growth were revealed to be allometric. High relative condition factors (Kn) were observed in both months indicating that the species is relatively ‘fat’ during these periods. Meat yield was high but was significantly different in May (12.77%) and September (14.26%) (p<0.05) that may be attributed to energy partitioning during gametogenesis and reproduction. These morphometric and biometric characters underscore the strong potential of the species for mariculture

THE DIVING FISHERY OF SAN DIONISIO ILOILO, NORTHEASTERN PANAY

Burgos L, Campos A, Lapara S,

This study documents the existing diving fishery for mollusks in San Dionisio Iloilo, northeastern Panay. Catch composition, catch volume (kg), and catch rates (kg.h$^{-1}$) were monitored from June 2018 to May 2019 based on the daily records of divers or fishers in the area. Compressor diving in San Dionisio is conducted by local fishers in the near shore and offshore areas of San Dionisio, Odiogan and Bagacay Bays. The catch were dominated by the dog conch shell *Strombus canarium* (‘sikadsikad’), pen shell *Atrina pectinata* (tarab), saddle window shell *Placuna sella* (‘bayad’) and inaequivalve ark shell *Scapharca inaequivalvis* (litob). Overall mean daily catches were highest in the earlier part of the sampling period and decreases towards the southwest monsoon months. In contrast, *Atrina pectinata* a highly targeted species, due to its high commercial value (Local price of meat= Php 180 kg$^{-1}$; export price Php 200 kg$^{-1}$) showed increase in catch towards these months. This increase was mostly likely due to bulk order by the processing plant located in the area. On the average, diving is conducted 2-6 hrs day$^{-1}$, from 8-20 days per mo$^{-1}$. A typical operation is comprised of 1 boat, one compressor unit with 2-5 divers and 1 operator. The total annual harvest was derived by multiplying the mean monthly catch with 12 months and the total number of divers in the area. This value was then multiplied by the price (Php kg$^{-1}$) of each species to estimate the corresponding annual value of the catch.

COMPARATIVE ANALYSIS ON SEX RATIO, MATURITY, GONADOSOMATIC INDEX AND MORPHOMETRY OF SPLENDID PONYFISH (*Leiognathus splendens* CUVIER) CAUGHT IN SAN PEDRO AND CARIGARA BAYS, EASTERN VISAYAS

Merro S,

A comparative analysis on the sex ratio, maturity, gonadosomatic index and morphometry of *Leiognathus splendens* (n=496) was carried out in two major bays, San Pedro Bay and Carigara Bay in Leyte form October 2017 to March 2018. The male to female ratio in Carigara Bay was found to be higher at 1:2.7. Classification of maturity stages in female *L. splendens* was done with four stages observed in the two bays. Of the total female samples in San Pedro Bay, 72.8% were found to be in the immature stages. Mature individuals (Stage IV) were found to be highest in
October in San Pedro Bay while it was observed in March in Carigara Bay (60%). Gonadosomatic index of female *L. splendens* were also higher in San Pedro Bay at 3.28 compared to Carigara Bay which was observed at 2.68. The size group of 10-12 cm was dominant in both bays and indicated that individuals caught were generally below the length-at-first-maturity of *L. splendens* suggesting that both bays are in need of management interventions to sustain the supply of *L. splendens* in the region.

BLUE SWIMMING CRAB REFERENCE POINTS: A PARADIGM TO SCIENCE-BASED FISHERY MANAGEMENT

**Mesa S, Aparri R, Bayate D,**

Visayan Sea located at 11°12'N and 123°12'4'E, is one of the country’s productive fishing ground with wide variety of fishing practices and a home to bountiful marine resources dominated by sardine and blue swimming crab (BSC) (*Portunus pelagicus*, Linnaeus 1758). Like other productive fishing ground, it has been exposed to increasing fishing pressure. Section 8 of Republic Act 10654, the amended fisheries code RA 8550 asserts to establish reference points and harvest control rules (HCR) in a fishery management area or for a fishery. This study aims to establish the reference points of BSC in the Visayan Sea as science basis for HCR.

Data inclusion for this study came from 23 monitored fish landing centers of Region 6 in Capiz, Northern Iloilo and Negros Occidental covering CY 2010 to 2017. Activities include monitoring of total landed catch and effort and reproductive biology sampling. Analysis of results generated use the Adaptive Fisheries Management Approach to come up with indicators for reference points as CPUE(kg/panel), Froese, LBAR, Exploitation (E) values, and Spawning Potential Ratio (SPR).

CPUE from bottomset gillnet showed a continued decrease from 0.62 kg/panel in 1991 (Ingles, 1996) to 0.19 kg/panel in 2010 and 0.16 kg/panel in 2017. Froese threshold is 80% mature-sized catches and megaspawner at 20% of the mature population, while results showed that catches are composed of 60% juvenile, 30% mature and 10% megaspawner. LBAR sets a threshold of fishing mortality (F) equal to natural mortality (M) or F=2M. Results obtained is F=4.63 year⁻¹ twice the value of M=2.6 year⁻¹. This resulted to E value at 0.68 year⁻¹ in CY 2010 and 0.72 year⁻¹ in CY 2017, higher than the threshold of 0.5 year⁻¹. SPR threshold for tropical species is 20% for heavily exploited stocks while results is at 10% in CY 2010 and 8% in CY 2017. These indicators showed apparent growth and recruitment overfishing of BSC.

HCRs recommended based from the results include: increase catch rates by equitable distribution of fishing opportunities, eliminate catches of small sizes, regulate length of net gears, implement appropriate fisheries policy thru reduction of fishing mortality by putting limits to fisheries outputs; and increase retention of spawning population.
ASSESSMENT OF TRACE METAL LEVELS IN THE GREEN MUSSEL, PERNA VIRIDIS, IN SELECTED SITES ALONG MANILA BAY

Hermo M, Jacinto G,

The use of biomonitors to assess or evaluate trace metals in the environment has been long established. Mussels, in particular, have been widely used to compare metal concentrations in coastal environments on a global scale. Despite previous findings suggesting toxic metal accumulations in the bottom sediments of Manila Bay, which may, in turn, contaminate sedentary filter feeders consumed by the public, studies on trace metal contamination in bivalves in the Philippines are few. This study was done to obtain baseline data on metal accumulation of trace metals in *P. viridis* in selected sites along the coast of Manila Bay. Mussel samples were obtained in 2015 (Oct-Dec) and 2016 (May-June) in selected sites. A set of samples was also obtained from different seaside markets based on known preferred markets by Metro Manila residents in November 2014. After subjecting to microwave digestion, these samples were analyzed for trace metals using an Inductively Coupled Plasma Mass Spectrometer (ICP-MS). Overall results from this study indicate that mussels obtained from Limay, Bacoor, Samal, and selected seafood markets in Metro Manila are contaminated with chromium, copper, lead, and zinc. However, levels of metal contamination in mussels collected from these sites were below the computed level of concern and thus deemed generally safe for human consumption. Nonetheless, consuming mussels from these sites poses the most risk to pregnant women since Pb levels exceed the level of concern for this particular consumer group. Based on the results from this study, regular monitoring of metal concentrations in mussels collected from Manila Bay is deemed necessary to ensure safe human consumption. Moreover, monitoring of metal contamination should extend to point sources such as near river mouths to better assess the source of metals in the environment.

LONG TERM MONITORING OF CORAL REEFS IN DAANTABAYAN MUNICIPALITY

Dalongeville A, Mills I, Jorcin A,

As many coral reefs in the Philippines and worldwide, the reefs surrounding the island of Malapascua (Daantabayan, Cebu) are threatened by a wide range of natural and anthropic stressors, such as typhoon, outbreaks of coral predators, destructive fishing practices and tourism overdevelopment. Long-term monitoring is needed to understand how these threats affect the biodiversity and functioning of Malapascua’s coral reefs, and to predict their resilience capacity. However, few data are now available and an ecological baseline from which to monitor change and inform marine resource management plans is missing.

In the aim to overcome this lack of data, we developed a citizen sciences coral reef monitoring and biodiversity assessment programme on 19 locations across six barangays near Malapascua. Each site has been surveyed annually since 2015 to record benthic composition, abundance and biodiversity of indicator invertebrate and fish species, frequency and occurrence of anthropogenic and natural impacts and coral recruitment rate and density.
We have shown that the primary benthic cover in Malapascua is soft coral (36.5%). Reef builders (hard corals, fire coral and blue coral) constitute 24.2% of the benthic cover in average, which is slightly higher than the national average (22%). The mean hard coral cover has decreased of 15% between 2015 and 2018, which indicates a lack of natural recovery from the damages created by typhoon Yolanda in 2013. Impacted corals (bleached, recently killed and dead coral covered with algae) represent 2.4% of the benthic cover, which shows a high level of pressure on the reefs around the island.

Our long-term monitoring program allows to establish a baseline of habitat and biodiversity, and to study the diversity and abundances of marine organisms associated to the different types of coral reefs around Malapascua. The lack of natural recovery suggests that pressures on the reef may be too high to allow natural resilience. Active strategies, such as artificial reefs and restoration may be required to speed up the recovery process. Our results will help identifying key areas for the stakeholders and government departments to consider for the establishment of protected areas.

TEN YEARS OF PHOTO-IDENTIFICATION REVEAL THE POPULATION DYNAMICS OF WHALE SHARKS AT DONSOL, SORSOGON, PHILIPPINES

Miranda J, Bruce R, David D, Matalobos M, McCoy E, Labaja J, Snow S, Ponzo A, Araujo G,

The whale shark *Rhincodon typus* forms predictable circumglobal aggregations in tropical and warm temperate waters, normally associated with high productivity. Donsol, Sorsogon, is the longest running community-based whale shark ecotourism site in Asia, with whale sharks visiting between November and June. Whale sharks have unique spot patterns on their bodies that can be used for individual identification and thus usable in mark-recapture studies. WWF-Philippines began photographic identification (photo-ID) of whale sharks in Donsol in 2007, and partnered with LAMAVE in 2015. We used program i3S and the whale shark database “Wildbook for Whale Sharks” to validate individual identifications of whale sharks.

Between 2007 and 2017 (Dec-Jun) we conducted a total of 1,985 survey trips onboard tourist boats, yielding 6,786 encounters with whale sharks. Combined with photo-ID data from citizen science dating back to 1998, we identified a total of 479 individual whale sharks in Donsol. In 2017, this represented 44% identified whale sharks in the Philippines. Visual size estimates of whale sharks ranged between 2 and 10 m (mean 6.5 ± 1.6 m). We confirmed the sex of 180 whale sharks, 88% of which were male, highlighting a significant male bias in this aggregation of whale sharks (χ² = 58.2, p < 0.001). The majority of males (53%) were considered mature, with claspers extending beyond the pelvic fins and having a cauliflower appearance. Maturity in males (LT₅₀) was estimated at 6.8 ± 0.2 m total length.

Whale sharks visited yearly, with annual fluctuation of 15 - 185 (mean 104 ± 55.53) individuals visiting Donsol. Whale sharks spent a considerable amount of time in the area, with modified maximum likelihood methods suggesting mean residency of 49.8 ± S.E. 14.5 [95% CI (32.3-78.6)] days, and 47.1-60.8 whale sharks at any one time.
Open population models suggest a superpopulation of \( 1,766.6 \pm 40.7 \) individuals. Some whale sharks were observed \(>10\) years apart at the site, and matched to multiple areas in the Philippines, highlighting their strong site fidelity and mobile nature. Our results highlight the importance of Donsol for the endangered whale shark.

**REPRODUCTIVE BIOLOGY OF SARDINES Amblygaster leiogaster (VALENCIENNES, 1847) AND Amblygaster sirm (WALBAUM, 1792) FROM WEST PHILIPPINE SEA**

Sese E, Palla H,

Sardines are commercially important species that commands high market demand for canned, fresh and dried fish in the Philippines. Despite of their importance, the reproductive biology is unknown. This study was conducted to determine the sex ratio, mean length at maturity, spawning period and fecundity of *Amblygaster leiogaster* and *A. sirm*. Specimens were collected from commercial fishers in the West Philippines Sea. Macroscopic examination of gonads was used to determine the sex ratio, gonadal development and mean length at maturity; the mean monthly gonado-somatic index was computed to estimate the spawning period, while the gravimetric method was administered to estimate the batch fecundity. A total of 1,082 specimens were analysed. The sex ratio of both species did not show significant difference in most of the months. *Amblygaster leiogaster* attains its 50% maturity at lengths of 18.9 cm and 18.7 cm for males and females, respectively. Meanwhile, the lengths at 50% maturity for *A. sirm* were estimated at 17.4 cm and 17.9 cm for males and females, respectively. The spawning season of *A. leiogaster* was difficult to discern since the species was not present in other months of sampling while for *A. sirm* was observed in the months of March to June and September to October. Estimated fecundity for *A. leiogaster* varied from 5,574 to 19,351 eggs while for *A. sirm* ranged from 4,368 to 28,072 eggs. This study revealed the first record for reproductive biology of *A. leiogaster* in the world and first record for *A. sirm* in the Philippines.

**CURRENT STATUS OF GIANT CLAMS: AN IMPLICATION FOR CONSERVATION MANAGEMENT IN THE ISLAND GARDEN CITY OF SAMAL**

Sobradil R, Edullantes C, Gumanao G, Tabalanza T,

The status of Giant Clams natural populations in the Island Garden City of Samal was investigated from May to July 2018. Field surveys were complemented with Focus Group Discussion to understand local perceptions on the giant clams status, threats, and fishing practices. During field surveys, four species, Tridacna gigas, T. squamosa, T. maxima and T. noae were identified at depths of 2m to 12m. T. noae, a rare species, is the first record in the Island. Of the total individuals found, 78% were live giant clams and 21% were empty shells. The shell length ranged from 3cm to 38cm. On the other hand, five species of giant clams were identified by local communities namely T. gigas, T. squamosa, T. derasa, T. maxima and T. crocea. In 2000, T. crocea was not observed by fishers and was not also observed during field surveys. It is possible that there is local extinction of T. crocea. Communities are aware of giant clam regulations however, they are still currently being harvested and
mode of collecting giant clams in the wild have evolved through time. Better conservation and management strategies should be drafted to prevent continuous decline of the giant clam population in the Island Garden City of Samal

DETECTING SARDINE SPECIES AND POPULATIONS USING OTOLITH OUTLINE ANALYSIS
Dilan M, Cordillo P, Pante M, Libungan L,

Outline-based shape analysis is applied on fish otoliths to differentiate sardine species and populations. Otolith shape of six sardine species - *Sardinella lemuru*, *S. fimbriata*, *S. gibbosa*, *S. goni*, *Herklotsichthys quadrimaculatus* and *Amblygaster sirm*, were described and compared. For detecting population differentiation, otolith shape analysis was used in *S. lemuru* samples from embayments of the northern coast of Mindanao. Otolith outlines were extracted automatically using shapeR package on the R platform. Independent shape coefficients were obtained using Wavelet transform analysis. ANOVA-like permutation test (F=26.111, p<0.001) show variation of shape among different species, which is in line with results of canonical analysis of principal coordinates (CAP) when examining differentiation in first two discriminating axis (CAP1=68.9%, CAP2=17.7%). The greatest variations are found to be in the rostrum and posterior rim of the otoliths. The classification accuracy of otolith outline shape analysis on the sardine species is 82.43%. There is also population structuring detected among sites (F=1.9396, p=0.002) in northern coast of Mindanao, with neighboring sites clustering together.

THE PHILIPPINE RISE AND WHAT’S DOWN UNDER: ASSESSMENT OF REEF FISH ASSEMBLAGE IN THE DEEP REEFS OF THE BENHAM BANK REGION
Garcia J, Velos M, Cabasan J, Arceo H,

The Philippine Rise, located approximately 250km from eastern Luzon, is a vast underwater seamount with shallowest point, the Benham Bank, at around 50m. It is acknowledged as a traditional fishing ground for Filipinos due to high catch of commercially valuable fishes such as tuna and trevallies. Despite great dependence on the bank, it was only in recent research expeditions that an extensive coral reef area was discovered, suggesting the presence of various habitats that can support large amounts of marine resources. To widen knowledge and provide additional baseline information on these marine resources, specifically on reef fish assemblages in deep reefs, fish surveys using Baited Remote Underwater Video Systems (BRUVS) were done across the Benham Bank. A total of 19 stations, with deployment depths ranging from 53-67 m, were surveyed in the area. Preliminary video analyses revealed prominent occurrences of apex predators such as Tiger sharks (*Galeocerdo cuvier*), Barracuda (*Sphyraena barracuda*), and large-bodied Groupers (e.g. *Plectropomus leopardus* and *Variola albigirmitata*), fishes with high commercial value (e.g. Fusiliers, Emperors, Snappers, Tuna, and Trevallies), and even threatened fish species (e.g. Napoleon wrasse - *Cheilinus undulatus*). These findings add more weight on the importance of the Benham Bank region as a possible marine resource reservoir of the Philippines. Further explorations in the area is needed for a better understanding of its role in the greater reef system of the Philippines.
TEMPORAL VARIATIONS IN POPULATION OF BROWN-SPOTTED SEA CUCUMBER (BOHADSCHIA MARMORATA) WITH NOTES ON RECRUITMENT SEASON
Jontila J, Quinitio G, Santander-de Leon S, Altamirano J, Monteclaro H

The Brown-Spotted sea cucumber (*Bohadschia marmorata*) is among the heavily collected sea cucumbers in Palawan, Philippines. However, its collection is not regulated due to limited information on its population and spawning season. Thus, this study was conducted to determine the temporal variations in the population of *B. marmorata* and investigate its recruitment season for management purposes. The study was conducted in Arrecife Island, Honda Bay, Puerto Princesa City, Philippines, from June 2015 to May 2016. Two sites were selected and three permanent 5m x 5m quadrats were established in each site. Monitoring was done every month during low tide in the afternoon. All individuals in the quadrats were measured (cm) and counted. Tide level, temperature, salinity, and pH were also monitored and data were analyzed using one-way Analysis of Variance (ANOVA) and Tukey Test. Results showed that densities between two sites did not vary significantly but densities across months had significant variations (p<0.05). Densities were particularly high from April to July and also in December. The high densities during the said periods were attributed to aggregating individuals, except in July in which density was due to the addition of juveniles and sub-adults. The presence of aggregations from April to May and December and the occurrence of small individuals in the succeeding months strongly suggest that recruitment occurred during the said periods. It was also found out that high density is associated with high temperature and tide level. Overall, this study showed that temporal variations in the population of *B. marmorata* are associated with their recruitment, which is highly affected by temperature and tidal fluctuations. Therefore, it is suggested to declare the months of March until May as closed season to protect the breeding population and prevent the depletion of this commercially important species.

LOOK TO THE EAST: THE ROLE OF BENHAM RISE IN PHILIPPINE FISHERIES
Velos M, Cabasan J, Garcia J, Arceo H

The Philippine (Benham) Rise, a prominent underwater plateau located approximately 250km northeast of the Provinces of Aurora and Isabela in Luzon Island, has received increasing attention since 2014 when it was found to host pristine coral reefs and high biodiversity. Among the important ecological services that this area has to offer is its contribution to fisheries. This study aims to characterize the small-scale fisheries sector utilizing Benham Rise as a fishing ground, and to compare estimates of production in near-shore counterparts. Using semi-structured questionnaires, a total of 183 respondents were interviewed in three municipalities in Quezon and Aurora Provinces from October to December 2018. Initial scoping activities across the municipalities facing Benham Rise revealed that majority of the fishers capable of going to the area come from the Municipality of
Infanta. Preliminary results show that 22% of the respondents, all of whom come from Barangay Dinahican (Infanta), fish in Benham. The primary fishing gear being used is hook-and-line (i.e. simple handline, and drift long line), targeting large pelagic (e.g. tunas and blue marlins) and coral reef species (e.g. snappers, emperors, groupers). Fishing effort is mostly focused around fish aggregating devices. Further analyses of commodity flow reveal how the area contributes to regional fisheries production, fisher income, and the challenges faced in the high seas. This study is one of the first attempts to describe the municipal-based fisheries being supported by Benham Rise, and is an important step in understanding and recognizing its value to both Philippine marine biodiversity and food security. It also highlights the imperative to strengthen conservation and management measures in highly productive seas in order to secure important ecosystems and highly valuable food sources.

SHARK CATCH IN PHILIPPINE SMALL-SCALE FISHERY

**Escoro M, Arceo H, Arceo H,**

Globally, there is a growing concern on shark fishery and conservation. Sharks (Elasmobranchs) are considered as K-selected species which make them highly vulnerable to overexploitation, potentially causing trophic cascade in the marine ecosystem. In Philippines, despite the reduction in shark fin production and exports, shark fishery is still on going and largely remains unregulated and unmonitored. Methods for shark population assessment and monitoring are often expensive and labor intensive. The limited quantitative data (e.g. fishing effort, total catch, relative abundance, etc.) make shark fishery management and conservation planning in the country difficult. This study characterizes the sharks caught by small scale and subsistence fishers using fisher’s perception from 310 coastal “barangays” in 47 coastal towns across the country (Luzon= 15, Visayas= 23, Mindanao= 9). Results show that majority of the respondents are presently catching sharks. Majority of these sharks are taken as incidental catch, which means that solely banning of shark fishing is not enough. Also, most of the fishers are using sharks for consumption, but if being used for livelihood, they usually sell the sharks within the local neighborhood, and catch does not reach the market or landing areas where most surveys are conducted. Percentage of fishers catching sharks, uses, and catch rates vary across geographic locations. Small scale fishers represent a large portion of the Philippine fishery, and their unreported shark catch has the potential to exceed the sustainable fishing level. This prompts the need to increase awareness with regards to the ecological consequences of local extinction in the Philippines, as well as to improve shark fisheries management.

STATUS OF THE SEAWEED INDUSTRY OF THE PHILIPPINES


Forty (40) provinces from fifteen (15) regions of the Philippines were surveyed for seaweed farms. Each survey included the mapping of active farms, interviews through Focal Group Discussions (FGDs) and Key Informant interviews (KIIs), and
basic water quality assessments. With over 100,000 ha of active seaweed farms mapped, the entire Philippines produces several dozens of seaweed varieties from three (3) species: *Kappaphycus alvarezii*, *K. striatum*, and *Eucheuma denticulatum* although some *Codium sp*, *Gracilaria sp*, *Halymenia sp.*, and *Porphyra sp.* were also being culture and/or harvested. With global revenue at over USD 6 billion, the Philippines’ need to reevaluate best practices, improve logistics competence, and fortify support are paramount to continue to contend with other country productions and maybe hold again the title of being top, which results to being able to effectively and efficiently generate more revenue from its production, as it is, globally, 3rd in volume but only 5th in gross revenue.

**HOW CHINA HAS TRUMPED OVER THE PHILIPPINES: A PERCEPTIVE CASE STUDY ON THE SEAWEED INDUSTRY OF THE PHILIPPINES**


In 2017, the seaweed industry is estimated over USD 6 billion, and the demand of this commodity is still growing each year. However, with the Philippines ranking 3rd in volume production (1.6 million tonnes, 2015) but 5th in gross revenue (over USD 200 million, 2015), China still remains at the top and produces 60% of the global industry (about USD 3.6 billion in gross revenue, 2017). Each decade the Philippines trails behind with lower percentage production while efforts and programs are still geared to empower the local Filipino seaweed farmer. The equation does not add up. As former top producer, the Philippines in the recent years following its reign over the producers have suffered from natural barriers albeit anthropogenic sources are more likely to be blamed. The barriers include: climate change (changing seasons, onset of typhoons), disease outbreaks, fluctuating market conditions, and sometimes boils down to the effective implementation of financial and technical support of the local government. Here, the attempt to discuss the socio-economic crises that are presently dominating over the success of our seaweed farmers are compiled through interviews (i.e. Focal Group Discussions, Key Informant Interviews), secondary data, and desk research. The attempt is driven by the possibility of providing compelling information and reason to facilitate evidence-based policy decision-making to concerned sectors.

**ASSESSING CITIZEN ENGAGEMENT IN ENHANCING COMMUNITY WELL-BEING IN THE COASTAL COMMUNITIES OF CONCEPCION, ILOILO, PHILIPPINES**

Hernando C, Babiera N, Fernandez C, Subong R, De Leon F, Belanio J, Dumpit D,

The social dimension of managing natural resources is fast becoming an essential aspect for collaborative decision-making. However, little appear to be known about citizen engagement in the promotion and enhancement of well-being, especially in resource-dependent communities. This study integrates information from eight key informant interviews, 100 resident surveys, and two focus group discussions to illustrate how citizen engagement enhanced community well-being in the coastal communities of Concepcion, Iloilo, Philippines.
town of Concepcion in Iloilo. Thematic and statistical analyses reveal that activities relating to coastal protection and livelihoods have positively contributed to the overall quality of life of coastal residents. Findings further reveal the availability of local legislations providing the legal framework for citizen engagement, and organization and mobilization of citizens in local planning, social welfare, environmental protection, tourism, and agriculture and fisheries, among others. However, also evident are the lack of quality participation, citizen advocacies not translated into concrete plans, inadequate budget and logistics, and lack of mobility due to the town’s geographical nature. Interestingly, the municipality has long-standing partnerships with NGOs, CSOs, and higher education institutions. To further enhance community well-being, this study recommends policy measures for addressing threats to citizen engagement and sustaining functional collaborations between CSOs and the local government unit in service delivery and development undertakings.

COMMUNITIES UNDERSTAND AND RESPECTS (CURE) THE SEA PROJECT
Manuel, Jr. J, Ortega M, Prado V, Junio A, Tepait E, Rivera R,

The Communities Understand and Respect (CURe) the Sea Project was aimed to increase the level of awareness and understanding of the participants in marine environment: Its importance, utilization, management, protection and conservation. The project conducted a total of six training-workshops from June 2017 to July 2018 with a total number of 339 participants composed of school teachers, local government units and barangay officials, fisherfolks, women, students and out-of-school youth from the Municipalities of Balaoan, Bacnotan and Luna in the Province of La Union. To ensure effective transfer of information and knowledge to the participants, resource speakers from agencies involved in the protection and management of the marine resources were invited to discuss the topic. Among the agencies were the Bureau of fisheries and Aquatic Resources, Department of Environment and Natural Resources, National Fisheries and Research and Development, Provincial Government of La Union, Local Government Units of Luna, Balaoan and Bacnotan, the Don Mariano Marcos Memorial state University and the Pangasinan state University. The participants were exposed to the marine resources to be able to appreciate its importance to human life. Video showing were also conducted and topics were comprehensively discussed. Based on the post evaluation, the participants found the project to be effective in transforming better insights in the protection, conservation, utilization and management of marine life and enthusiastically applied what they have learned during the training cum workshop such as coastal clean-up, establishment of marine protected areas and effective implementation of regulations/ordinances related to coastal resource management.

THE MEN AND WOMEN AS THE KEY DRIVERS IN SUSTAINABLE MANGROVE CONSERVATION IN MANGROVE CONSERVATION PARK IN CALATAGAN, BATANGAS, PHILIPPINES
Creencia G, Querijero B,
Mangrove resources around the world are now overexploited and undervalued without realizing its direct and indirect benefits. This study determined the level of knowledge and awareness (KA) of local government, people's organization, and local community of Barangay Quilitisan toward mangrove resources, services, and mangrove conservation practices; the perceived valuation of direct uses of mangrove resources; and the gender difference on the level of knowledge and awareness and the economic valuation of direct uses of mangrove resources. The researcher used the structured questionnaire to determine the knowledge and awareness of the stakeholders, and the value of direct uses of mangrove resources. The data were analysed through the use of mean, frequency and Duncan Multiple Range Test. The women from the PO and local community have very high level of awareness and knowledge on mangrove resources, services and conservation practices. Men from the LGU have higher awareness on conservation practices than women. However, it was observed that men (LGU and PALITAKAN) have very high level of awareness toward mangrove conservation. Both men and women would sell the different mangrove resources in different prices. The knowledge and awareness and economic valuation of the three important stakeholders of the mangrove conservation park give a better picture on how the value mangrove forest.

COMMUNITY-BASED ECOTOURISM AS A SUSTAINABLE DEVELOPMENT OPTION FOR TAWI-TAWI, SOUTHERN PHILIPPINES
Muallil R, Guinto-Sali M, Tawi-Tawi E,

Tawi-Tawi is the southernmost province of the Philippines with hundreds of islands surrounded by vast and pristine marine ecosystems. It is part of the Sulu Archipelago which borders the marine biodiversity rich Sulu and Sulawesi (Celebes) Seas that make up the Sulu-Sulawesi Marine Ecoregion (SSME). Aside from the rich marine resources, Tawi-Tawi has colorful cultures that are unique from the rest of the Philippines. Recent economic development in Tawi-Tawi is promising but among its usual consequences are environmental degradation and loss of local cultures unless preventive measures are done. Currently, there are limited efforts done in Tawi-Tawi as far as conservation of natural resources and preservation of local cultures are concerned. Much of this can be attributed to the remoteness of the province and the rumored peace and order problem in the area. Community-based ecotourism is seen as the potential way toward sustainable development in Tawi-Tawi and that Mindanao State University Tawi-Tawi has a big role to play, as the only university in the Sulu Archipelago with specific mandates to ensure effective marine ecosystems conservation and inclusive economic upliftment of the Muslims and other cultural minority groups in the area. Here, we present the on-going Quest for Love project of MSU Tawi-Tawi in partnership with the iLOVE Foundation, various government agencies, the local community and ABS CBN media network, to make Tawi-Tawi as the premiere marine ecotourism destination in Southern Philippines. The project primarily aims to conserve the rich marine biodiversity and local cultures in Tawi-Tawi while providing sustainable alternative livelihood to the fishers and the highly marginalized Sama Dilaut / Bajao people of Tawi-Tawi.
AWARENESS OF STUDENTS FROM SELECTED HIGH SCHOOLS IN BATANGAS CITY TOWARDS THE STATUS OF VERDE ISLAND PASSAGE AND THEIR LEVEL OF COMMITMENT IN ITS CONSERVATION AND PROTECTION

Gonzales F, Abrenica D, Magtibay A,

From the region of the Coral Triangle, Verde Island Passage in Batangas, Philippines was declared by marine scientists as the center of the center of marine biodiversity and considered as the most diverse marine ecosystem in the world. Since this is located between the provinces of Batangas and Mindoro, it should be the pride of Batangueños and be agents in the conservation and protection of this area which is considered globally to be of highest biodiversity importance. With these, the researchers assessed the awareness of high school students from selected schools in Batangas City towards the status of Verde Island Passage and determined their level of commitment to its conservation and protection. A validated self-structured questionnaire was administered to the students of Bugtongnapulo National High School, San Agustin National High School and University of Batangas. Results showed that students from the University of Batangas Senior High School and San Agustin National High School are slightly aware about the Verde Island Passage as the center of the center of marine biodiversity. On the other hand, students of Bugtongnapulo National High school are found to be not aware about Verde Island Passage at all. Meanwhile, the students of University of Batangas are committed in the protection and conservation of Verde Island Passage, while those from San Agustin National High School and Bugtongnapulo National High School are only slightly committed. The level of awareness of the three groups of respondents regarding the status of Verde Island Passage as center of marine biodiversity were significantly different from each other. The level of awareness of the respondents on Verde Island Passage as center of marine biodiversity did not significantly relate on the level of their commitment to conserve and protect the Verde Island Passage. These results give implications on the integration of marine biology and biodiversity conservation in the K-12 curriculum.

STATUS OF CORAL REEFS IN LAGONOY GULF WITH EMPHASIS ON MARINE PROTECTED AREAS

Mendoza A, Asejo R, Borejon M, Kubota S,

Status of coral reef health of 8 MPAs, 8 adjacent MPA reefs and 5 regular reefs of Lagonoy Gulf were assessed to determine its present status and compare it previous gulf-wide assessments in 1994 and 2004 with focus on Marine Protected Areas (MPA). Results showed that present living hard coral cover in MPAs are low with 26% as compared to adjacent MPA reef areas (30%) and regular reef stations (33%). A downtrend was noted from 1993 - 2004 with 10% decline of MPA reefs while from 2004 to 2018 decrease was almost 20% and from 1993 to 2018 an average fall of 25% was detected. Overall, Lagonoy Gulf reef health is declining and is attributed to both natural and fisheries activities. However, non-MPA reefs decline was observed to very minimal as compared for both MPA and adjacent MPA reefs ranging from 1% to 6%. With this, MPA management schemes should be revisited and amended to improve and strengthen MPA governance, direction and strategies.
ONSHORE-TO-OFFSHORE GEOLOGIC CONTINUITY AS ADDITIONAL CRITERIA IN THE SELECTION OF POTENTIAL MARINE PROTECTED AREAS

Rodolfo R, Fullon J, Cardenas B, Lapus M, Cabria H,

The Fisheries Code of the Philippines requires as much as 15% of the total coastal area of a municipality to be set as marine protected areas (MPA) and sanctuaries. For local government units that are still in the processes of identifying and establishing marine protected areas, the seaward continuity of geologic formations and features may be used as additional criteria for the selection of potential MPAs and sanctuaries. Geologic features such as faults and fractures break and displace rock units generating additional surface areas for coral growth, as well as crevices which provide shelter and protection to other marine organisms. These geologic features, in addition to the stratigraphic arrangement of geologic formations, also serve as a pathway for nutrients from the land to the sea through submarine groundwater discharge (SGD). Potential sites may be identified through lineament mapping using aerial photos, satellite images, digital elevation models and geologic maps validated through field mapping, particularly from onshore to offshore. Additional assessment can be done on land and underwater to evaluate the site if it also meets other criteria for MPA selection. Lastly, the presence of SGD can be investigated by mapping out subtidal springs as well as radon measurements along the coastline. This was observed in several popular dives sites in Mabini, Batangas including the Twin Rocks Marine Sanctuary which is among the best marine protected areas in the country.

SUSTAINING MPA MANAGEMENT THROUGH IMPROVED COMPETENCIES OF MPA MANAGEMENT BODIES


The establishment of marine protected areas (MPAs) is the most common strategy in coastal resources management (CRM) for biodiversity conservation, fisheries and threat reduction. The capacity of the MPA management body plays a crucial role in achieving these CRM objectives and conservation impacts. To effectively and equitably manage MPAs, there has to be an appropriate investment on improving the competence of MPA management body, which could help attain MPA management success. This study presents the development of a competence assessment tool for MPA managers and practitioners and how the tool can be used to help capacitate the management body in terms of planning, financing, communications, enforcement and monitoring and evaluation. The tool aims to help gauge the current level of knowledge, skills and attitudes in performing one’s assigned duties and responsibilities for the MPA. The development of the Competence Assessment Tool followed a rigorous process of reviewing existing literatures, multiple pre and pilot testing and consultations, and finalization and packaging to ensure its simplicity, comprehensiveness, and applicability to a wide range of MPA contexts. Results of the assessment tool provide an overview of the current competence of an individual, as well as the competency gaps that needs to be improved. This also highlights how Individual competence of MPA managers influences the overall MPA management effectiveness. The ultimate goal of the tool
is to translate these competencies into strategies that would sustain and institutionalize better protected area management.

DENSITY OF JUVENILE CORAL AS AN INPUT TO CORAL RESILIENCE IN SELECTED MARINE AREAS OF LAGONOY GULF, BICOL REGION
Bradecina S, Mendoza A, Nieves P,

In the face of wide coral degradation in the fishing ground of Lagonoy Gulf Eastern Bicol, protecting and conserving of juvenile corals are the significant way to save and restore the life of coral reef ecosystem as well as the livelihood of fisher folks in Bicol Region. As the foundation of future life of Lagonoy Gulf, juvenile corals need serious attention and monitoring to prevent its attrition. This paper determine the current status of juvenile coral in selected marine fishing ground of Lagonoy Gulf, Eastern Bicol and the possible resiliency of coral reef ecosystem by examining its life form cover.

TROPHIC STRUCTURES OF REEF FISH ASSEMBLAGES : A COMPARISON OF TWO MARINE PROTECTED AREAS IN THE PHILIPPINES
Felix L, Paraboles L, Malingin M, Guarte D, Campos W,

Establishment of Marine Protected Areas (MPA) have gained attention in recent decades as an important tool to alleviate the impact of human activities on coastal habitats and their productivity. It is thought that effective MPAs increase reef fish abundance and biomass over time and may also lead to positive changes in reef community structure. This study addresses the latter. Underwater fish visual censuses were conducted every 2 years from 2013 to 2017 to examine temporal changes in reef fish composition, abundance and trophic structure in two different reef areas in the Philippines. In each set of surveys, three MPA sites were monitored in each area, with ten station transects (5 inside and 5 outside MPA boundaries) surveyed in each site. To provide insights on how marine reserves help in maintaining the natural balance of the food web overtime and how these vary in different reef systems, a fractional trophic level was assigned for each fish species and their abundance and biomass were plotted along different trophic spectra. Patterns of change in reef fish assemblage structure are discussed and correlated with different biotic and abiotic factors.

ASSESSING MPA EFFECTIVENESS USING ECOLOGICAL, SOCIAL AND ECONOMIC INDICATORS IN PHILIPPINE COMMUNITIES
Abrina T, Yñiguez A, Rosales R, Cruz-Trinidad A, Ting M, Aliño P,
Marine Protected Areas (MPAs) in the Philippines have proliferated and have been shown to allow for the recovery of declining marine ecosystems. While this growth of MPAs can be an indication of potential benefits, other studies have shown that many MPAs in the country are not so effective. These concerns highlight the need to better understand what benefits can be derived from MPAs and their potential feedbacks. Using General Additive Models with data from the MPA Effectiveness Assessment Tool (MEAT), the Para el MAR MPA Awards biophysical assessment score card, and the Socio-Economic Assessment Tool (SEAT), we analyse the correlation between investments, processes, and benefits for 15 MPA sites in the Philippines. In general, financial capital deviances can be highly explained by biophysical improvements from management interventions (33.6% - 95.2%), confirming the frameworks in the literature on management, ecosystem services, and human well-being in this sample. Direct pathways between interventions and these benefits however, especially those directed towards human and social capital, are not as defined. For more conclusive evidence of this relationship, a full impact evaluation and ex-ante project evaluations are recommended for similar MPA projects.

EFFECTS OF PROTECTION ON THE AGE AND GROWTH OF COMMERCIALLY TARGETED FISH SPECIES IN THE FRENCH MEDITERRANEAN

Camarines C, Arceo H,

Humans depend greatly on marine ecosystems that are healthy, resilient and productive. However, over the years, our oceans have been experiencing exploitation of resources, loss in marine biodiversity, and alterations of trophic interaction due to human activities. To alleviate some of these problems, Marine Protected Areas (MPAs) are being implemented all over the world and are an essential tool in the recovery and protection of our oceans. A previous study conducted in the Cap Roux Fishery Reserve (Saint-Raphæl, French Mediterranean) investigated the possible direct and indirect effects of protection on adult fish community structure, specifically fish density, biomass and trophic dynamics. The present study aims to complement their results by looking at the growth and age structure of fish populations between the MPA and unprotected areas. Specifically, this study aims to determine how the MPA affects commercially important fishes with the hypothesis that protection from fishing mortality will enable them to grow faster, bigger and live longer. Age determination was done on three fish species namely, *Scorpaena porcus* and *Scorpaena scrofa* of the Scorpaenidae family, and *Sciaena umbra* of the Sciaenidae family, all of which have high commercial value. Sagittal otoliths from a total of 73 fish samples were processed and analyzed to determine age and growth patterns. Differences between the age structure and growth rates inside and outside the MPA will be discussed.

STATUS OF MANGROVE COMMUNITIES IN MALABUNGOT PROTECTED LANDSCAPE AND SEASCAPE

Nieves J, Bradecina R,

Mangrove ecological habitats of Malabungot Protected Landscape and Seascape (MPLS) were assessed along the coastline of Malabungot Island, Garchitorena,
Camarines Sur. Line plot method was employed to determine the forest structure, biodiversity, ecosystem health and resource status, regenerative capacity, document disturbances and perturbations and create geo-tagged photos and maps. A total of thirteen (13) species belonging to 7 families of true mangrove species were identified. *Rhizophora apiculata* and *R. mucronata* were found to be the most dominant mangrove species in all stations. Station 3 harbours the most diverse assemblage (diversity index=2.206) manifesting inverse relationship with lowest computed value for dominance (D=0.148) and evenness of 0.876. Though Station 1 exhibited smaller diversity index (0.804), it is one of the sites with high computed index of dominance (D=0.499) and low value of evenness (E=0.499). Exhibiting high regeneration capacity of seedlings and saplings (excided 50% of its matured trees) in Station 1 and 4, it would mean that more mangroves would sustain their existence. Further, Station 2 congregated the highest percent crown cover having 75% of the sampled area attributed by the abundance and massive tree cover of *R. mucronata*. The degree of damage, disturbances and perturbations in MPLS fall under good condition. In such, it is recommended to generate alternative land-based livelihood opportunities, promote mangroves as recreational, educational and ecotourism sites, increase environmental consciousness and awareness, collaborate with various sectors (LGUs, academe and community), establish a local monitoring team and allocate funds for the maintenance of the mangrove forests.

ESTIMATING DUGONG HERBIVORY HIGHLIGHTS THE IMPORTANCE OF CONSERVING SUBTIDAL SEAGRASS MEADOWS

Dugongs are critically endangered Indo-West Pacific marine mammals, known to feed primarily on seagrasses. Being naturally aloof, dugongs are seldom observed directly over long periods, and feeding mostly in subtidal meadows. Thus, quantification of population sizes, migration routes, reproductive rates, as well as herbivory still remains a continuing challenge. This study derives dugong herbivory within experimental plots (10m x 10m), and approximates grazing pressure relative to the meadow maintenance (composition, abundance, and productivity rates) of a subtidal seagrass bed in Mati, Davao Oriental, where dugongs are sighted frequently, and feeding trails are persistent, and traceable. Here, meandering trails extended up to 17 m long, averaging 4.6 m, 17 cm wide, numbering 9 to 17 trails (feeding events) per plot, comprising a cumulative grazed surface area of ca. 11% of the plot size. Apparently though, these trails depicted dugong preference to cut across *Halophila ovalis*-dominated vegetation (~1,600 shoots m−2), avoiding bare areas and *Enhalus acoroides* patches. Using known demographic constants of *H. ovalis*, we reckoned that such trails are likely to be recolonized to pre-feeding densities in 5-6 months. Considering trail morphometrics, seagrass densities, and derived time handles, we approximated a mean harvest rate of 1.308 kg fresh weight of *H. ovalis* in 6 months per plot, or ca. 0.096 kg per trail (likely, a feeding event). This grazing pressure appeared to be well within the regeneration capacity of *H. ovalis*, but clearly unsustainable for the other co-occurring species (*Syringodium isoetifolium*, *Thalassia hemprichii*, and *Cymodocea serrulata*). Individually, adult dugongs are known to consume 30-40 kg fresh weight of seagrasses daily, equivalent to about 500 feeding events per day. We further reckoned that, on a daily
basis, dugong individuals are not likely grazing more than once within the same plot. Hence, about 5 hectares of subtidal seagrass meadows likely distributed along feeding routes (in Mati, such range could extend up to 10-km long) would be necessary to sustain an individual dugong. From these results, we highlight the importance of the migration-route-range mapping, detailed assessment, connectivity- and corridor-based conservation of subtidal seagrass meadows, in sustaining existing populations of dugongs.

GRAZING OF THE BLACK LONG SPINED SEA URCHIN (DIADEMA SETOSUM) ON FLAT AND COMPLEX CORALLINE SUBSTRATE TYPE
Aguirre A, Ticzon V,

Invertebrate grazing has a significant role in regulating macroalgal growth on coral reefs. In particular, echinoid grazing on macroalgae is fundamental in sustaining coral reef ecosystem by promoting coral recruitment. Grazing of the sea urchin Diadema setosum in different coralline substrates (flat, columnar and branching) overgrown with low relief, filamentous algae was determined in this study. Rubble with algal growth of different complexities (i.e. flat, columnar and branching) was placed inside a tank setup with pre-fabricated blocks with holes for mounting the substrates. Three replicate tanks were set-up for the following treatments: a) flat vs flat; b) branching vs flat; c) columnar vs flat ; d) branching vs columnar; e) columnar vs columnar; and, f) branching vs branching. In each setup, one starved and acclimated Diadema setosum with test diameter of 5 cm was placed at the center of the tank and allowed to graze for 18 hours. The location of the sea urchin every 30 minutes was recorded to determine preference. Photographs of the substrate before and after grazing were enhanced using photoshop. Points were overlaid on the photo and percent cover of algae on each substrate type was determined to compute for grazing rates using digital image analysis. The results showed no significant preference in substrate type grazed by Diadema setosum. However, grazing was more evident in flat substrate compared to columnar and branching substrates. The results show that invertebrates show similar grazing preference on both high and low complexity substrates further emphasizing their role in coral reef resilience. However, Diadema setosum is a relatively more effective grazer on flat substrate. This stresses the importance of more mobile fish grazers in grazing high complexity substrate types on the coral reef. The study corroborates existing literatures on the importance of both invertebrate and vertebrate grazers in the coral reef.

SEA URCHINS ARE MAJOR MACROALGAL BROWSERS IN A REEF FLAT IN CALATAGAN, BATANGAS
Umali C, Aurellado M,

Herbivores such as certain reef fishes and sea urchins feed on algae and thus, prevent algal overgrowth and clear space for coral recruitment in a coral reef. The type of herbivores in a community may have varying effects on the population regulation of certain algal species; however, few experimental studies in Philippine coral reefs have examined the process of macroalgal browsing. This study used
cage exclusion experiments to examine the relative importance of sea urchins and herbivorous fishes in the grazing of *Padina australis* and *Sargassum cf. cinctum*. Algal biomass loss was higher in open plot treatments (~50-60%) compared to the partial and closed cage treatments (~5-20%). The lack of difference in algal loss between closed cage and partial cage treatment, which exclude sea urchins but not fishes, suggests that sea urchins are the major algal grazers in the reef flat of the area. This is supported by video evidence and the high abundances of the sea urchin *Diadema setosum* (311 individuals 150 m-2) compared to the negligible presence of herbivorous fishes in the area. Biomass loss did not differ between *P. australis* and *S. cf. cinctum* which could indicate a lack of diet preference by *D. setosum*. Results suggest that the herbivore community composition on a reef may affect grazing pressure on macroalgae.

**BIOEROSION OF CORALLINE SUBSTRATE BY BLACK LONG-SPINED SEA URCHIN (*Diadema setosum* LESKE, 1778) IN CALATAGAN, BATANGAS**

Salva C, Ticzon V,

In the face of intensifying climate impacts on coral reef erosion, research on the rate of bioerosion has become an impetus in coral reef ecology studies. Sea urchins in general are considered as one of the major bioeroders in coral reef ecosystems. In spite of this, no studies have been conducted to quantify the rate of sea urchin bioerosion in the Philippines. The study aims to address this data gap and build on the published bioerosion rates attributed to sea urchin. In the study, the amount of calcium carbonate in the gut of the black long spined Diadema setosum was obtained and the erosion rate of the coralline substrate was estimated. Extraction of the gut of sea urchins and treatment of HCl were used in quantifying the amount of calcium carbonate in each test animals. The change in the weight of gut samples before and after acidification were estimated to be the bioerosion rate of individual per day. The result of the study showed that test diameter size of the sea urchin is directly proportional with the bioerosion rate. Adult sea urchins (>5 cm) have a mean bioerosion rate of 0.5693 ± 0.1149 g CaCO3/urchin/day while juvenile sea urchins (3-5 cm) only have 0.2680 ± 0.0743 g CaCO3/urchin/day. Moreover, organic materials were also larger in amount in adult sea urchins (1.9283 ± 0.2821 g organic material/urchin/day) than juvenile sea urchins (0.6276 ± 0.0930 g organic material/urchin/day). The results confirmed the significance of sea urchin in eroding coralline substrate. Moreover, the bioerosion rate derived from *D. setosum* showed little difference from other species of sea urchin.

**BEHAVIOR OF JEWEL DAMSELFISH (*Plectroglyphidodon lacrymatus*) IN AREAS OF VARYING PREDATOR BIOMASS**

Maala G, Aurellado M, Ticzon V,

Given that predators’ presence and their magnitude alter reef fish herbivory and behavior, the behavior of reef fish in areas with significantly varying predator biomasses could differ. To describe and differentiate damselfish behavior in areas of varying predator biomass, algal farm territories of Jewel damselfish (*P. lacrymatus*) in three stations in Batangas, characterized by significantly different piscivore biomass were videotaped for one hour. These stations include two special management areas, Layag-Layag and Dead Palm Reef, and the Twin Rocks Marine
Reserve with estimated piscivore biomasses of 0.38, 6.22, and 22.45 kg per 500 sqm respectively based on the November 2017 survey. Feeding and hiding time budgets and chasing events were quantified from the videos. Hiding for jewel damsels in Layag-Layag, Dead Palm Reef, and Twin Rocks were, on average, 12%, 28%, and 28% of the time, respectively. Mean counts of aggressive chases were 14.6, 17.2, and 17.6 per hour for the three stations, respectively. Time spent hiding and frequency of chasing events did not differ among stations, although differences in time spent feeding were found. Specifically, feeding time was higher in Dead Palm Reef (16%), which is one of the areas with low predator biomass, than in Layag-Layag (7%) or Twin Rocks (8%). No relationship between these activities with predator biomass was found. Thus, other factors including predator size and identity could possibly be more influential to the damselfish’s behavior. Furthermore, the lack of significant differences and correlation between behaviors and predator biomass suggest that non-consumptive effects in areas of low predator count may not be as pronounced as those in areas with more predators.

**EFFECT OF PREDATOR SIZE ON THE BEHAVIOR OF THE JEWEL DAMSELFISH** (*Plectroglyphidodon lacrymatus*)

Guevarra M, Aurellado M,

The reduction of large predatory individuals through overfishing can potentially alter the community structure on coral reefs by inducing behavioral changes in their prey’s behavior. The Jewel Damselfish (*Plectroglyphidodon lacrymatus*) is a territorial farming herbivore that is abundant in many coral reefs in the Philippines yet few studies have examined the effect of predators on their behavior. This study investigated the effect of acute predation risk and predator size on the behavior of *P. lacrymatus*. Foraging (i.e., biting on substrate), aggression, and antipredator behaviors were quantified from videos of individuals exposed to predator models, a wooden bar, and no object (i.e., control) for ~15 minutes. The first experiment showed that the presence of a predator model reduced the feeding rate of damselfish by 67% and increased its avoidance behavior relative to the control. In contrast, foraging activity did not decline in the presence of a wooden bar, suggesting that damselfish perceived the predator model as a threat. The second experiment showed that when different-sized predators (30 and 40 cm in total length) were used, foraging activity, aggression, and vigilance decreased whereas duration of avoidance increased in the presence of a predator regardless of its size. These results showed that predators at least 30 cm in length can modify damselfish behaviors that might influence algal farm maintenance. This study also emphasizes the importance of improving the population size structure of predators which could affect the benthic community structure of Philippine coral reefs.

**PREY-PREDATOR RELATIONSHIP OF REEF FISH JUVENILES AND PREDATORS IN A SPONGE DOMINATED REEF LAGOON**

Nuevas E, Cabaitan P,

Coral reef degradation reduces substrate complexity and changes benthic community composition, which may lead to alternative reef states dominated by sponges instead of corals. These changes in habitat availability may have consequences on associated fauna such as fishes, likely by altering prey-predator
relationships. This study examined whether the spaghetti sponge *Callyspongia samarensis* provided refuge for reef fish juveniles from predation in a reef lagoon in Bolinao, Pangasinan northwestern Philippines. Bimonthly underwater visual surveys and phototransect method for three months from the peak of reef fish recruitment from 2016-2018 were conducted to quantify the abundance of reef fish juveniles and predators, as well as the percentage cover of *C. samarensis*. Initial results showed a positive relationship between the abundance and diversity of juvenile reef fish and sponge cover which suggests that the spaghetti sponge is used by juvenile fishes as habitat, and may mediate predation. This study shows the importance of spaghetti sponge in providing an alternative suitable habitat for juvenile fish in degraded coral reefs.

**CORAL NUBBIN DETACHMENT WHEN EXPOSED TO FISH HERBIVORY AND PREDATION**

*Quimpo T*, Cabaitan P, Hoey A,

Coral transplantation of even a few hectares warrants the culture of numerous coral fragments or nubbins at nursery sites to minimize collateral damage to natural reefs. While at the nursery however, nubbins are exposed to reef fish herbivores and corallivores. Previous studies have suggested that incidental grazing and directed predation can reduce coral recruit and juvenile survivorship, and are thus likely to also negatively affect coral nubbins, but exactly how they affect coral nubbins, and whether this varies among fish species and nubbin size warrants further investigation. Here, we first used a field experiment to identify the impact of herbivory and predation on *Porites cylindrica* nubbins showing that 2% of nubbins are detached after 6 hours of exposure to a depauperate local fish assemblage. A laboratory experiment then followed that exposed nubbins of six different sizes (0.5, 1, 2, 3, 4, and 5 cm height) to one of four species, *Chlorurus spilurus* (scraper/excavator), *Siganus fuscescens* (cropper/browser), and corallivores *Chaetodon lunulatus* and *C. kleinii* for 8 hours. Laboratory results showed that detachment was higher when exposed to grazers (4-10%) compared to corallivores (1-2%), probably due to the feeding behavior employed by each species as grazers either gouged the substrata or cropped certain sections of the algae when feeding that may have also removed the nubbin from the substrata; while corallivores generally “picked” the polyps of the coral nubbins. Nubbin size also affected detachment rate, but only when exposed to herbivores, suggesting that size may offer an escape from incidental grazing. Detachment of nubbins is higher when exposed to fish herbivores and corallivores, hence may be detrimental to restoration efforts. Maximizing coral nursery protocols through the use of larger sized nubbins and/or the use of cages can be implemented to reduce nubbin detachment by reef fishes.

**TISSUE REGENERATION IN MARINE SPONGES**

*Diamante V*, Conaco C,

Sponges (Porifera) exhibit one of the greatest capacities for regeneration. This allows these sessile organisms to recover and grow rapidly after physical damage. However, little is known about regeneration rates and cellular behavior across
diverse sponge species. In this study, we measured the wound healing rates in several sponge species. Rapid regeneration of tissues at wounding sites were observed, eventually resulting in filling of the wound depression over the course of several weeks. Sponge fragmentation experiments were also conducted to compare growth rates and sponge body patterning in comparison to the parent colony. Interestingly, different wound healing and regeneration behaviors were observed across species suggesting that variability may be tied to differences in growth form, internal construction, growth rate, and vulnerability to damaging agents.

OCCURRENCE, FECUNDITY AND UTILIZATION OF NON-ININDGENOUS INVASIVE CHARRU MUSSEL, *Mytella charruana*, IN THE PHILIPPINES

Fuertes V, Monteclaro H, Golez S, De Los Reyes R,

The distribution and ecology of the non-native mussel species *Mytella charruana* in the Philippines were investigated from April to December 2018. Reported incidence of charru mussels were examined along coastal provinces in the Philippines. Site surveys, focus group discussions and key informant interviews were conducted among local fishers, mussel growers and local fishery officials to determine the period of emergence of charru mussels, its habitat niche, its impact with the local fishery, and the local government unit’s response to the occurrence of the potentially invasive mussel species. Furthermore, utilization of charru mussels by the local coastal communities were also assessed. Results confirmed occurrence of charru mussels along the coastal municipalities of Cagayan, Pangasinan, Bulacan, Bataan, Cavite and Metro Manila. In the said areas, dense colonies of charru mussels were observed fouling on hard substrates such as nets and floaters of fish cages, stakes and nylon ropes for green mussel and oyster cultures, or found burrowed in dense mats on muddy bottoms. The invasive mussel species has also established its presence along green mussel culture areas of Bataan, Cavite, Pangasinan and Manila Bay and was found to have negative impacts. Fecundity is high, with the smallest mature individual at 1.2 cm. On the other hand, survey showed various utilization of charru mussels by the local coastal communities. Although low in the level of acceptability, charru mussels were either harvested for household consumption, sold in local public markets, or used as feed. In all affected areas, no particular management program was initiated. The results of the study indicate wide distribution of charru mussels and its potential for exploitation in the Philippines.

REPRODUCTIVE RHYTHM OF SENATORIAL SCALLOP (*Chlamys senatoria*, GMELIN 1791) IN RELATION TO LUNAR PHASE

Cabiles C,

In Masbate, senatorial scallop *Chlamys senatoria* (Gmelin, 1791) is one of the five commercially important species of scallop present in Asid Gulf but poorly understood in the Philippines. To provide biological information for future conservation and management, the reproductive rhythm of senatorial scallop in relation to lunar phase was investigated from October 2016 to March 2017. Scallops that were collected daily from the catches of scallop fishers were measured, dissected and processed for histological analysis whereas fecundity and size of eggs (diameter) were also determined. Ecological parameter such as bottom water temperature was monitored during the sampling period. *C. senatoria* is a highly fecund species which ranges
from $3.8 \times 10^5$ to $2.1 \times 10^6$ oocytes per female and its sizes (oocytes) ranges from 53.8-µm to 72.5-µm while Gonado-somatic index (GSI) ranges from 3.2 to 7.1. Fecundity, egg diameter and GSI decreases during new moon (NM) and full moon (FM). GSI indicates that the onset of spawning activity commences during NM and FM. Environmental parameters that were monitored show significant variations in relation to lunar phase (temperature - $P = 0.03$, water amplitude - $P = 2.1 \times 10^{-6}$, moon illumination - $P = 3.24 \times 10^{-15}$). Spawning of scallop *C. senatoria* follows lunar reproductive pattern which was initiated and influences by the variations of different factors such as temperature, water amplitude and light as the effect of lunar/tidal cycles. These findings indicate that reproduction and necessarily spawning in the scallop are related to factors associated with lunar phases. Strategies for managing the resource can be formulated using the temporal dimension of lunar phases.

STATUS AND SEXUAL SYSTEM OF ANCHIALINE SHRIMP PARHIPPOLYTE UVEAE BORRADAILE, 1900 IN TINIGUIBAN ISLET, GUIMARAS, PHILIPPINES

Ebreo K, Felix L, Domingo J, Gerona J, Rañises D, Malay M,

Anchialine pools are water bodies positioned close to the seashore that fluctuate with tides due to connections to both the open ocean and freshwater aquifers. Salinity in these pools varies from euhaline to fresh, while dissolved oxygen levels in these environments are usually low to none. Anchialine pools were first reported in the Philippines by Wear and Holthuis (1977), concerning a pool in Tiniguiban Islet, Guimaras with a large population of the red barbouriid shrimp *Parhippolyte uveae*. We revisited the said anchialine pool to provide an update of its status. Physico-chemical parameters were measured and appear to be similar with the reported data, except for lower dissolved oxygen levels. The population size of *P. uveae* appears to be stable after forty years, despite human modifications to the pool including partitioning and addition of a riprap around it. Caridean shrimps are known to have diverse sexual systems and thus this was investigated for *P. uveae*. Examination of the gonopores and the presence or absences of appendices masculina, appendices interna, and coupling hooks indicate that *P. uveae* exhibits protandric simultaneous hermaphroditism. Seven individuals initially thought to be juvenile *P. uveae* were identified as *Antecaridina lauensis* (Edmondson 1935), though identification still needs confirmation. This is the first reassessment of the status of the Tiniguiban pool since the initial report forty years ago, and the first report of the occurrence of another shrimp species in Tiniguiban pool.

BEHAVIOR, SEXUAL SYSTEM, AND COLOR POLYMORPHISM OF THE SEMI-TERRESTRIAL SHRIMP *Merguia oligodon* (DE MAN, 1888) FROM TAKLONG ISLAND, GUIMARAS, PHILIPPINES

Malay M, Rañises D,

Crustaceans invaded terrestrial habitats multiple times, however among shrimp this major ecological transition only occurred once, in the genus *Merguia* Kemp, 1914. A small population of the semi-terrestrial hippolytid shrimp *Merguia oligodon* (De Man, 1888) was discovered during nighttime surveys of the mangrove forests fringing the Marine Biological Station of the University of the Philippines Visayas at Taklong Island, Guimaras. This constitutes only the second report of this remarkable species from the Philippines. *Merguia oligodon* is capable of walking and even jumping on dry land. We report observations on its habitat and behavior, describe
previously unreported ontogenetic changes and geographic variations in its color patterns, and study its sexual system. *Merguiola oligodon* appears to be a protandric hermaphrodite, a condition not uncommon among caridean shrimp. Taklong Island was heavily impacted by the 2006 MT Solar I oil spill, and the presence of *M. oligodon* could be a sign of the healthy recovery of the mangrove forest from effects of the bunker oil spill.

EGG SIZE OF BALI SARDINELLA *Sardinella lemuru* (BLEEKER, 1853) OFF BULAN, SORSOGON

Kwon J, Campos W, Paraboles L, Felix Jr. L,

The reproductive potential of Bali Sardinella, *Sardinella lemuru*, was determined by evaluating egg quality based on egg diameter. Oocytes of the species become larger as eggs mature to the hydrated stage, allowing more nutritional reserves per oocyte. *S. lemuru* is the dominant species in waters off Sorsogon and the Zamboanga Peninsula, among the top sardine-producing areas of the country. Samples from drift gill net and ring net catches off Bulan, Sorsogon, Philippines were collected from October to December 2016. Egg quality was assessed by measuring the hydrated oocyte diameter using ImageJ public domain software. Distribution of oocyte diameter per size class was then determined. Results showed a rightward shift of modal and median egg size translating to bigger egg sizes in larger size classes in Bicol region with its size class ranging from 13.1 - 17.0 cm. On the contrary, same species from Zamboanga with smaller size class (11.1 - 15.0 cm), showed no significant difference of mean oocyte diameter between classes. This corresponds to total fecundity trend of the species where Bicol showed a higher correlation between fecundity and size length. When overlapping classes were compared, hydrated oocytes from Bicol showed significantly larger diameter for all overlapping size classes. This greater diameter translates to a larger volume, more than a two-fold difference for 14.1 - 15.0cm size class. And this larger volume further translating to larger juveniles that can survive better. This study suggests for further studies on whether the difference falls on the range of variation due to environmental factors or is it purely size length of the maternal phenotype.

THE DEVELOPMENT OF REPRODUCTIVE POTENTIAL IN PROTOGYNOUS CORAL REEF FISHES WITHIN NO-TAKE MARINE RESERVES IN THE PHILIPPINES

Bucol A, Abesamis R, Stockwell B, Russ G, Alcala A,

No-take marine reserves (NTMRs) are expected to enhance fisheries by becoming net exporters of fish larvae to areas open to fishing - an effect known as recruitment subsidy. However, few studies have investigated how the reproductive output of fish builds-up over time inside NTMRs compared to fished areas and how this effect varies amongst species with different life history strategies. This study investigated how the reproductive output of three species of protogynous (sex changing from female to male) hermaphroditic coral reef fish species may develop inside versus outside NTMRs in the Philippines. Two of the species (*Chlorurus bleekeri* and *Scarus niger*) were parrotfishes (Labridae, Scarinae) that have a “faster” life history and one species (*Cephalopholis argus*) was a grouper (Serranidae), which has a “slower” life-history. We first estimated reproductive parameters such as female size
at first maturity, size at sex change, and how fecundity varies with female size. Using these parameters, we then estimated how reproductive output would change through time inside NTMRs compared to fished sites using two kinds of fish population data: 1) pairs of NTMRs and fished sites in a space-for-time substitution approach; and 2) long-term monitoring in one location (Apo Island). Results suggested that reproductive output differential in *C. bleekeri* and *S. niger* increased with NTMR protection over 13 years. Differentials were found to be higher in *C. bleekeri* (8-10 fold) than in *S. niger* (3-5 fold). No strong trends were detected in *C. argus* using the space-for-time substitution approach. However, long-term data suggested that reproductive potential of *C. argus* increased exponentially, with a differential of 2.6 maintained from the fifth to the twenty-ninth year of strict protection. This study showed that with enough time the reproductive output of protogynous coral reef fishes can accumulate inside NTMRs, producing substantial egg output differentials between NTMRs and fished areas but rates may vary depending on the general life-history traits of species. The overall results of this study underscore the importance of strict long-term (decadal), if not permanent, protection of NTMRs if substantial recruitment subsidy is to be expected from them to help rejuvenate declining fisheries.

AGE DETERMINATION AND GROWTH PATTERNS OF *Chlorurus flavipectoralis* IN CEBU, PHILIPPINES

*Itao F*, Arceo H,

The analysis of age and growth patterns provide information on the population dynamics of fish which can be used to determine fishing rates and develop effective resource management strategies. *Chlorurus flavipectoralis* (Family Labridae; Subfamily Scarinae), commonly known as the yellowfin parrotfish, are dominant external bioeroders wherein they scrape surfaces of rocks and corals encrusted with algae that would otherwise compete with reef-building corals for space. From this, they produce sediments that characterize the coral reef environment and also contribute to island building. Hence, they are important for the development and maturation of coral reef communities. They are also important in local reef fish catches for human consumption. However, information on the biology of *C. flavipectoralis*, especially age-based studies, is still limited. Thus, the aim of this study is to address this knowledge gap and contribute to the global fish species database. A total of 50 samples of *C. flavipectoralis* were collected from major fish landing areas and markets around Cebu Province in Central Visayas. The length, weight, sex, and developmental stage of gonads of each sample were recorded. For age determination, annual growth increments in the sagittal otolith were counted. Results showing relationships between growth and other biological parameters, such as age and sexual maturity will be presented. From these data, insights on harvest rates and vulnerability to overexploitation of the yellowfin parrotfish in Cebu, Philippines will be discussed.

AGE AND GROWTH OF THE DORY SNAPPER, *Lutjanus fulviflamma* (FORSSKÄL, 1775) IN CEBU, PHILIPPINES

*Sybico S*, Arceo H,
With the increasing demand of fishes, age and growth studies are essential in the planning and management of fish culture and fishery researches. Knowledge of age structures of fish populations allow the estimation of growth, age at sexual maturity, and average life span. Snappers from the Lutjanus family are amongst the most important commercial fishes of tropical and subtropical seas since they are highly used as food. The dory snapper, Lutjanus fulviflamma, is a common species that can be found in fish markets in Cebu, Philippines. With the lack of age studies of dory snappers in the area, this study aims to do an age-based determination of the population biology of L. fulviflamma in Cebu, Philippines using sagittal otoliths. Otoliths have been proven to be the most consistent and reliable incremental growth structures for age determination. The weight, length, sex, and gonad stage of the samples were also determined. Through these biological data and otolith analysis, this study will determine the male to female ratio, size and age at sexual maturity, size-age relationship, and growth rate of the dory snapper in Cebu, Philippines. From these data, insights on the harvest rates and exploitation status of the dory snapper can be inferred and discussed.

AGE DETERMINATION AND GROWTH OF Siganus guttatus IN CEBU, PHILIPPINES
Ualat S, Arceo H,

The study of growth and age in fishes is essential to generate information on mortality, longevity, recruitment, and fluctuations in fishery caused by various year classes. In the Philippines, the orange-spotted spinefoot rabbitfish, Siganus guttatus, is a popular food item because of its taste and its ability to resist spoilage better than any other fish. As such, it is heavily fished and are sold in large numbers in markets. Heavy exploitation may already be significantly decreasing its local populations, but population studies for this species are limited especially in the Philippines. The present study aims to address this knowledge gap and to contribute data on S. guttatus in the global fish base. Age and growth determination of S. guttatus from different fish landing sites and markets across Cebu Province, Central Visayas was conducted. Its length, weight, sex, and gonad stage were determined. Sagittal otoliths from 50 samples were obtained and sectioned, and annual rings were counted. Relationships between age, length and other reproductive characteristics will be discussed. Insights on its growth rate and age structure will be helpful for future course and action in the fisheries management policies for S. guttatus in Cebu Province.

MODELLING CORAL LARVAL CONNECTIVITY OFF EASTERN LUZON AND THE POTENTIAL ROLE OF THE BENHAM BANK
De Maligaya J, Magdaong E, Villanoy C,

The Benham Bank, through previous explorations, was shown to contain a healthy population of coral reefs. It has then become an interest on how this population is connected to the nearby islands of East Luzon. This study modelled the larval dispersal and settlement patterns of Acropora and Porites larvae in the Eastern Luzon domain. Released larvae were advected using a hydrodynamic model with 1/25° resolution and coupled with biological parameters of the modeled particles.
Clustering for both genus was divided into two main groups with boundary on Catanduanes island. The Benham Bank was a major sink of Acropora larvae from Jomalig Island of Quezon Province and a self-seeding habitat for Porites. It was also revealed that larvae released from the Benham Bank can reach to distant reefs 400km away such as the Bicol Shelf. These results can provide insight on the conservation and management of the resources the area can offer.

NEAR-BED FLOW CHARACTERISTICS OVER DIFFERENT BOTTOM TYPES
Gammaru A, Villanoy C, Solera L,

Boundary layer (BL), a layer characterized by gradient in flow velocity, is produced due to the interaction of flowing water with bed topography. BL facilitates on the exchange of materials, resources delivery, dispersal and settlement of particles or larvae. High resolution velocity measurements using acoustic doppler current profilers were conducted over a fringing reef to investigate the effect of different bottom roughness on near-bed hydrodynamics and to provide estimates of boundary layer parameters (shear stresses, roughness length, drag coefficient, BL thickness). The results showed that near bed flow structures and boundary layer parameter values changed over different bottom types which can be attributed to dominant flow conditions in the area and also to frictional effect imparted by roughness of the bed.

LARVAL CONNECTIVITY AND ITS IMPLICATIONS FOR MARINE RESERVE NETWORKS IN THE PHILIPPINES

Larval connectivity, the linking of local populations through larval dispersal, is a primary consideration in designing networks of no-take marine reserves (NTMRs). However, field studies on the extent of larval connectivity are rare because larval dispersal is very difficult to measure. Starting in 2011-12, we conducted genetic parentage analysis on the vagabond butterflyfish (Chaetodon vagabundus, Family: Chaetodontidae) to infer patterns of larval connectivity among NTMRs and fishing grounds in south-eastern Negros. We detected occurrences of individual fish larval dispersal that connected NTMRs and fishing grounds across several municipalities (scale of ~60 km). Our first estimate of the larval dispersal kernel (the probability of larval settlement with increasing distance) based on this initial data predicted strong larval connectivity occurring within a few 10,000s of km from source populations (mean distance = 36.5 km, with 50% of settlement <33 km and 95% <83 km). This first kernel offered important empirical support for the expectation that networks of closely-spaced NTMRs will enhance fish populations and fisheries through recruitment subsidies. In 2014, we expanded the parentage study to include more municipalities in a broader seascape (~200 km long) that includes additional sites in Siquijor and southern Bohol. Currently, we are gauging the robustness of our first kernel by examining the combined data on dispersal events that occurred in 2011-12 and 2014. The variability of larval dispersal kernels derived from different aspects of the data can provide valuable insights for designing NTMR networks in the Philippine setting.
EXAMINING CONNECTIVITY OF SCYLLA OLIVACEA POPULATIONS IN THE SULU SEA BASIN: LARVAL DISPERAL MODELLING AND GENOMIC APPROACHES
Mendiola M, Ravago-Gotanco R,

Connectivity of populations of marine organisms is largely driven by the combined influence of biophysical factors such as oceanographic circulation, habitat distribution, and life history characteristics, on dispersal across the seascape. Understanding the spatial scales and patterns of population connectivity provides important insight to support the design of spatially-explicit management and conservation interventions. This study employs larval dispersal modelling combined with population genomic analysis to examine the influence of ocean surface circulation patterns and habitat distribution on connectivity of the orange mudcrab, Scylla olivacea populations in the Sulu Sea basin. The dispersal model was carried out in the Connectivity Modelling System (CMS) using the Hybrid Coordinate Ocean Model (HYCOM), at 1/25° resolution with configured mangrove habitats (release and settlement) around the Sulu Sea basin, and parameterized based on characteristics of early life history (e.g. mortality rate and pelagic larval duration) of S. olivacea. Connectivity patterns estimated for larval dispersal simulations reveal that the Sulu Sea throughflow, a strong ocean surface current that enters through the Mindoro Strait and exits via the Sibutu Passage, strongly enhances population connectivity along the western boundary of the Sulu Sea basin, which extends from Palawan (North to South) down to the Sulu Archipelago (Tawi-Tawi). Moreover, the inflow of the strong westward current of the Bohol Sea Jet drives asymmetric larval dispersal across the Sulu Sea basin, with predominant influx of larval particles from populations along the eastern boundary of the Sulu Sea basin. The presence of cyclonic circulation features at the southern boundary of the Sulu Sea basin is linked to the high self-recruitment observed in the Southern Palawan and Sulu Archipelago populations. Genetic connectivity was examined by analyzing single nucleotide polymorphism (SNP) markers generated from reduced representation sequencing (double-digest RAD sequencing approach) of the S. olivacea genome. Comparison of connectivity patterns estimated from modelling and population genomics approaches provides insight on the influence of major ocean surface currents on population connectivity of S. olivacea in the Sulu Sea basin.

VARIATIONS OF EDDY FORMATION AND PROPAGATION AROUND THE PHILIPPINES
del Rosario A, Villanoy C, Repollo C,

Ocean mesoscale eddies are formed by wind stress curl variations or mean ocean current instabilities. Islands act as obstacles for ocean currents while high topographic features interact with strong and stable winds generating eddies at the lee. Eddies are also generated by horizontal shear instabilities (barotropic instability)
or slumping density gradients (baroclinic instability). This study presents an analysis of mesoscale ocean eddies, its spatial and temporal variability around the Philippines. Eddies were detected and tracked using satellite-derived sea level anomaly (SLA) data from 1993 to 2017. Heat and freshwater transport of detected eddies were investigated using satellite-derived data and ARGO float profiles. Changes in the evolution and propagation were observed in conjunction with the reversal of monsoons. Eddies formed more frequently in the west of the Philippines than in the east, as the Kuroshio Current interacts with eddies coming from the Pacific Ocean based on 24-year merged SLA data. Regions with consistent eddies from different datasets were summarized and their possible eddy generation mechanisms elucidated.

OCEAN CIRCULATION AND CONNECTIVITY IN WESTERN PHILIPPINES
Villanoy C, Pata P, del Prado J, Yniguez A,

The western seas of the Philippines exhibit strong monsoonal seasonality which will influence strong seasonal reversals in larval dispersal. A larval dispersal model driven by HYCOM model velocities was used to explore connectivity patterns on a seasonal, and interannual time scales. The results show a seasonally dominant dispersal pattern and a stronger connectivity between reefs in a monsoonally-dominant area where dispersal directions reverses with season compared to areas along the western coast dominated by unidirectional flow.

POPULATION DYNAMICS, CONNECTIVITY AND MOVEMENT OF WHALE SHARKS FROM A GLOBAL HOTSPOT IN PALAWAN, PHILIPPINES

Targeted whale shark fisheries operated in the Philippines into the late 1990s, particularly in the Bohol Sea and Mindanao, while being opportunistically taken in Honda Bay, Palawan. Whale sharks are now protected nationally, with sighting reports occurring year-round, country-wide. The Philippines is a global hotspot for whale sharks with over 1,500 individuals identified to date, making it the third largest known whale shark aggregation in the world following Mexico and Australia. Additionally, the Philippines is the largest whale shark tourism destination in the world, attracting > 400,000 tourists per year. Whale shark tours in Honda Bay have been in operation since 2009; however, no systematic work on the occurrence of whale sharks was conducted. We deployed pop-up archival satellite tags, employed citizen science and conducted dedicated field research to better understand the whale shark aggregation in Honda Bay. We conducted 159 surveys onboard outriggered boats from April to October 2018, identifying 117 individual whale sharks through their unique spot patterns. A further 66 individual whale sharks were identified through contributions from the general public as citizen scientists. Whale sharks were primarily juvenile males (96.5%) ranging from 2.25 - 8.00 m in total length (mean 4.5 m). Modified maximum likelihood methods estimated a mean ~41 individual whale sharks in the study site at any one time, residing ~6 days within. Whale sharks moved broadly within and beyond the Sulu Sea, including photo-ID matches to TRNP and Oslob in Cebu. Honda Bay is a globally important site for the endangered whale shark with one of the largest seasonal occurrences in the region
and found to have connectivity within. Due to the large influx of local and international tourists that visit Palawan and being one of the five major aggregation of whale sharks in the Philippines, it is critical to establish proper whale shark tourism management and ensure wildlife interaction guidelines are being strictly enforced. Current efforts are focused on working with the emerging tourism industry in Honda Bay to minimise disturbance to the species.

SPECIES-SPECIFIC SPATIALLY EXPLICIT INDIVIDUAL-BASED MODELLING OF MANGROVE FOREST DYNAMICS

Estacio I, Quinton K, Macatulad E, Salmo S,

A species-specific spatially explicit individual-based simulation model was developed to predict the development of mangrove forests. The model is a forest stand model that forecasts mangrove forest development in a 50 m x 50 m plot by simulating the recruitment, growth, and mortality of individual mangrove trees. Salinity, drought, light availability, and below-ground resources are considered as environmental factors which dictate the environmental conditions of individual trees. The model used a modified Field of Neighborhood (FON) approach to simulate competition separated into above and below parts. The above part represents light availability used for species-specific responses to light availability while the below part represents below-ground resource availability. The results showed different dominant species in the forest stands with different salinity values and different test sites in the Katunggan It Ibajay (KII). A different simulation experiment showed complete dominance of a single mangrove species in a mangrove forest stand after a long time period. The developed model can be readily adapted to any mangrove forest site by incorporating the specific mangrove species in the site.

THE CURIOUS CASE OF THE MISSING RNA BAND: EVIDENCE OF A GAP DELETION IN GIANT CLAM 28S RRNA AND ITS IMPLICATIONS IN STUDYING NON-MODEL ORGANISMS

Tan K, Conaco C,

The increased accessibility of advanced and inexpensive sequencing technologies and bioinformatic tools have realized high-throughput RNA sequencing as an effective approach for studying non-model organisms, such as marine invertebrates. While it was formerly assumed that the benchmark for RNA quality assessment (28S:18S ratio of 2 or higher) is applicable to all organisms, observations of nonconforming RNA profiles in some groups have demonstrated that this is not usually the case. Earlier studies in insects have documented a ‘hidden break’ now known as a gap deletion, in the 28S ribosomal RNA due to the deletion of a short stretch of nucleotides in its central
domain, which causes the RNA strand to split equally into two fragments (28Sα and 28Sβ) when denatured. In standard gel electrophoresis, this results to the comigration of the two fragmented 28S rRNA with the 18S rRNA, producing a single band, which can be misinterpreted as degraded RNA and therefore bias quality assessment. Routine RNA work in giant clams led to the inadvertent observation of an RNA profile that appears to be similar with those reported in arthropods. Here, we provide evidence of the gap deletion in giant clam 28S rRNA obtained from native and denaturing gel electrophoresis, PCR methods, and sequence analyses. Furthermore, the tissue- and species-specificity of the gap deletion was examined by sampling from different tissues and giant clam species, respectively. This is the first report confirming the 28S rRNA gap deletion in tridacnine bivalves, supporting the proposition that this phenomenon occurs more widely than previously thought. Additionally, literature search revealed similar observations on bacteria, cyanobacteria, protozoans, higher plant chloroplasts, fungi, and other protostomes suggesting that this phenomenon occurs not only in animals but also in other taxa. As high-throughput RNA sequencing is becoming a usual practice in answering biological and ecological questions, studies like this can help identify proxies for assessment of RNA integrity (e.g. the absence of smearing and presence of the 18S rRNA) for non-model organisms and provide insight into the evolution of pre-rRNA processing in eukaryotes.

HILL’S NUMBERS AS AN EMERGING TOOL IN TEMPORAL ANALYSES OF SPECIES DIVERSITY IN CORAL REEF COMMUNITIES

Sorgon K, Aurellado M, Fetil J, Ticzon V,

Species diversity is generally defined as the variety of living organisms within a delineated region of interest and serves as an indicator of ecosystem status. The importance of biodiversity through indirect and direct benefits (e.g., ecosystem services, resources) warrants an urgent need to develop monitoring programs that provide robust integrative measures that can be utilized by both investigators and policy-makers. Numerous measures have been widely proposed and used. However, these measures are univariate and fall short of capturing the multivariate nature of biodiversity. Traditional measures also exhibit ambiguity due to their non-linear relationship with richness, making them prone to misinterpretation. Here we utilize Hill’s numbers, an inclusive measure of biodiversity that considers both richness (number of species) and evenness (degree to which abundances are equally divided among species), as a variety-indicator of biodiversity in coral reef communities. We first show how Hill’s numbers measure richness and evenness with respect to the relative abundance and rarity of species. We then provide a visualization of Hill’s numbers within a three-dimensional space in relation to its parameter q to provide a better display of temporal changes. Finally, we then apply the aforementioned methods to measure and compare changes in reef fish assemblages between a marine protected area (MPA) and a non-MPA site over time. Hill’s numbers provided effective and more realistic measures of temporal changes in biodiversity compared to conventional richness and evenness metrics by providing a direct link between diversity and similarity between observations. Coupled with volume-indicator
measures (i.e. this variety-indicator aims to provide a more robust measurement and comprehensive monitoring of biodiversity changes in coral reef communities.

RECONSTRUCTING HISTORICAL IMPACTS AND TRANSPORT PATHWAYS OF ANTHROPOGENIC RADIONUCLIDES IN THE WESTERN EQUATORIAL PACIFIC OCEAN AND WEST PHILIPPINE SEA USING 14C AND 129I IN CORALS
Bautista A, Matsuzaki H, Siringan F,

14C and 129I in coral cores are promising tracers for reconstructing impacts of human nuclear activities and understanding pathways and oceanographic processes involved in radionuclide transport. Here we show 14C and 129I in corals from the east (Baler) and west (Parola) sides of the Philippines and how these were used to reconstruct impacts and transport pathways of radionuclides from nuclear weapons testing in the Pacific Proving Grounds (PPG). Results show that for every Megaton (fission) detonated in the PPG in year $y$, there is an increase of about 1.5 of $^{129}$I/$^{127}$I ($\times 10^{-12}$) in Baler in $y+1.2$ years (through the North Equatorial Current or NEC) and 0.3, 1, and 1.5 of $^{129}$I/$^{127}$I ($\times 10^{-12}$) in Parola in years $y$ (through the atmosphere), $y+5$ (through the northward bifurcation of NEC via Kuroshio Current and Luzon Strait), and $y+9$ (through the southward bifurcation of NEC via Mindanao Current and Indonesian Throughflow), respectively. Surprisingly, these results indicate that the southward bifurcation of NEC is the most significant pathway from the PPG to the South China Sea. Coral 14C and 127I were likewise used to estimate concentrations of other bomb radionuclides for a more comprehensive radiological impact assessment. In addition, 129I reflects impacts of global nuclear fuel reprocessing and the Chernobyl Accident of 1986. Lastly, there are possible links between 14C in Baler and Parola and fluctuations of El Nino Southern Oscillation and the Pacific Decadal Oscillation through variations of the bifurcation latitude of the NEC. Ultimately, these results serve to better understand these past events to help predict and prepare for similar or related events in the future.

CLONAL PRODUCTION OF KAPPAPHYCUS ALVAREZII (DOTY) DOTY IN-VITRO
Luhan M,

Micropropagation technique has proven to be a reliable method to mass produce certain crops. This method was also tested in macroalgae to produce clones for seaweed farming. Protocols for callus production and shoot regeneration from protoplast have been established for some seaweed species like Kappaphycus alvarezii. Cells and larger tissues, whether in solid or suspension media were used to propagate clones which were tested for suitability for farming. Although clonal production was successful, the length of culture in-vitro limits the production process making the growing of Kappaphycus in-vitro an expensive technique to produce clones. In this study, Kappaphycus alvarezii (KA) was grown in-vitro to develop a more efficient protocol for the production of clones. Small sections of Kappaphycus were
grown in suspension for one month under the same temperature, light and salinity (as what?). Media, source of explants, length of explants, and stocking density that resulted in the highest growth rate and survival rate were determined. Growth rate of KA is significantly higher in media with inorganic nitrogen added than in Grund Medium and Ascophyllum nodosum medium only. Shoots develop significantly faster in explants from tips than sections from older branches. Growth rates of explants approximately 3 and 5 mm are significantly higher than 10 mm sections. Growth rate of KA grown at 0.5, 0.75, 1, 1.25 individual/s per 10 mL of media are not significantly different. The appearance of shoot primordia as early as 7 days was observed in the media with higher nitrogen concentration. This protocol could be adapted to reduce the time of culture in-vitro and make propagules for farming affordable to the stakeholders.

NEW BENCHMARKS AND SCALES FOR EVALUATING HARD CORAL COVER AND DIVERSITY DATA FROM PHILIPPINE REEFS

Licuanan W, Robles R, Reyes M,

We present benchmarks and scales for evaluating hard coral cover and diversity data from reefs at Philippine national and the bioregion level. We also present trends in the status of reefs in the last three years. These are updated, locally-applicable and relevant, being based on NACRE-SHINE assessments of 206 stations, and the CORVA-MIRROR monitoring of 101 stations. The NACRE-SHINE project operated from 2014-2017 and was funded by the Department of Science and Technology while the CORVA MIRROR project ran from 2015-2018 and was funded by the Department of Environment and Natural Resources. The benchmarks and assessment scales are best applied to data from upper reef slopes (2-5m tide-corrected depth) of fully-formed reefs facing the dominant monsoon in a given area. Data for their use must also be collected and processed using NACRE-SHINE methods and protocols to help ensure adequate sampling and consistent identifications. The Sulu Sea bioregion had more reefs in best HCC and diversity categories, while most reefs in the Pacific coasts of the country were in the worst HCC and diversity categories of these scales. The benchmarks and scales are recommended to underlie classification and zoning of reefs for management and conservation in sub-national assessments. Their application also provides insights on disturbance history and levels of stress experienced by local reefs, and their potential resilience to future threats.

UTILIZING FACEBOOK FOR ESTABLISHING MARINE WILDLIFE BASELINE INFORMATION IN THE PHILIPPINES

Yapinchingay A, Maguyon N, Talaue P, Aca E,

Marine Wildlife Watch of the Philippines (MWWP) has been utilizing social media content to establish baseline information on marine wildlife in the Philippines. Documentation of sightings, encounters, and strandings reported online, mostly through Facebook (FB), have led to better understanding of various species, including inventory, distribution and occurrence, seasonality,
habitat, and threats. The MWWP FB page, due to its content and online activity, has become a major reporting site for marine wildlife encounters in the Philippines. Since 2011, MWWP has amassed 1,160 (until 31 August 2018) encounters in its database, mostly from shared FB posts or direct reports to the MWWP FB page. Basic information on each encounter such as location, date, incident description, outcome, and pictures are used to verify species and authenticity of shared and submitted reports. With more than 72,000 likes (as of 31 January 2019), the MWWP FB page has also become instrumental in disseminating information and news on marine biodiversity which allows users to engage and discuss its broader social, economic, and environmental concerns. It has also become a useful site for law enforcement when protected species are concerned through active online calls and campaigns directed towards concerned agencies. Although useful in many ways, data extraction through social media has its limitations, especially regarding the quality and veracity of the information presented. Nevertheless, the initiative is an innovative way in establishing baseline information on marine wildlife, allowing for better monitoring and awareness of marine biodiversity in the Philippines.

IS THE C30 METHOD ADEQUATE FOR CITIZEN SCIENCE ASSESSMENTS AND MONITORING OF LOCAL CORAL REEFS? 

There is an increasing need to engage citizen scientists to monitor changes in corals reefs caused by climate and human impacts. Citizen science involvement can be facilitated by implementing more inclusive and simplified coral reef assessment and monitoring methods. We present ‘C30’ a simplified, low-cost method that allows free and skin divers to take photo-quadrat images of reefs for hard coral cover (HCC) and diversity estimation. The abilities of the C30 method for evaluating HCC and diversity of local reefs was compared with those of the more established CRTR (‘C5’) method used in the recently completed nationwide assessment of Philippine reefs. Costs, time-, and equipment-requirements were also evaluated. We found C30 adequate for assessments and monitoring of HCC, despite the lower precision of the HCC estimates. More frames should be sampled to get higher precision and to adequately quantify coral diversity. Deployment of the C30 is simpler, faster, more cost-effective, and requires less training of field personnel. However, SCUBA divers may still be needed to properly demarcate the sampling stations, thus somewhat negating the greater accessibility of C30 to skin divers and free divers. Inexpensive action cameras may be used for C30, but the use of waterproof point-and-shoot cameras promise better still images at comparable costs. Given these findings, the deployment of the C30 method by citizen scientists is best done in partnership with scientists from local academic, research, or government organizations to allow it to be more effective in improving the management and conservation of coral reefs in the Philippines.

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A CITIZEN SCIENCE REEF FISH MONITORING SCHEME BASED ON SPECIES RICHNESS OF BUTTERFLYFISHES

Carpenter K, Williams J, Principe A, Burke M, Gosliner T, Licuanan W,

Marine biodiversity conservation-oriented citizen science in the Philippines can be problematic because of the extreme concentration of species richness. The long periods of training before realizing competent field identification of species can detract from the accuracy of data produced for reef fish monitoring schemes by citizen scientists. The Butterflyfishes of the Family Chaetodontidae are a diverse but easily identifiable group of reef fishes that can potentially serve as a proxy for overall reef fish community diversity. Their high diversity in the Philippines may be a strength for accuracy as an indicator for overall reef fish diversity. Counts of butterflyfishes made during snorkeling appear to be replicable and appealing for citizen-scientists from a wide range of educational backgrounds. These counts are consistent with total reef fish species richness and diversity, as derived from roving censuses of fishes in the vicinity of butterflyfish monitoring sites. We discuss the feasibility of this method on a wider scale in the Philippines using the results of a one-year pilot study supported by the Oscar M. Lopez Center.

USING ACOUSTIC TELEMETRY TO UNDERSTAND MOVEMENTS OF GREY REEF SHARKS AT TUBBATAHA REEFS NATURAL PARK

Murray R,

Gaining knowledge on the movement and dispersal rates of highly exploited shark species can improve their conservation. Grey reef sharks *Carcharhinus amblyrhynchos* are a meso-predatory reef associated species whose ecology is poorly understood within the coral triangle. Here we present preliminary acoustic telemetry data in an effort to assess site fidelity and inter-reef connectivity of *C. amblyrhynchos* in Tubbataha Reefs Natural Park (TRNP), the largest no-take Marine Protected Area (MPA) in the Philippines. Seven acoustic receivers were deployed throughout the park between June 2016 and June 2017. Fourteen mature grey reef sharks, seven male and seven female, with total lengths ranging 138-170 cm ($\bar{x} = 153.86$ cm, $sd = 12.76$ cm), were implanted with Vemco acoustic tags over two years. Preliminary data shows all grey reef sharks were detected on the acoustic array within the park. Sharks exhibited a residency index between 0.13 - 0.88 ($\bar{x} = 0.40$, $sd = 0.27$), extrapolated from two years of monitoring. Sharks travelled a straight-line distance of 6 - 26 km ($\bar{x} = 14.1$ $sd = 9.62$) and three sharks displayed inter reef movements between the North Islet and South Islet. One male shark completed the longest straight-line movement over deep water covering a distance of 25 km. These results confirm broad-scale movements of *C. amblyrhynchos* between unconnected reef systems separated by deep water channels ($\leq 1000$ m in depth) and underline the importance of TRNP for this species in the Philippines.
ESTIMATES OF MIXING ON THE MINDORO-PANAY-TABLAS STRAIT JUNCTION USING CTD DATA

Maloles J, Cabrera O, Villanoy C,

Two oceanographic surveys during February 2008 and 2009 were conducted in the Mindoro-Panay-Tablas strait junction (Triple Junction). With the use of CTD data from these surveys, density profiles were processed and analyzed to identify regions of mixing via Thorpe scale analysis. This analysis hinges on the assumption of a gravitationally stable ocean model and that any deviation from the ideal density distribution indicates overturn and mixing. Mixing rates via estimated kinetic energy dissipation rates ($\varepsilon$) were found to be high at few areas and mostly associated with sill-induced, bottom intensified mixing and wind-driven surface mixing in wind jet areas. Comparison of the 2008 and 2009 dataset also show that the region is more well-mixed during the 2008 survey.

INTEGRATING GENOMICS WITH IMAGE ANALYSIS, GIS AND MOBILE COMPUTING FOR IMPROVED REARING OF MANGROVE CRABS

Ablan Lagman MCA, Vince Cruz-Abelledo CCE, Garcia MVF, Lilagan CA, Perez KC, Irigan G, Joaquin BM

Genetic and genomic marker associated research investigates gene and genome structure and function to help understand the nature of diversity of life and interactions and response of organisms at the molecular level. Genetic markers such as allozymes, microsatellites, sequence haplotypes, and more recently SNPs from the genomes, have been used to investigate individual identity, genetic population structure and connectivity, and phylogeny in the marine environment. More recently gene expression markers from single genes using qRT PCR, whole transcriptome sequencing and RNA Seq have increased the menu and resolution of information that can be gained from molecular markers allowing investigation into response of organisms at the molecular level. The Practical Genomics Laboratory at DLSU has taken the challenge of harnessing the growing power of molecular marker research and develop products that address practical problems in aquaculture. This paper presents some of the technologies develop at the laboratory for the improved rearing of mangrove crabs. The intention is to obtain feedback on the research and establish collaboration for other applications. The examples to be presented include:

CrabAPP is a mobile phone based automated species identification tool for the identification of juvenile Scylla spp species.
CrabMAP is a QGIS developed temperature vulnerability mapping program which presents heat maps of temperature range and variation.
CrabADAPT was an effort to determine the response to heating of differences in of *S. serrata* crabs exposed to sites with varying temperature range and variation combinations. CrabMOLT like crab map is being developed as a phone app which can sort crabs according to their molt stages. CrabSNP is attempt to identify genes or gene regions that are very different among female crabs, male crabs and the intermediate phenotype. These technologies are at various stages of development ranging from published patents to prototype testing and final design stages.

STATUS OF WATER QUALITY OF THE COASTAL ENVIRONMENT SURROUNDING MALABUNGOT PROTECTED LANDSCAPE AND SEASCAPE

Atole M

The quality of the physicochemical and biological components of coastal aquatic ecosystem is vital to its dynamic functioning. This underscores the need to assess their current status to generate the needed information that would serve as basis for developing and implementing actions that would sustain the ecosystem and the various services it provides to the communities within the Malabungot Protected Landscape and Seascape (MPLS). This paper examined the physico-chemical, microbiological parameters and nutrient loading of the coastal waters of MPLS. Water samples were collected in four (4) sampling points in strategic representative areas of the coastal ecosystem in MPLS. Sampling and laboratory analysis of physical, chemical and microbiological parameters were done following standard protocols. The mean values for each parameter were established following descriptive statistics and were compared against the standards set by DENR-EMB - DAO 2016-08 for Class SA. Results showed that most of the physico-chemical parameters are within the standards set for protected areas. While a few slightly deviated positively and negatively, the water quality parameters in general are capable of sustaining ecosystem functioning and biodiversity and cannot cause negative structural effect on MPLS biota and ecosystem. The level of microbiological loading across sites however failed the standard. Although the negative deviation of the microbiological parameters of the coastal waters may not directly impact ecosystem functioning and biodiversity, it might compromise public health, fishfood safety and quality and tourism in the MPLS area in the long term. Strategies for addressing negative deviations of water quality parameters were recommended in the context of biodiversity conservation, coastal resource management and sustainable tourism.

MODELING THE INTERCONNECTIVITY OF COASTAL CURRENT CIRCULATION AND LANDSCAPE HYDROLOGY ALONG VERDE ISLAND PASSAGE MARINE BIODIVERSITY CORRIDOR (VIPMBC)

Briones R, Gamier D, Vacarizas J, Saco J

The agro-industrializing land use patterns continue to increase the nutrient and sediment discharge along Verde Island Passage Marine Biodiversity Corridor (VIPMBC). Along the coast, current circulation influence nutrient and sediment distribution thereby affecting coastal biodiversity and productivity. We propose here modeling approach for nutrient and sediment dispersion and deposition through
coupling of a continuous distributed hydrologic model and a boundary current model. Weather, topography, soil, and land cover are the input data and will be parameterized for model optimization. Onsite flow and current measurement and analysis will be used for calibration and validation. We expect that storm flow during wet season discharges high amount of nutrient and sediment. Dispersion and deposition within rias, bays, and coves with un-even coastal terrain are more complex than longshore. Disturbance from recurring sediment and nutrient influx on coastal ecosystems such as coral reefs, seagrass bed and seaweed bed can be observed and validated. This study on the interconnectivity of watershed dynamics and coastal ecosystem must be multiplied to support the establishment of integrated protected areas system which encompasses both landscape and seascape.

SEDIMENT YIELD SIMULATION USING SWAT IN THE VERDE ISLAND PASSAGE, PHILIPPINES
Gallentes A, Maloles P, Villanoy C,

On a global scale, coral bleaching and ocean acidification resulting from climate change have become the main threats to coral reefs. On regional to local scales where humans can have a more direct environmental control, terrestrial pollution (especially heavy sedimentation) has become the main threat to inshore corals. Here, sediment yield simulation (2000-2018) was done for the Verde Island Passage (VIP), a marine corridor declared as the world’s center of the center of marine biodiversity. Trends in the hydrologic characteristics of the watersheds draining into the VIP are discussed. SWAT model results indicate that relative maxima of sediment yield coincide with precipitation maxima, and that consecutive rainfall events which start around midyear results to higher erodibility and thus, higher peaks in sediment yield during the second half of each year. Dependence of sediment yield on slope class/angle and land use was also observed, identifying Mindoro island in the southern side of the VIP as a critical source of land surface erosion. Qualitative validation shows that there is reasonable agreement between monthly-averaged sediment yields from the model and satellite images in the area. Outputs of this study can be used as science-based reference in crafting laws and ordinances for proper land use and Marine Protected Area (MPA) management plans.

SEDIMENT PLUME BEHAVIOUR AND COASTAL CURRENT CIRCULATION PATTERNS IN THE COASTAL MARINE ENVIRONMENTS OF THE CAGAYAN DE ORO RIVER CATCHMENT
Tan M, Rollon R, Cabrera O, Moya T, Dylan Korczynskyj D,

To determine the river sediment plume dynamics within the river mouth and offshore, a hydrodynamic model for Macajalar Bay using a nested Delft3D model was developed. The model was used to drive the circulation of surface current velocity and the dispersal of suspended sediments (TSS) in the coastal waters. Three different river discharge conditions were used to simulate coastal current circulation patterns and suspended sediment distribution: low runoff from April 15 to May 15 2013 time series with zero sediment load; average runoff discharge from the same time series but with sediment load of 57 mg/L; and extreme high discharge from
Typhoon Washi (1,245.33 m³/s and 1,550.33 mg/L) with the corresponding actual bay weather conditions (e.g. wind, tide, and rain). Low and average river conditions resulted in a relatively high TSS concentration range (10 to 50 mg/L) at the river mouth and a minimum TSS concentration range (10 to 30 mg/L) inshore. Extreme discharge condition raised TSS concentration to a very high range between 1,400 to 1,800 mg/L at the river mouth and between 200 to 300 mg/L inshore east of the river mouth. The model predicts eastward and southeastward flow of dispersed sediments and subsequent depositions on the southeast portions of the bay. The current circulation is tidal dominated but stronger north/northwest wind also reinforces the prevailing coastal flow direction. For the initial structure and direction of the river plume, river velocity and shelf bathymetry are the determining factors. Both actual and simulated results particularly the salinity values confirmed that river discharge made relative encroachment on both sampling sites. With regard to sediment encroachment, no positive correlation was shown at both sampling sites. However, coastal manifestations such as heavy siltation at the river mouth and mudflat formation support the model results. The presence of nearby seagrasses and the coral composition may also support the model’s claim of minimum to moderate TSS concentration along inshore waters during normal rain days.

WEIGHING IN ON THE INFLUENCE OF LAND-SEA BREEZES ON THE OBSERVED NORTHWEST LUZON COASTAL CURRENT IN AUGUST 2017

Solera L, Cabrera O, Repollo C, Villanoy C,

The Northwest Luzon Coastal Current (NWLCC) is a quasi-permanent and persistently northward feature in ocean models. A research cruise conducted in August 2017 was aimed at actual observations of the NWLCC during the southwest monsoon. Transects were occupied at 16°N, 17°N, and 18°N. Along-track profiles of ocean currents showed that the NWLCC extends down to 200 m, with the core of the current at 70 m and with a speed of 0.46 m/s. The northward flow was found within 100 km distance from the coast, narrower than previously seen in a global ocean model. Farther offshore, flow was generally southward. Repeat transects at 16°N and 17°N also show that flow along the approximate width of the observed NWLCC shifted southward over a diurnal period. Air-sea forcing, using shipboard observations of surface winds and salinity and temperature profiles, and using satellite-derived sea surface height anomalies, were examined to account for these observations. Results show that the NWLCC structure may highly vary, depending on the interplay of several forcing at any given time and space. The local land-sea breeze was also found to be a very important forcing at the coast and may even exceed the influence of prevailing monsoon winds. Given the changing structure of the NWLCC over a diurnal period, this study underscores the necessity to conduct repeat transects, covering several days and different seasons to learn how local land-sea breezes and its interaction with larger scale forcing can change this prominent coastal current.

SEA-LEVEL CHANGES IN THE PHILIPPINES
Sta Maria M, Siringan F,
Sea-level rise (SLR) is one of the direct consequences of global warming. It results from the melting of ice sheets and glaciers, and thermal expansion of the ocean. The Philippines is located in a region where the rate of sea-level rise (SLR) is three times higher than the global mean. This poses a serious threat to the Philippines where 60% of the population lives near the coast. However, global sea-level rise is not the only threat to the Philippines. On a local scale, sea-level rise may be amplified or attenuated by local condition (i.e., local tectonics, sediment compaction). This study aims to estimate the rates of SLR and relative sea-level rise (RSLR), respectively, from satellite altimetry data and tide gauge data. To date, there are 38 stations: four stations have records since 1947 while most of the new stations were established between 2008 and 2011. Results show that SLR patterns and rates are highly variable within the Philippine archipelago; the highest rates are observed off the Pacific and Celebes coasts while the lowest rates are in the Luzon Strait. Long-term trends of RSLR indicate areas where SLR is amplified by subsidence or remains stationary. The northern delta plain of Manila Bay is an area where subsidence exacerbates the impact of global SLR. For the period 1993-2009, the tide-based sea-level trend in Manila Bay is almost 3x higher (16.7 mm/y) than that of satellite altimetry (6 mm/y). On the other hand, the long-term RSLR for Cebu appears to be stationary, which suggest tectonic uplift. Of the 10 primary tide stations, the Puerto Princesa City station shows least difference between rates of SLR (6.36 mm/y) and RSLR (5.04 mm/y) for the period 1993-2009, which may indicate relative stability. Combining SLR and RSLR is essential for identifying areas that are in danger of accelerated SLR due to local conditions. This information may guide our government in prioritizing the allocation of resources to areas that are in danger of being submerged by rapid SLR.

RAPID MANGROVE COLONIZATION AT THE MOUTH OF A MAN-MADE RIVER: A CASE STUDY IN THE JARO FLOODWAY, ILOILO, PHILIPPINES
Flores M,

The construction of the Jaro Floodway was completed in 2011 to divert the floodwater from the Jaro River towards the Iloilo Strait. However, its construction may pose a threat to the nearby mangrove forest due to its large-scale anthropogenic disturbance. This study aims to determine the effect of the floodway to the nearby mangrove forest in terms of its areal change. A grid with a 200 m spacing bounded by geographic coordinates 122.5836°E, 10.7487°N and 122.5982°E, 10.7361°N was created in QGIS software, which served as a guide in downloading high resolution Google Earth images. Imagery are available for the years 2005, 2009, 2012, 2014, 2016, and 2018. The images were digitized in QGIS and classified into three thematic classes, namely, mangrove, non-mangrove, and water. The calculated mangrove cover before the floodway was completed is 9.61 and 9.06 ha for 2005 and 2009, respectively. Mangrove cover then rapidly increased in the succeeding years measuring 17.95 (2012), 15.95 (2014), 26.45 (2016), and 43.82 ha (2018). The decrease in 2014 is attributed to conversion to fishponds. The general increase in mangrove cover from 2012 is attributed to a combination of factors such as high sedimentation rate and mangrove planting efforts by the government. The mangrove planting activities were also a result of a rehabilitation effort due to the presence of a nearby coal-fired power plant of the Panay Concepcion Power Corporation. However, its contribution could not be
quantified due to the lack of formal documentation on when it started and how many hectares has already been planted. On the other hand, sedimentation has been closely related to the distribution of mangroves as seen in some of the megadeltas in the world. The construction of the floodway lead to the formation of a new delta on which the mangroves currently thrive on. Historical maps of the study area available from the National Mapping and Resource Information show that from 1953 to 1988, mangrove cover increased from 7.01 ha to 43.83 ha; which is attributed to the formation of a new delta as a result of the switching of the river mouth of Jaro River.

MICROPLASTICS IN THE MANGROVE CLAM Geloina expansa (MOUSSON, 1849) IN LAWAAN, EASTERN SAMAR AND PALO, LEYTE PHILIPPINES

Cabansag J, Pajares C,

Microplastic pollution represents a major global environmental problem, especially when ingested by a variety of organisms. In this study, a total of 100 Mud Clam or Mangrove Clam Geloina expansa (Mousson, 1849) individuals and five sediment samples (i.e. top 1cm layer) were collected from each study site, i.e. Lawaan, Eastern Samar and Palo, Leyte to quantify and compare their respective microplastic contaminations. Data revealed shell lengths to range from 50 to 88 mm, while the tissue weight ranges from 2.07 to 23.61 g. Among all the bivalve samples from Lawaan, 9% was found to have ingested microplastics, while 79% of the samples in Palo have been observed with microplastics. Likewise, contamination of sediment samples is found to be higher in Palo than in Lawaan, with a total of 138 observed items in the former and 61 in the latter. The average abundance of microplastics in bivalves and sediment were 0.003 items/g and 0.33 items/g, respectively. Results suggest that (1) using an independent samples T-test (p < 0.05), the microplastic content in G. expansa and sediment samples from Palo, Leyte are significantly higher than that of the Lawaan samples, (2) a strong positive correlation between the amount of microplastics among the bivalves and in the corresponding sediment was observed, and (3) there is a negative correlation in bivalve tissue weight and the amount of microplastics.

IDENTIFICATION AND QUANTIFICATION OF MICROPLASTICS IN THE GUTS OF RABBITFISHES (SIGANIDAE), BIVALVES, AND SEDIMENTS FROM SELECTED COASTAL AREAS OF NEGROS ORIENTAL, PHILIPPINES

Romano E, Bucon L, Bucon A, Alvarez G,

The accumulation of plastic pollutants in the marine environment is alarming. Degradation and fragmentation of plastic debris present in the ocean leads to the formation of minute particles of plastic called microplastics. This study reports findings of an on-going study on microplastics from the guts of commercially important marine organisms: two siganid species (Siganus spinus and S. fuscescens) and one bivalve Polymesoda expansa. In addition, marine sediment samples from the shallow coastal waters of densely populated cities (Dumaguete, Tanjay, Bais) in Negros Oriental were also analyzed. Microscopic examination of
sediment samples and KOH-dissolved guts of siganids and bivalve samples revealed that majority of the microplastic samples were microfibers (polyesters, nylon) and microfilms (polyethylene). Aside from microscopic examination and quantification of microplastics, we also determined each type of microplastic materials using an FTIR (Fourier Transformed Infrared Spectroscopy).

INCIDENCE AND CHARACTERIZATION OF INSECT PESTS AND DISEASE-CAUSING MICROORGANISMS ASSOCIATED IN PLANTED MANGROVE (RHIZOPHORA SP.) SAPLINGS IN PNAP SELECTED SITES, MALITA, DAVAO OCCIDENTAL

Elemino M, Avenido P, Bontia L, Fuentes A, Generalao I,

The study was conducted to determine incidence and characterize insect pests and disease-causing microorganisms associated in planted mangrove Rhizophora sp. saplings in the two PNAP selected sites at Buhangin and Tubalan, Malita, Davao Occidental. The study was focused on the Rhizophora species as this mangrove species showed high dispersal patterns and exhibits high percentage of planted mangroves covered during the implementation of the project.

Results showed that there were eight species identified in terms on the level of infestation based on insect-pest occurrence under Phylum Arthropoda (1 Class Malacostraca: Aratus pisonii (Mangrove Tree Crab), 1 Bivalvia: Ostrea lurida (Olympia oyster), 2 Arachnida: Tetragnatha josephi (Mangrove big-jawed spider) and Ligurra latidens (Mangrove jumper) and 4 Insecta: Camponotus gigas (Giant Forest Ant), Polistes versicolor (Polistine Paper Wasp), Hyblaea puera (Teak defoliator) and Archips spp. (Tortrix). Among the recorded insects, four species were considered harmful to mangrove ecosystem. They were Aratus pisonii (Mangrove Tree Crab), Ostrea lurida (Olympia oyster), Archips spp (Tortrix) and Hyblaea puera (Teak defoliator). Other four species were classified harmless namely Tetragnatha josephi (Mangrove big-jawed spider), Ligurra latidens (Mangrove jumper), Camponotus gigas (Giant Forest Ant), and Polistes versicolor (Polistine Paper Wasp).

On the other hand, there were two other organism identified which occurred in Buhangin and Tubalan study sites such as Littorina angulifera (Mangrove periwinkle) which was considered harmless and Terraria palustris (Mangrove whelk) as harmful pest.

Moreover, three leaf diseases were noted in the samples i.e. leaf spot, leaf blight and leaf chlorosis. For leaf spot, three species of fungi were identified Cercospora sp, Acrenomium sp and Cladosporium sp., whereas, for leaf blight, two fungal species were observed Rhizoctonia sp and Phytophthora sp. Upon further verification, leaf spot and leaf blight were caused by fungi, whereas, leaf chlorosis was affected by bacteria.

Relationship on the level of infestation and extent of incidence in mangrove Rhizophora sp. saplings showed high positive correlation degree of relationship with a value of ±.745. This implies that when level of infestation increases, the disease incidence correspondingly increases.
NON-USE VALUES OF CORAL REEF RESTORATION IN THE PHILIPPINES
Abrina T, Bennet J,

This paper reports on the use of choice modelling, a stated-preference valuation technique, to estimate the non-use values associated with coral reef restoration investments in the Philippines. The capacity to use the values so estimated at different scales of investment - ranging from local individual reefs right through to a national investment - is investigated. Differences in values held by people living in close proximity to a reef being restored and those of people living in Metro Manila are also analysed with the goal of enhancing the accuracy of survey value extrapolation and benefit transfer.

ASSISTED MASS SETTLEMENT OF ACROPORA CF. LORIPES CORAL LARVAE IS AN EFFECTIVE CORAL RESTORATION APPROACH
dela Cruz D, Harrison P,

Restoring ecosystems is pivotal in mitigating the effects of anthropogenic disturbances and essential for maintaining biological diversity to ensure continuous flow of ecological goods and services. In the case of coral reefs, innovative restoration technologies aimed at large scale interventions are viewed as one of the primary solutions to the rapid and increasing worldwide reef degradation. For reef systems with limited natural larval supply and ongoing management of primary threats, provision of many thousands to millions of competent larvae is a technique that may provide a means to replenish adult coral populations. This study used a direct mass larval provision technique with mesh matting to restore a coral population in the Bolinao-Anda Reef Complex, Pangasinan, northwestern Philippines. Acropora cf. loripes larvae were cultured ex situ following spawning in June 2014. Approximately 300,000 competent larvae were transported and introduced in each of three 6 x 4 m plots directly on the reef. An organza-hapa matting (150 μm mesh opening) enclosure was used to retain the larvae inside each treatment plot for five days. Three adjacent 6 x 4 m plots that served as controls were also covered with matting but no larvae were introduced. Each plot contained ten 10 x 10 cm settlement tiles cut from dead tabulate Acropora. The larval settlement and post-settlement survivorship and growth of corals on recruitment tiles and natural substrata inside the experimental plots were monitored periodically for 35 months. After five days larval settlement, settlement on tiles in the larval enhancement plots was significantly higher (27.8 ± 6.7 spat per tile) than in control plots, in which no single recruit was monitored. After 35 months, the size of each of the remaining 47 A. cf. loripes coral colonies surviving on the natural substrata and recruitment tiles reached 438.1 ± 5.4 cm³ with a mean diameter of 7.9 ± 0.6 cm. The average production cost for each of the surviving A. cf. loripes colonies at 35 months was USD 35.20. These colonies are expected to spawn and contribute to the natural larval pool when they become reproductively mature, thereby enhancing natural coral recovery in the area. The results of this study indicate that mass coral larval enhancement using mesh matting is a method that can rapidly increase larval settlement and recruitment rates on degraded reef areas to initiate coral population regeneration.
ENHANCING DEGRADED REEFS THROUGH INTRODUCTION OF HATCHERY REARED ACROPORA MILLEPORA LARVAE
Harrison P, dela Cruz D, Cameron K, Cabaitan P, Ligson C, Gomez E,

Coral reefs around the world have been challenged by natural and artificial disturbances, thereby, placing coral populations to significant decline. Hence, restoration techniques have been utilized in bringing back healthy state of reefs. Presently, the larval reseeding approach has been developed and improved for coral restoration efforts. Here, we used the reef-building coral Acropora millepora as source of propagules due to its known reproductive pattern in northwestern, Philippines. A. millepora colonies were collected for culture ex situ. A total of 894,000 A. millepora larvae were released into the degraded reef plots in Magsaysay. Two plots were enclosed with tent design of fine mesh while other two plots enclosed using drop sheet design, both of which aim to enhance larval settlement. Differences in fine mesh designs are used to determine settlement variability among plots enclosed in tent or drop sheet fine mesh. Initial results of settlement revealed that coral settlement is enhanced among the treatment plots compared to control plots having no recruits. Insights of this study will provide information on optimizing methods on coral larval enhancement for reef restoration.

APPLYING CORAL LARVAL ENHANCEMENT TECHNIQUE TO RESTORE DEGRADED AREAS IN HUNDRED ISLANDS NATIONAL PARK, NORTHWESTERN PHILIPPINES
Harrison P, dela Cruz D, Cabaitan P, Ligson C, Gomez E, Cameron K,

The development of coral restoration strategies has gained interest with the increase of reef degradation around the world. One of these strategies is larval enhancement method, wherein coral larvae are cultured and reared in the laboratory. Competent larvae are then directly introduced to degraded reef to increase coral recruitment. However, most restoration strategies often use single coral species. In this study, we tested the feasibility of larval enhancement method by using two species with different growth form on degraded areas of Quezon Island of the Hundred Islands National Park, northwestern Philippines. These degraded areas are composed of stable rubble bed with very low coral cover. Three 7x7-m plots and one 4x20-m plot were assigned as treatment, and another three 7x7-m and one 4x20-m plots as control. All plots were photographed to characterize the initial condition of the benthos prior to the experiment. Five settlement tiles were deployed in each of the plot to monitor the initial larval settlement after the introduction of coral larvae. All treatment and control plots were covered with nylon mesh matting. In May 2018, coral larvae of the branching coral Acropora tenuis and the massive coral Favites colemani were cultured in the hatchery facility of Bolinao Marine Laboratory, Bolinao, Pangasinan. After six days of coral larval culture, each of the 5x5 m treatment plots received 230,000 larvae of A. tenuis and 178,000 larvae of F. colemani. In the 4x20-m plot, 460,000 larvae of A. tenuis and 178,000 of F. colemani were added. Mean settlement on tiles from larval-enhanced 4x20-m plots reached 18.7 ± 5.7 while zero
on the control plots. After two months, 12.5% survivorship was calculated, with differing survivorship for the two species - 15.4% for A. tenuis; 9.8% for F. colemani. Initial results indicate that larval enhancement technique can increase larval settlement and recruitment and can be a potential coral restoration tool.

EFFECTS OF RESTORED REEF USING CORAL LARVAL ENHANCEMENT ON FISH COMMUNITY STRUCTURE IN THE NORTHERN PHILIPPINES

Gomez R, Cabaitan P, dela Cruz D, Harrison P,

In the past decades, several research and conservation efforts have centered on exploring methods to actively restore reefs and to mitigate degradation caused by natural and anthropogenic disturbances. Active coral restoration technique employing the use of sexually propagated coral larvae directly supplied to degraded reefs have been shown to be an effective method in replenishing reef coral colonies. However, the effects of such technique on reef fish communities have yet to be fully understood. In this study, a series of coral larval enhancement interventions have been conducted in 2013 (using Acropora tenuis larvae), 2014 (using A. granulosa), 2016 (using A. tenuis), and 2018 (using A. tenuis) on a degraded reef areas in northwestern Philippines. The reef area with multiple 4x6 m and 5x5 m plots were assigned as the “coral restoration site.” Six 25-m transects have then been laid out to survey reef fish communities quarterly in the site and were compared across communities in selected relatively “healthy” and “degraded” reef sites. Initial results reveal highest species richness and abundance in coral restoration sites compared to the healthy and degraded sites; whereas, fish biomass was still highest for healthy reef site followed by the coral restoration site. Within the coral restoration site, plots where coral larvae were directly introduced and had grown into sexually mature colonies harbored more fishes in terms of species richness and abundance, as well as higher fish biomass versus control plots. These preliminary data support the importance of live coral cover to reef fish communities and further highlights the effectivity of coral larval enhancement method as a viable and important restoration option.

LONG-TERM CHANGES IN FISH ASSEMBLAGE COMPOSITION ON RESTORED DEGRADED REEF PATCH BY CORAL TRANSPLANTATION AND GIANT CLAM RESTOCKING TREATMENTS

Gomez R, Cabaitan P, dela Cruz D, Harrison P, Gomez E,

Global efforts on restoring degraded coral reefs through active approaches such as direct coral transplantation and coral gardening, artificial reef construction, and restocking of various marine species have been explored in the past decades. However, their long-term impacts on the local reef community structure have not been thoroughly examined. In this study, we resurveyed the fish community structure in 25 experimental plots (~25 m²) on degraded reef patches in northwestern Philippines. The degraded experimental plots were restored using five treatments employed 10 years ago. The treatments were 1) direct coral transplantation of Acropora spp. and Pocillopora spp. fragments, 2) giant clam
(Tridacna gigas) restocking, 3) restocking of T. gigas with Acropora spp. branches glued to their shells, 4) deployment of empty T. gigas shells, and 5) control treatments with no intervention. In 2008, fish community structure was surveyed three months prior to the intervention and every month to eleven months after the treatments. Resurveys after ten years were conducted at the start and end of 2018. Results showed an increase in fish abundance, biomass, and species richness for live coral and clam treatments compared to empty shell and control plots. Thus, as the transplanted corals and giant clams grew and survived, they further enhanced the benthic habitat complexity and associated fish biota over the decade. These findings further build on the positive impacts and importance of live corals and other marine organisms such as giant clams to reef fishes and their feasibility as long-term, sustainable reef restoration options.

COASTAL WATER QUALITY PRIOR TO AND DURING THE CLOSURE OF BORACAY ISLAND
Rayos del Sol M, Sotto L, Jaraula C, San Diego - McGlone M, Jacinto G,

Boracay, famous for its powdery white sand beaches is touted to be one of the top tourist destinations in the Philippines. With the surge of tourism in the island, the initial annual tourist count of 164,000 in the 1990s, has reached 2 million in the year 2017. This surge of tourists has continually contributed to anthropogenic pollution, resulting to its “cesspool” label early in 2018. This drove the imposition of the 6-month closure and rehabilitation of Boracay starting April 2018. We examine and compare the water quality before and during the imposed closure of Boracay, particularly in the areas of the west (Bulabog beach) and east (White beach) sides of the island. Water samples obtained in December 2012, along with samples obtained during the closure of Boracay in August 2018 were analyzed and compared. Before closure, sewage in Boracay found its way to the sea through sewage pipes located in the east side of the island, and as expected, nutrients, chlorophyll, DIC, total alkalinity, and coliform bacteria concentrations were found to be higher in this area compared to the west. In contrast, water samples obtained during closure showed a significant decrease in concentration in most parameters, save for persistent relatively high concentrations of phosphate. These observations are indicative of an improvement in the water quality in Boracay as the rehabilitation proceeds.

BREAKWATERS: A GREEN-GRAY STRATEGY FOR MANGROVE REHABILITATION IN HIGHLY ERODED COASTLINE OF PEDADA, AJUY, ILOILO, PHILIPPINES
Primavera J, Furukawa K, Loma R, Sta. Maria Y, Siringan F,

Mangroves are natural buffers that protect coastal communities from wave surges and tsunamis. In the Philippines, mangrove cover has drastically declined and its loss has been associated with conversion to other uses, particularly aquaculture ponds in the 1980s. Various management and rehabilitation efforts were implemented in the country to reverse the trend. However, physical factors such as waves, currents and wind affect survival rates of newly planted seedlings along the seafront. The Zoological Society of London - Philippines explored different strategies to increase survival rates of mangroves in high energy coasts. In 2010, two 70-m breakwaters were constructed in Pedada, Ajuy, Iloilo, Philippines, an area where
erosion has lowered elevation by >1 meter, too low for mangrove survival. The breakwaters are temporary piles of rocks 0.9 m high and 1.5 m wide designed to last until the mangroves are at least 5 years old and can withstand wave action. Results show an increasing trend in elevation with a maximum sedimentation rate of 50 cm/year behind the breakwaters. Accretion in one of the breakwaters increased from 210 m$^2$ in 2010 to 3,822 m$^2$ in 2016. Identifying the edge of soil accretion has been difficult in the recent years as it already started to converge with landward sediments and natural recruits have already established. None survived among the *Avicennia marina*, *Sonneratia alba* and *Rhizophora mucronata* planted in 2010. Planting continued in 2012 when sediment was already firm and stable. *S. alba* was recorded to have the highest survival rate at 73.6% among the species planted. Natural recruitment of *S. alba* and *A. marina* was also recorded in 2013, but it was difficult to distinguish between planted seedlings in succeeding surveys. The Pedada, Ajuy breakwater highlights science-based approaches backed up by properly designed engineering structures enhancing mangrove survival in highly eroded areas.

MOVEMENT PATTERNS OF BLACK-SPINED SEA URCHIN (*DIADEMA SETOSUM*) IN CALATAGAN, BATANGAS
Alojado M, De Luna T, Pepito J, Salva C, Aurellado M,

Understanding the movement patterns of black-spined sea urchins (*Diadema setosum*) are important in examining their spatial distribution, yet few studies have examined how starvation affects their movement. This study aims to examine the effects of starvation on the distance travelled and directionality in *D. setosum*. Twenty adult (>5 cm) sea urchins were randomly collected from the reef flat of Calatagan, Batangas and tagged. Ten randomly selected urchins were deployed randomly on the coral pavement whereas the other 10 individuals were placed in holding tanks and starved for 16 hours prior to release. Each sea urchin was then observed for one hour and their positions recorded. Distance travelled by starved urchins (~5 m) did not differ from that of the control group. Likewise, mean displacement of sea urchins was ~2.5 m and did not differ between control and starved urchins. Various circular statistical tests were then used to examine the directionality of urchin movements. Rayleigh test of uniformity and Watson test showed that both control and starved sea urchins had similar directionality in their movements and tend to travel east or towards the shoreline where seagrass beds were found. This study shows that starvation has no observable effect on the diurnal movements of *D. setosum*. In addition, the clear directionality of their movements differs from previous reports of random dispersal of other echinoids and suggests the possible influence of local environmental factors on *D. setosum* movements.

TIDAL MOVEMENT OF THE INDO-PACIFIC HORNY SEA STAR (*PROTOREASTER NODOSUS LINNAEUS, 1758*) IN A SEAGRASS MEADOW IN CALATAGAN, BATANGAS
Manaligod H, Ticzon V,

*Protoreaster nodosus* is an important seagrass grazer that is over-exploited for trade and ornamental use. Yet, very few studies have been conducted on its ecology, particularly its movement in relation to tidal periods. The study investigated the
movement of *P. nodosus* as affected by tides and microhabitat types present in a seagrass meadow in Calatagan, Batangas. Two 250m² permanent plots were established and divided into 2m by 1m grids. With the grids as the smallest spatial dimension, the benthic habitat of the plots was mapped, and the distribution and feeding frequency of both adult and juvenile sea stars were determined across tidal cycles. Distance covered by randomly selected *P. nodosus* was measured per tidal cycle. Observations were made in a total of 3 diurnal tidal cycles. Results showed that adult *P. nodosus* were more abundant in seagrass beds exposed to wave action, while juvenile *P. nodosus* were found in shallower seagrass beds. *P. nodosus* preferred feeding during low tide and tagged individuals were observed to move southward across two tidal cycles. The study was the first to show that *P. nodosus* displacement was limited and movement is influenced by tide. Discerning movement patterns of *P. nodosus* on shallow reef flats of the country is important in strategizing efforts to sustain its population.

**MOVEMENT PATTERNS OF SHRIMP-ASSOCIATED GOBIES DEPEND ON GOBY CLADE AND PREDATOR DENSITY**

*Stiefel K, Manogan D,*

In the tropical and sub-tropical Indo-Pacific, gobiid fishes and alpheid shrimp share burrows in a symbiosis which involves burrow construction by the shrimp and visual detection of approaching predators by the fish. We analyzed the movement patterns of several species of shrimp-associated gobies in marine environments in the Philippines using software-aided video analysis.

We analyzed the frequency and distance of the excursions of the gobies from their home burrow dependent on fish genus and clade (“silt shrimp gobies” and “reef shrimp gobies”), sampling site, light levels and predator abundance. We also analyzed the activity patterns of the shrimp, and how they were correlated with those of the goby.

We observed significant differences between the activity patterns, which can best be explained by a combination of clade and predator abundance.

We also observed a change of the pigmentation (light to dark) of the crest above the eye in *Ctenogobios ferculosus* and *Amblyeleotris steinitzii* on a time-scale of minutes. Since the pigmentation change does not correlate with changing light levels, we tentatively conclude that it is a social signal and not a mechanism involved in vision.

We discuss our findings in the context of optimal foraging theory, extended by a limited transfer of information from the goby to the shrimp.

**HABITAT UTILIZATION OF HARPACTICOID COPEPODS IN RELATION TO BODY FORMS IN TAKLONG ISLAND GUIMARAS, WEST CENTRAL PHILIPPINES**

*Lapara S, Campos A, Burgos L,*
The Calaparan rocky shore site in the Taklong Island National Marine Reserve (TINMAR) in Guimaras was the study site for the examination of habitat utilization of harpacticoid copepods in relation to body forms in the years 2012 and 2013. Sampling was done following the NaGISA protocol (Rigby et al., 2007) on October 2012 and September 2013 with four 27-meter transect lines laid in different depth gradients namely THT (high tide), TMT (mid tide), TLT (low tide) and TST (1 m depth, sub tidal) parallel to the shore. For the harpacticoid body form analysis, meiofauna samples obtained in the “mid-section” (7, 12 and 17m) sampling points for both years were accounted for in the study. Twenty four families of harpacticoids were identified with Ectinosomatidae as numerically abundant family comprising 15.96% of the total harpacticoid sampled in both years, followed by Canuellidae (10.27%), Tetragonicipitidae (9.07%), Diosaccidae (7.96%) and Metidae (6.84%). Families belonging to Ectinosomatidae are usually ubiquitous, and are known to be good swimmers, well adapted to burrowing and displayed active emergence from the sediment thus conforming to their ability to make use of a wide range of habitats. Overall, epibenthic families such as Ectinosomatidae had the highest percentage (44.99%) in terms of the modes of existence which indicates the complexity and diversity of the habitat selectivity of harpacticoids brought about by the nature of the organisms to exploit different areas other than benthic environments in search for food.

**DIEL ACTIVITY PATTERN OF Cassis cornuta (HELMET SHELL)**

Calle L, Cabaitan P, Tan Shau Hwai A, Sayco S, Conaco C,

The helmet shell, Cassis cornuta, is a marine gastropod that inhabits the sandy and rubble areas of coral reef ecosystems. Their large shells provide habitat to various marine organisms and they are known to be a predator of echinoderms, such as sea urchins. In the Philippines, they are harvested for food and ornaments, which has caused a decline in their population. Despite their ecological and economic importance, few studies have been conducted to understand their biology and ecology. Here, we investigated the activity and behavior of both juvenile and adult C. cornuta over the course of 24 hours. Individuals were placed in flowing seawater tanks half-filled with sand and were provided with sea urchins for food to mimic conditions in their natural habitat. Behavior was scored as either active (i.e., feeding hunting, moving) or inactive (i.e., burrowing or stationary). Result shows that C. cornuta individuals are inactive for almost 13 hours in a day with adults half-buried in sand and juveniles fully buried with only their siphons exposed. Most adult and juvenile individuals are active from 1600H to midnight when they are observed to move around the tanks to hunt and feed. Upon capturing prey, both adults and juveniles take an average of 8 hours to complete feeding and discard the remains of the sea urchin. Individuals that do not capture prey burrow again into the sand. This basic information on the biology and ecology of C. cornuta is essential for future research and conservation of the species.

**VIDEO-BASED SURVEYS AND IMAGE ANALYSIS OF DAMSELFISH SHOALING BEHAVIOR**

Manogan D, Cabaitan P, Stiefel K,
Shoaling, defined as the formation of groups by fish, is a behavioral response induced by environmental factors including predation and habitat characteristics. This group behavior involves a coordinated and rapid response through data transfer signaling important antipredator or threat information. Shoaling by organisms is mostly advantageous and a better understanding of its mechanisms would allow the study of natural changes in the behavior of shoals. Here, data is presented on the shoaling characteristics of the sergeant damselfish (*Abudefduf sexfasciatus*) on two geographic locations with differing predator densities and habitat conditions (i.e., Bauan, Batangas and Bolinao, Pangasinan). We used video surveys and image analysis to extract detailed trajectories of members of a free-swimming shoal. Several measures such as distribution to the nearest neighbor, angle of each member and speed were calculated to describe shoal behavior. In the high-risk location (Bauan, Batangas), individuals swam closer together, were more synchronized and swam faster, as compared to the location with less number of predators. This suggests that shoaling damselfishes have the ability to respond more collectively to threat when conditions are perceived as more risky.

**SEAGRASS FILEFISH, *Acreichthys tomentosus* (LINNAEUS 1758), A MASTER OF CAMOUFLAGE**

Gumanao G, Bos A, Randal J,

The Seagrass filefish, *Acreichthys tomentosus* was studied at Marine Reserve Park, Davao Gulf, Mindanao Island, Philippines between 2016-2018. Using SCUBA, observations, photographs and videos of the Seagrass filefish were made at day and night, in different habitats to describe its camouflage and other dominant behaviors. Examples of protective resemblance are discussed for filefishes (family Monacanthidae) that not only alter their color to match their benthic environment but enhance the deception by having filaments or flaps from the skin, and by their behavior. The species, *Acreichthys tomentosus* (Linnaeus 1758) effectively uses all these guises and found to be superior in remaining undetected, whether in its usual seagrass environment or adjacent sand, algal or coral zones. The juveniles of the filefish are remarkably well hidden in benthic algae of several species, most are recruitment sites. Adults and sub-adults are most often seen in seagrass beds, mostly in *Enhalus acoroides* where they matched the color and amount of epiphytic growth on seagrass. The filefish not only change its color pattern to match its immediate environment but it is also able to instantly change the texture of its skin, including producing of dermal filaments a few mm in length. Moreover, the sleeping behavior of *A. tomentosus* and mutualism are also featured in this paper.

**FIRST SATELLITE TRACKING OF TIGER SHARKS IN THE PHILIPPINES: THE ROLE OF MARINE PROTECTED AREAS FOR MIGRATORY APEX PREDATORS**

Murray R,

Shark migration is a topical issue for conservation practitioners as their long range movements can undermine effective spatial management strategies. The tiger shark *Galeocerdo cuvier* is a highly migratory circumtropical apex predator often associated with coral reef and lagoon habitats. Despite their highly influential role in maintaining healthy ecosystems, knowledge on tiger sharks in the Philippines is extremely lacking. The Tubbataha Reefs Natural Park (TRNP) is the largest no-take
Marine Protected Area in the country and a rare example of an undisturbed reef system. Tiger sharks are observed year round in TRNP yet wide ranging movements outside the park are poorly understood. Between the 14th of June 2016 and 29th of May 2018 satellite position only tags (SPOT) were attached to the dorsal fin of three mature female tiger sharks with a total length ranging between 263 - 343 cm ($x\bar{O} = 304$). The satellite tags provided spatial data for 96 - 216 days with one shark still transmitting location data. Even though satellite tracking data from two sharks tagged in 2016 and 2017 showed the sharks remained in the vicinity of the park, the shark tagged in 2016 was caught incidentally in December 2017 by a purse seiner in waters near Subico, Zamboanga del Norte, Mindanao 280 km from TRNP. The tiger shark tagged in 2018 travelled from TRNP to waters in western Mindanao on two separate excursions, traversing a total distance of 1800 km during 216 days of monitoring. Here we demonstrate that tiger sharks in TRNP exhibit wide roaming repeat migrations outside the protective boundaries of the park and the fishing incident highlights the existential risks associated with such behaviour. Further research will enhance our understanding of the drivers behind these movements and these findings provide relevant data to guide future management strategies for tiger sharks in the Philippines.

STATUS AND TRENDS OF REEF FISHES IN THE PHILIPPINES

Arceo H, Garcia J, Velos M, Recamara D, Cabasan J,

Coral reef fishes significantly contribute to food security and livelihood of coastal communities in the Philippines. Yet, there has not been a comprehensive and systematic assessment of reef fishes in the country despite their considerable importance to both local economy and global marine biodiversity. Most of the information used to obtain a synoptic picture of their status have come from projects with varying objectives. In 2014, a framework for a nationwide assessment was developed to determine the present state and trends in the community structure of reef fishes across the country. Surveys in at least 75 localities have been carried since then. Underwater fish visual census was used to obtain data on reef fish density, biomass and species richness. Around 716 reef-fish species belonging to 71 families and subfamilies were recorded from more than 900 transects. Mean species richness ranged from 9.5 to 69.2 species per 500 m$^2$. Mean adult fish density ranged from 120 individuals to 2,195 individuals per 500m$^2$. Lastly, mean reef fish biomass ranged from 1.6 to 95.8 metric tons per km$^2$. Using categories previously established for reef fishes in the country, majority of the sites (75%) have high to very high levels of species richness. For density, 61% of the sites have moderate levels with only 4 localities having high levels. Meanwhile, most of the sites (44%) fall under the very low to low categories (i.e., $\leq$ 10 metric tons per km$^2$) of biomass. Around 23% of the sites high biomass levels, and only 4 localities have mean biomass greater than 40 metric tons per km$^2$. In most cases, sites with high levels are protected areas or areas with resource management programs. The study provides an update of the current state and of reef fishes in the Philippines amidst emerging and long-term exposure to both anthropogenic and natural threats. It also highlights the need to establish a monitoring system if any declining trend were to be sufficiently addressed.
THE STATUS OF GROUPERS IN THE PHILIPPINES


At least 54 or one third of the world’s grouper species can be found in the Philippines. Their existence is critical, functioning as the apex predators that maintain the fish community structure of coral reefs. However, Philippines’ grouper stocks have been deteriorating since the country continues to be a top exporter of groupers in the global market, notably with its active participation in the live grouper trade. Despite reports on stock declines and extirpation, the status of groupers remain largely undocumented in the Philippines. The goal of this study is to provide a snapshot of the current state of groupers in the Philippines. Grouper data were obtained from the fish visual underwater census of the NACRE-PEARRL conducted from 2015 to 2017. A total of 537 transects were surveyed in 75 sites, including several MPAs to determine whether the existing level of protection is effective towards the conservation of groupers in the country. Twenty-eight grouper species were censused but only 5 non-target species had high abundances and wide spatial distribution. Fourteen target species were observed, but each one only contributed to 0.1% to 2% of the total grouper abundance. Majority of the sites, even those under protection had less than four grouper species. The fast growing and voracious species C. argus dominated all sites. Mean grouper density and biomass for the Philippines was at 2.62 ind/500m$^2$ and 181.02 g/500m$^2$ respectively. Small, non-target species dominated the grouper densities, while grouper biomass were exceedingly low since most groupers surveyed had small body sizes. MPAs showed significantly higher densities and biomass but only for the small non-target grouper species. Nonetheless, few notable MPAs showed propensity to maintain larger species that also enabled them to attain bigger body sizes. Compared to other tropical sites (e.g. Caribbean, Seychelles and Great Barrier Reef), Philippines remains to have one of the highest species richness but yielded severely low densities and biomass. Compared to Hong Kong, the world’s center of live grouper trade, the state of groupers in the Philippines may be less severe but is nonetheless starting to follow Hong Kong’s trajectory if both fisheries and stocks remain unmanaged.

TAWI-TAWI: THE HEART OF THE CORAL TRIANGLE FOR COMMERCIALLY IMPORTANT CORAL REEF FISHES

Muallil R, Enojario M, Tambihasan A, Ong Y,

The Coral Triangle, which is the region encompassing the Philippines, Indonesia, Malaysia, Papua New Guinea, Timor Leste and Solomon Islands, is considered as the center of coral reef biodiversity. Carpenter and Springer (2005) showed that the highest fish diversity within the Coral Triangle is found along the Verde Island Passage between Batangas and Mindoro provinces. Nañola et al. (2011), based on very comprehensive underwater fish visual census data all over the Philippines, recently revealed that coral reef fish diversity was the highest in the Sulu Sea.
particularly in the nationally protected Tubbataha Reef Natural Marine Park in Palawan. In our study, we conducted an inventory of commercially important coral reef fishes from the markets of Tawi-Tawi. We then compared the results of our study with available similar studies conducted in Palawan and Panay Island and found that our study recorded more species for all the fish families/groups considered than any of the two studies mentioned above. In addition, Tawi-Tawi has the highest proportion of unique species than Palawan and Panay island. These findings suggest that Tawi-Tawi could be considered as the Heart of the Coral Triangle in addition to the fact that it is geographically located right at the Center of the Coral Triangle.

STATUS OF CORAL REEF FISHES IN TAWI-TAWI

Injani A, Ong Y, Muallil R,

Reef fishes are valuable resources which provide a major livelihood among the coastal communities in Tawi-Tawi. The province is found in the southern portion of the Sulu archipelago Reef Complex, bounded by the Sulu Sea and the Celebes/Sulawesi Sea, is considered a marine key biodiversity area. However, less is known about its marine biodiversity. In this study, underwater surveys were done by scuba diving along 10 m by 50m belt transects laid along reef slopes with depth ranging from 6-12 m. A total of 59 transect covering a total area of 29,500 m² in five municipalities namely; Bongao, Sibutu, Simunul, Tandubas and Panglima Sugala were assessed from April to December, 2018 during day time from 08:00 to 16:00 hours. A total of 443 species belonging to 48 families were recorded constituting about 58% of all the species recorded from surveys all over the Philippines employing the same method (Nañola et al., 2011). In this study, we assessed the assemblages of 11 commercially important coral reef fish families of five municipalities. The most dominant families in terms of number of species were Labridae (84 species), Pomacentridae (74 species), Chaetodontidae (39 species) Acanthuridae (34 species), and Scaridae (26 species). We have also recorded rare species such as Maming (Cheilinus undulatus), Kat (Bolgometopon muricatum), kuhapu kubing (Epinephelus altivelis). Fish biomass ranged from about 4 to more than 40 mt/km². In our study, showed a high diversity of reef fish communities in Tawi-Tawi. However, threats from anthropogenic sources such as blast and poison are rampant. More efforts should be done to conserve the reef fishes to ensure the long-term sustainability of coral reef ecosystems in Tawi-Tawi.

COMMUNITY ASSEMBLAGES OF CORAL REEF FISHES IN FIVE ISLAND MUNICIPALITIES IN TAWI-TAWI

Ong Y, Injani A, Muallil R,

Tawi-Tawi is located at the southwestern part of the Sulu Archipelago which boarders the Sulu Sea and Celebes Sea. It is called the Southern Ecological Frontier of the Philippines due to its vast and relatively pristine marine resources. In this study, we compared the community assemblages of coral reef fishes among five island municipalities (Tandubas, Panglima sugala, Simunul, Bongao and Sibutu) in Tawi-Tawi. Fish visual census (FVC) surveys was conducted during day time from 8:00 am to 4:00 pm from April to December 2018. A minimum of five (5) to a maximum of ten (10) by10m x 50m belt transects were laid along the reef slope at
6-12 m deep, the surveyed include both inside and outside marine protected areas (MPAs). A total of 443 species, 157 genera and 48 families were recorded. Only about 12% of the species recorded were found in all five municipalities. Interestingly, about 42% of the species were recorded from one municipality only. Our study suggests that different islands in Tawi-Tawi have unique marine fish diversity. Further details about fish community assemblages in each of the islands surveyed and its implication coral reef conservation shall be discussed.

COMMUNITY ASSEMBLAGES OF FAMILY CHAETODONTIDAE IN TAWI-TAWI, PHILIPPINES
Habibuddin A, Injani A, Ong Y, Muallil R,

Chaetodontidae is one of the most conspicuous and specialized coral reef fishes which feed mainly if not exclusively on scleractinian corals. Their community assemblages are widely known for health indication of coral reef areas. Tawi-Tawi is the southernmost part of the Philippines, blessed with diverse marine resources. In this study, we conducted fish visual census (FVC) conducted in four island municipalities of Tawi-Tawi namely, Bongao, Simunul, Sibutu, and Tandubas from April to December 2018. In each municipality, ten to sixteen 10m x 50 m transects laid on reef slope with depths ranging from 6-12 m were surveyed. A total of 1,466 individuals belonging to 35 species, 6 genera of butterflyfishes were recorded. The most abundant species were Chaetodon kleinii, Hemitaurichtys polylepis, Chaetodon lunulatus, Heniochus varius and Forcipiger flavissimus. Butterflyfish community assemblages will be compared among the sites. Our study provides valuable insight for coral reef conservation in Tawi-Tawi.

STATUS OF BENTHIC COMMUNITIES ON CORAL REEFS IN TAWI-TAWI, SOUTHERN PHILIPPINES
Muharram J, Habibuddin A, Injani A, Muallil R,

Tawi-Tawi is known for its rich marine resources that serve as main sources of income in the province. However, being part of the coral triangle where the center of the marine biodiversity is located, it also happens to be the most threatened by anthropogenic disturbances. Unfortunately, few scientific studies have been done to assess the status of coral reefs in the province. In this study, we assessed the benthic communities in five (5) municipalities in Tawi-Tawi using a line intercept transect (LIT) method (English et al., 1997) on 50-m long transect laid on reef slope with 6-12 m deep. Five (5) to sixteen (16) transects were surveyed in each municipality. Results showed coral cover ranged from 25.44% in Tandubas to 46.65 % in Simunul corresponding to “poor” and “fair” conditions, respectively, based on Gomez et al., 1994 categories. We also use the Mantachitra index (1994) was also used to describe the status of benthic communities. Implications to coral reef conservation in Tawi-Tawi will be discussed.
MID HOLOCENE SEA SURFACE TEMPERATURE AND PRECIPITATION CHANGES RECORDED IN FOSSIL CORAL FROM TROPICAL NORTHERN PHILIPPINES

Garas K, Watanabe T, Yamazaki A, Kase T, Aguilar Y,

Coral geochemical proxies are used to reconstruct past climate and oceanographic conditions. Corals incorporate elemental and isotopic tracers from the ambient seawater during the calcification of CaCO₃. Trace element (Sr/Ca), oxygen isotope (δ¹⁸O) and carbon isotope (δ¹³C) can track changes in sea surface temperature, salinity, precipitation, light intensity and turbidity (Beck et al. 1992; Juillet-Leclerc and Schmidt, 2001; McConnaughey et al. 1997). Using geochemical proxies in fossil corals, we can know the response of ocean to climate systems such as East Asian Monsoon (EAM) and Intertropical Convergence Zone (ITCZ) during time intervals beyond instrumental records. Northwestern Pacific experienced higher solar insolation and continent-ocean temperature gradient during mid-Holocene (4200-8200 years ago). However, the extent of influence of orbital and oceanic forcings in past SST and precipitation is still unclear.

Core sample was drilled from fossil coral colony in coastal area of Damortis, Sato Tomas, La Union. The coral growth rate is 1.8 cm/yr measured from x-ray photograph of 5-mm thick slab. XRD and SEM analyses show that fossil coral has pristine aragonite skeleton, devoid of diagenetic alteration from secondary aragonite and calcite. ¹⁴C dating was used to determine the absolute age date of 4158-4200 yrBP. We reconstructed sea surface temperature (SST) and precipitation using 40 year-record of Sr/Ca, δ¹⁸O and δ¹³C in fossil coral.

Mean Sr/Ca of the 40-year fossil coral record is 8.77 mmol/mol equivalent to 29.73°C (standard error: +1.6°C). Mean annual SST at 4698 yrBP was higher by 1.4°C compared to instrumental mean SST (28.37°C) from 1981-2019 and reconstructed SST from modern coral (28.4°C) from 1954-2012 (Ramos et al. 2017). Mean annual δ¹⁸O at 4698 yrBP is -6.09‰ (+0.53). This is lower than published oxygen isotope data (Yokoyama et al. 2011) from Northern Philippines of -5.42‰ at 6600 yr BP and -5.98‰ at present. The decreasing δ¹⁸O values from 6600 to 4698 yrBP was controlled by the enhanced rainfall in South China Sea from mid to late Holocene due to southward retreat of EAM and ITCZ. Coral δ¹³C and seawater δ¹⁸O were compared to determine the timing of precipitation and terrestrial input from river flooding during summer monsoon.

EFFECT OF ELEVATED TEMPERATURE ON THE CORAL IMMUNE RESPONSE

Palic D, Da-anoy J, Conaco C,

Scleractinian corals are essential in building the reef structures that support the diversity of the marine life. However, corals are threatened by many stressors particularly elevated sea surface temperature, which triggers bleaching of susceptible coral colonies. The damage brought about by bleaching to corals, albeit drastic, is not always a death sentence for the reef. Some corals are resilient and can recover quickly should conditions return to normal and if human impacts are kept at a minimum. The coral itself has a complex genetic repertoire of innate immune response and repair mechanisms that protect the animal. However, how these mechanisms are involved in the coral thermal stress response remain to be
elucidated. In this study, homologs of major immune response genes will be identified in the transcriptome assembly of four scleractinian corals, *Acropora digitifera*, *Seriatopora caliendrum*, *Montipora digitata*, and *Favites colemani* which exhibit differential responses to thermal stress. The expression of these genes will be determined from the transcriptome data obtained from coral fragments subjected to 32±1°C for various time points versus controls at 28±1°C. We expect to find a complex innate immune gene repertoire in the selected coral species. Elucidation of the immune regulatory pathway that is activated under stress may potentially explain how these genes contribute to the resilience of corals amidst unprecedented rates of climate change.

STILL HOLDING ON TO THAT NUGGET OF HOPE: A CASE FOR ADAPTIVE BLEACHING IN PHILIPPINE CORALS

**Torres A**, Aliño D, Gotanco R,

Prolonged thermal stress and high levels of solar irradiance disrupt the mutualistic relationship between corals and their photosynthetic dinoflagellate symbionts causing bleaching, reduced overall fitness, and probable mortality of the cnidarian host. However, hope for survival of reefs amid rapidly heating oceans has been seen on adaptive bleaching and the acclimatization of corals which posit bleaching as an opportunity for the coral host to switch its currently susceptible symbionts with more stress-tolerant species. In this study, we explored the diversity of zooxanthellae across coral hosts from different marine biogeographic regions in the Philippine archipelago. Using PCR-DGGE fingerprinting and sequencing of the zooxanthella ITS2 region, we characterized endosymbiont diversity within species under four scleractinian families of interest across archipelagic thermal regimes. Haphazard sampling of 573 coral fragments was conducted in 14 reef sites across the Philippines from July 2015 to May 2018. Uniformity in dominant zooxanthella species was observed in *Acropora spp.*, *Porites cylindrica*, and *Heliopora coerulea* across all sites sampled. In contrast, species under the family Pocilloporidae (*Pocillopora spp.*, *Seriatopora spp.*, and *Stylophora pistillata*), exhibited biogeographic variation in zooxanthellae composition. Pocilloporid coral communities in the warmer clusters harbored *Durusdinium trenchii* (previously *Symbiodinium* subclade D1a), an endosymbiotic species hypothesized to be resistant to thermal stress. Communities in the cooler clusters hosted a diverse array of Cladocopium (previously *Symbiodinium* clade C) lineages. Variability in zooxanthellae assemblages reflect host-specific responses to ecological or environmental gradients across biogeographic regions. More importantly, such patterns of variability may provide insights on the adaptive capacity and resilience of Philippine coral populations in the face of predicted increase in severity of environmental stressors in the years to come.

EFFECTS OF FOUR VARYING TEMPERATURES ON THE PLANULAR SETTLEMENT AND ASEXUAL REPRODUCTION OF THE TROPICAL UPSIDE-DOWN JELLYFISH, *Cassiopea andromeda* (FORSKÄL, 1775)

**Geson S**, Sotto F,
Temperature is one of the factors influencing the life-stages of many marine organisms including scyphozoans. The tropical upside-down jellyfish, *Cassiopea andromeda*, inhabiting the Philippine waters, experiences a narrow range of temperatures all throughout the year. This study aims to determine the effects of varying temperatures on planular settlement, percentage of strobilating and budding polyps, and the strobilation duration of the *C. andromeda*. Temperatures treatments (27, 29, 31, 33, and 35°C) were based from the ambient environment of the medusae. Sexually produced planulae were collected from mature medusae and were made to settle at different temperatures. Results showed that planular settlement increases with increasing temperature over time. Strobilation and budding of polyps reared from sexually produced planulae were also investigated at varying temperatures. Strobilation and budding was observed to occur at temperatures 27–33°C, but not at 35°C. The percentage of strobilating polyps was not significantly affected with increasing temperature, whilst the strobilation duration decreased. As temperature increases, the percentage of budding polyps also increases. Based on the results of this study, warmer temperatures especially during the summer months greatly favors *C. andromeda* thriving in tropical waters.

OCEAN WARMING AND ACIDIFICATION ADVERSELY AFFECT THE TRUE GIANT CLAM, *Tridacna gigas*, AND ITS SYMBIONTS
Baquiran J, Nada M, Tejada A, Cabaitan P, Conaco C,

Massive and uncontrolled carbon dioxide (CO₂) emissions due to human activities contribute to the continued increase in acidity and temperature of the ocean. The combined effect of ocean warming and acidification pose serious threats to many marine organisms, such as the true giant clam, *Tridacna gigas*, which is already vulnerable due to overharvesting and habitat destruction. To gain an understanding of the physiological response of *T. gigas* to changing ocean conditions, we subjected juvenile giant clams (9.79 ±0.05 cm shell length) to different treatments simulating predicted seawater pH and temperature levels in the future. Temperature had the largest effect on the giant clams, regardless of pH level. All individuals subjected to 34°C died within one week of exposure. On the other hand, most individuals were able to survive the other treatment combinations. However, we observed a decrease in symbiont density along with an increase in symbiont cell size at 32°C. This indicates that, under these conditions, there is disruption of the association between *T. gigas* with its symbionts, which could negatively impact giant clam health. In addition, hemocyte count significantly increased in *T. gigas* individuals exposed to 32°C and pH 7.6 compared to individuals under control conditions, suggesting activation of the innate immune response. Collectively, the results of this study suggest that although *T. gigas* juveniles can tolerate temperatures up to 32°C and pH as low as 7.6, prolonged exposure to these conditions, along with other environmental stressors, may be detrimental to the growth and survival of giant clams.

EFFECT OF SALINITY AND TEMPERATURE ON THE SURVIVAL AND GROWTH OF *Heliopora coerulea*
Esmolo R, Conaco C, Cabaitan P,
Rising sea surface temperature and reduced salinity due to increased rainfall intensity and frequency are two of the most immediate stressors faced by coral reefs in the Philippines. In the Bolinao-Anda reef complex in northwestern Philippines, salinity changes may be exacerbated by freshwater input from rivers, natural springs, and submarine groundwater discharge. Some reefs in this area are dominated by the blue octocoral, *Heliopora coerulea*, which surpasses scleractinian corals in terms of total percent cover. To understand how this coral has become so successful in the region, this study aims to determine its growth and survival under variable temperature (28°C, 30°C, 32°C, 34°C) and salinity (35, 30, 25, 20, 15 ppt). This study will investigate how combinations of temperature and salinity affect the physiology of the coral, specifically, in terms of its horizontal and vertical growth rate, photosynthetic efficiency, and symbiont density. The results of this study will contribute to a deeper understanding of the factors that support the dominance of *H. coerulea*.

**SPONGE HOLOBIONTS: NOT ALL WINNERS?**

**Posadas N, Baquiran J, Nada M, Cabaitan P, Conaco C,**

Ocean warming and acidification are major threats to marine organisms and influence the diversity and functioning of reef ecosystems. Under future ocean conditions, marine sponges (Porifera) are predicted to be winners on the reef because they possess complex physiologies and diverse microbiomes that contribute to efficient nutrition acquisition strategies and metabolism, as well as active immune and stress response machineries. However, sponges are a diverse group with members that produce either siliceous or calcareous skeletal elements, yet little is known about how these different types may be affected by environmental perturbations. To better elucidate the mechanisms underlying the organismal stress response of sponges, *Siphonodictyon siphonum* (siliceous) and *Leucetta chagosensis* (calcareous) were subjected to stress experiments simulating the conditions of 2100 RCP 6.0 and 8.5 proposed by the IPCC. Elevated temperature alone and combinations of acidification and warming caused minimal morphological changes and low mortality (7%) in the siliceous sponge, *S. siphonum*. On the other hand, calcareous *L. chagosensis* exhibited tissue necrosis and disintegration, resulting to high mortality (75%) within just three days of constant exposure to the stressors. After exposure, shifts in the symbiotic bacterial assemblage were observed in *L. chagosensis*, which has a relatively diverse microbiome compared to *S. siphonum*, which mainly consists of GC-rich ribotypes. Prediction of the functional contributions of the microbial community will provide insights into their roles in the holobiont stress response and in the differential survival of the two sponge types. These findings suggest that not all sponges may be able to tolerate future ocean conditions, emphasizing the need for more studies on this group of organisms.

**OCEAN ACIDIFICATION IN COASTAL WATERS: A PRIMER TO UNDERSTANDING CHANGES IN COASTAL CARBONATE CHEMISTRY**

**Isah R, Magyaya R, Tamayo N, San Diego-McGlone M,**

The continuing anthropogenic input of CO₂ into the oceans has led to an alarming shift in the marine carbonate chemistry. There is reduction in pH (ocean acidification)
and CaCO₃ saturation state, both of which potentially yielding negative effects to marine organisms and ecosystems. The Philippines harbors coastal ecosystems like coral reefs that hold significant value to human society and yet are most vulnerable to ocean acidification. Here we present current approaches to understand and assess changes in coastal carbonate chemistry. Parameters such as pH, total alkalinity (TA), and dissolved inorganic carbon (DIC) can be readily measured by sampling for seawater, and laboratory analysis (using the total alkalinity titrator), in addition to derived parameters such as pCO₂ and aragonite saturation state (Ωarag). From these parameters metabolic processes within a coastal ecosystem can be derived using TA-DIC diagrams to evaluate how they alter the carbonate system and to assess the effects of environmental stressors. Calcification/dissolution and photosynthesis/respiration are the two concomitant processes greatly controlling the balance of TA and DIC. Diel variability of carbonate chemistry is also important to assess the magnitude of changes in relation to the projected levels at the end of century. High frequency in situ measurements using pH sensor are now available and spectrophotometric pH method is developed for higher precision. Two coastal systems are examined to understand changes in carbonate chemistry and community metabolism. One is Bolinao-Anda in Pangasianan where unregulated mariculture activities have resulted in high input of organic matter that when decomposed release CO₂ with consequent lowering of pH. The other coastal area is in Mabini, Batangas where volcanic CO₂ vents release low pH water to the surrounding reef.

MONITORING REEF MANTA RAY CLEANING STATIONS VIA REMOTE UNDERWATER VIDEO


Remote Underwater video (RUV) surveys were conducted in two locations across the Philippines, San Jacinto (Masbate) and Taytay (Palawan), to assess and characterize manta ray populations. Since August 2018 in San Jacinto, a total 93 individuals reef manta rays (Mobula alfredi) have been identified, bringing the total number of identified mantas in the Region up to 155 animals so far, and confirming this location as the largest aggregating site in the country to date. This population presents a larger number of sexually mature males with 60 mature individuals against 11 immature, out of the 71 males for which the maturity is known. Out of these 93 animals sighted, 62 (67%) have been re-sighted to date, supporting the high-level fidelity. Moreover, several individuals previously identified from citizen science in the past years were re-sighted, with the longest interval of 11 years (2007-2018) highlighting the long term importance of this habitat. Visitation of the main cleaning stations was observed predominantly between 6 and 10am (42% of the sightings). In Taytay, since June 2018, 22 individuals have been identified to date at a complex system of shallow cleaning station, including 11 males, 8 females and 3 yet not determined. Out of these 22 individuals, 17 (77%) have been re-sighted over different months. Injuries due to fishing interactions resulting in line entanglements, severe cuts in the pectoral fins or missing cephalic fins were observed for 27% (n=42/155) of the animals in San Jacinto and 27% (n=6/22) in Taytay. This suggests the necessity for to regulate fishing interaction including gear modification and spatial planning. In light of the recent declaration of the Ticao Burias Pass Protected
Seascape, the monitoring of such a critical habitat as in San Jacinto is essential, providing baseline data for efficient conservation management strategies.

COASTAL SEA RESPONSE TO ATMOSPHERIC FORCING IN PANAY STRAIT, PHILIPPINES
Repollo C, Vidal X, Villanoy C, Flament P,

High-resolution 10 m wind forecasts from the Coupled Ocean/Atmosphere Mesoscale Prediction System (COAMPS) show the local atmospheric patterns in Panay Island, that were not fully resolved by the gridded QuikSCAT wind data during the Regional Intensive Observational Period cruises in February-March 2009 (RIOP-09) for the Philippine Straits Dynamics Experiment (PhilEx). The Northeast (NE) monsoon is characterized by distinct wind jets between islands and mountain gaps that generates an alternating band of positive and negative wind stress curl to the right and left downwind of each island. These bands are also observed in the Envisat Synthetic Aperture Radar (SAR) images. The Panay coastal sea response includes formation of a cyclonic Panay Lee (PL) eddy, the relatively smaller cyclonic Panay Tip (PT) eddy on the northwest flank of the island, and the localized coastal upwelling in Pandan revealed by the sea level measurements from the moored shallow pressure gauge and temperature from SBE37 CTD. Multiple sample iterations with TRIAXUS and ADCP repeatedly map subregions covering the PL and PT eddy which resolve tidal variability and low-frequency variability that represents the seasonal response to monsoon winds. The observed features were confirmed by satellite observations of sea surface temperature and chlorophyll concentration provided in near real-time during the PhilEX cruise.

ANTIMICROBIAL SENSITIVITY OF CRUDE SEA URCHIN TOXIN EXTRACT (Diadema setosum) AGAINST STAPHYLOCOCCUS AUREUS AND PSEUDOMONAS AERUGINOSA
Bautista J, Rubio J,

This study aimed to determine the antimicrobial activity of Diadema setosum crude toxin extract on Staphylococcus aureus and Pseudomonas aeruginosa. The sea urchin spines were collected at Calatagan, Batangas and extracted using an ethanol solvent. Three replicates were made per test organism with distilled water as the primary control and streptomycin for the antimicrobial sensitivity index control. The Kirby Bauer method using Mueller Hinton agar was used in testing the antimicrobial sensitivity of the crude sea urchin toxin extract to the selected microorganisms. 6 mm filter paper disks were soaked with the crude extract and placed onto the seeded plate. After 24 hr. the results were observed and the mean average zone of inhibition was measured in mm using Vernier caliper. The results yielded 0mm and 0mm respectively. The results were compared to the standard sensitivity index of streptomycin in determining the test microorganism sensitivity to the crude extract. The extract showed no antimicrobial effect on Pseudomonas aeruginosa and Staphylococcus aureus.
ANTIBACTERIAL ACTIVITY OF MARINE SPONGE EXTRACTS AND BACTERIAL ISOLATES

Opiña L, Sumayo M, Cuadra M, Campos W, Piloton R,

Marine sponges are a potential source for novel antibiotic substances for new antibiotics. In this study, extracts and bacterial isolates were taken from marine specimens collected from subtidal areas in General McArthur, Eastern Samar, Philippines. Ethyl acetate extracts of 23 marine sponges were tested and screened for antibacterial effects against Staphylococcus aureus, Enterobacter aerogenes, Enterobacter faecalis and Bacillus subtilis. Minimum inhibitory concentrations (MIC) and minimum bactericidal concentrations (MBC) were determined using 2-fold microdilution for bioactive extracts. Bacterial isolates were taken from sponges with active extracts and tested against the same set of pathogenic bacteria using disk diffusion and agar overlay method. Out of 23 extracts, 14 had inhibitory effects at concentrations ranging from 50 ppt to 0.39063 ppt. A total of 40 bacterial isolates isolated from Acanthella cavernosa, Auletta sp., Haliclonia sp., Paratitella bacca, Planktoris sp., and Stylissa carteri were tested for antibacterial activity. Inhibitory effects were exhibited by 23 of the bacterial isolates. This indicates that both extracts and associated bacteria from marine sponges are possible sources for new bioactive compounds.

FIRST REPORT OF HIGHLY BRANCHED ISOPRENOIDS PRODUCED BY MARINE DIATOMS IN TROPICAL WATERS

Mong J, Ferriols V,

Highly branched isoprenoids (HBI) C$_{25}$ and C$_{30}$ are unsaturated hydrocarbons ubiquitous in marine waters hence, are used as geochemical markers. Aside from the possible use of these hydrocarbons as a biofuel, interestingly, some C$_{25}$ HBI isomers were reported to have cytostatic effects on lung cancer cells, in vitro, indicating its potential use in the field of medicine. In this study, four C$_{25}$ HBIs were detected in the different waters of Panay Island. The water samples were collected from Ortiz Port, Fort San Pedro, Iloilo City and Ajuy, Iloilo. HBIs were identified using gas chromatography and mass spectrometry (GC-MS). There were variations in the ion fragment patterns present in the mass spectra of the different water samples, however, the structures of the HBIs appeared to be the same in all water samples. Two HBIs were identified while the other two were reported as possible novel HBI isomers (C$_{25}$:3 and C$_{25}$:4) based on their mass spectra. The first identified HBI was an acyclic C$_{25}$ triene containing double bonds situated at C$_7$-C$_{20}$, C$_9$-C$_{10}$, and C$_{23}$-C$_{24}$ and the other HBI was a C$_{25}$ pentaene containing double bonds at C$_2$-C$_3$, C$_7$-C$_{20}$, C$_9$-C$_{10}$, C$_{13}$-C$_{14}$ and C$_{23}$-C$_{24}$. The presence of HBIs were tentatively attributed to Rhizosolenia setigera, Pleurosigma normanii or other species of diatoms that could possibly be a new source of HBIs that were present in the water samples. Studies regarding the occurrence of highly branched isoprenoid alkenes and their producers are already available, however, these have been limited only to temperate waters, hence this study is the first report of its occurrence in tropical waters.
ALGICIDAL POTENTIAL OF CULTIVABLE BACTERIA FROM PELAGIC WATERS AGAINST TOXIC DINOFLAGELLATE Pyrodinium bahamense (DINOPHYCEAE)

Dungca-Santos J, Caspe F, Tablizo F, Purganan D, Azanza R, Onda D,

Associated and algicidal bacteria play roles in the succession and decline of phytoplankton blooms, including those of harmful algal bloom (HAB)-forming species. These diverse interactions led to studies on the ecological role of algicidal bacteria and their potential as biocontrol tools for HABs mitigation. In the Philippines, limited studies on algicidal bacteria also resulted in our incomplete understanding of HABs dynamics. Here, we tested 48 cultivable pelagic bacteria from three HAB-affected areas (Bolinao, Sorsogon and Matarinao) against non-axenic cultures of the toxic, thecate dinoflagellate Pyrodinium bahamense. These isolates exhibited varying activities in either or both direct and indirect attack assays. The level of algicidal activity however varied among isolates across taxa, suggesting that it may not be a conserved property with phylogeny. Furthermore, majority of the species elicited activity against P. bahamense, which was not present in the area where the bacteria were isolated, implying non-specificity of action. Potential preference for indirect mode of attack was also seen that may be possibly linked to their ability to produce secondary metabolites. Exposure to bacterial cells and lysates resulted in Pyrodinium pellicle cyst formation. Despite this, however, cell lysis and decline in cell abundance were observed, indicating the strong algicidal potency of our isolate. In depth understanding of the interplay between environmental factors and algicidal bacteria-microalgal interactions may provide significant insights on the management of HABs.

MONOGENEAN GILL PARASITES OF Lutjanus fulviflamma (FORSSKÄL, 1775) FROM BADIAN, CEBU, PHILIPPINES

Bitay A, Arceo H,

The Philippines is a major fishing nation, and the consumption of fish is a major protein source to Filipinos, thus making it a significant contributor of nutrition. Possible contaminants in fish may lead to health risk. Fish gills are a preferred habitat of numerous external parasites due to its constant contact and exposure to the aquatic medium containing various pathogens, toxins, and other particulate matter or organisms, making it susceptible to infection and physical damage. Coral reefs are areas of maximum biodiversity, but the parasites of inhabiting fishes are not well known. Only a few studies on fish parasites focused on species from the coral reef environment, where there are abundant species of fishes, as well as parasites. The dory snapper, Lutjanus fulviflamma, is an important commercial reef fish species commonly sold in markets in the Philippines. The present study aims to provide knowledge about monogenean gill parasites found in the dory snappers. Samples were obtained from local fishers in Badian, Cebu. The weight and length for each fish was measured, and the gills were excised and examined under the microscope. The work presented herein deals with the distribution of ectoparasites.
in various gill sections of the dory snapper and explores the structure of parasite communities in the gills and their possible relationship with ecological and oceanographic variables, and their potential roles as indicators of environmental health. Directions for future research on the parasites of fish gills in tropical regions are also discussed.

STRANDINGS OF LONGMAN’S BEAKED WHALE (*Indopacetus pacificus*) IN THE PHILIPPINES

Acebes J, Barcelona A, Yamada T, Dolar M, Santos M, Perrin W, Barbecho N, Tan J,

Longman’s beaked whale, *Indopacetus pacificus*, one of the least known of all whales is a cetacean species whose external appearance was only first described in the 21st century. Prior to 2004, the species was previously known from only six specimens. Although at least twenty more specimens were recovered from strandings since then, knowledge on the species is still very limited. In the Philippines, the first record of the species was confirmed through a live stranding in Davao on January 2004. Previous sightings of *Indopacetus pacificus* alive at sea in the Philippines were unconfirmed. Herein we account for all the confirmed strandings of the species in the Philippines and describe the specimens collected and their status. To date there are four confirmed strandings of the species: in Matina-Aplaya, Davao on 2004; in General Nakar, Quezon on 2016; and in Sta. Ana and Gonzaga, Cagayan Province on 2018. From two of these the skeleton, stomach contents and tissue samples were examined and collected. The skeletal specimen collected from Sta. Ana, Cagayan is by far the most complete in the country and is probably in one of the best conditions in the world. For cetacean species wherein very little is still known, the examination of each specimen from stranding events is a rare opportunity to study the species. Hence, the importance of standardizing necropsy and stranding data collection protocols, training stranding first-responders and establishing a database are emphasized.

CITIZEN SCIENCE AND YOUTH EDUCATION: IN MEMORIAM DR. MARICAR SAMSON

España N, Licuanan W,

We believe that the young kids are the ones who will take care of the environment when they grow up

~ Dr. Maricar Samson.

In fond memory of Dr. Maricar “Cai” Samson, the People and Nature Session highlights the role of citizen scientists, especially the youth, in the conservation and protection of the ocean and its vast resources. Cai, who sadly passed away in November 2018, had a major influence on mangrove and seagrass ecologists, conservation practitioners, resource managers, and fellow educators. Most of her research focused on understanding ecosystem services of mangroves and seagrass, and the importance of having sound management strategies to allow them to recover from climate related disturbances, as demonstrated in their recent paper.
on the impacts of Typhoon Haiyan. Her passion for teaching the youth, have led to the conception of the DLSU Coastal Scouts Program. Together with Dr. Wilfredo Licuanan, she has dreamed of cultivating appreciation, raising awareness, and continually inspiring the youth, especially those that live near the coast or are members of a fishing community, to learn more about marine biology through hands-on experiential education.

THE COASTAL SCOUTS AUXILIARY: YOUTH-BASED OUTREACH AND CITIZEN SCIENCE
Cancio E, Licuanan W

The Coastal Scouts Auxiliary (CSA) is a youth-centered citizen science initiative led by the De La Salle University. The CSA aims to provide experiential learning opportunities to the youth, primarily those in coastal communities, to foster awareness and appreciation for the marine ecosystem of the Philippines and to empower the youth to involve themselves in finding solutions to the problems that affect marine life and coastal communities. Under the direction of Dr. Al Licuanan and Dr. Maricar Samson, I was a member of the first batch of CSA launched in the DLSU Laguna Campus. As a member of the CSA, I gained first-hand experience of marine environments and their importance to coastal communities and society as a whole. These lessons were incredibly valuable because I learned about marine ecosystems through the perspective of the communities and people who relied the most on the ocean. Experiencing and witnessing the lives of coastal communities and our impacts on marine life helped me develop a deep sense of appreciation for the natural world and an urgency to solve the problems that threaten it. This attitude is shared among all the present and previous members of the CSA. Because of its success, I believe that the CSA program should be used as a model of effective citizen science and youth-based outreach and community development.

BUILDING HIGH SCHOOL TEACHERS CAPABILITY ON MARINE BIODIVERSITY RESEARCH: A BATANGAS STATE UNIVERSITY INITIATIVE

The Verde Island Passage (VIP) in Batangas, Philippines is considered as “the center of the center of marine shorefish biodiversity in the world”. Despite the pride and prestige that it gives to the region, it is being exposed to numerous threats to its ecosystem, and is already considered as a marine biodiversity hotspot. Further, it was identified as a priority area for biodiversity conservation at the regional scale. The Batangas State University in Batangas City, Philippines has recognized the important role of the VIP in the world’s biodiversity, thus, heeded the call for its conservation and protection. With its Verde Island Passage - Center for Oceanographic Research and Aquatic Life Sciences (VIP - CORALS), that is mandated to provide leadership in conducting research on different marine ecosystems in the Verde Island Passage for sustainable national development, it initiated a step that gives high impact in its conservation and protection. A Needs Assessment survey was administered to representatives of high schools in Batangas. Based on this assessment, eighty-nine percent (89%) of the respondents answered that they have a high need for a research capability training. Thus, an
extension activity involving the marine ecosystem in Isla Verde was conducted. Teachers from the Junior and Senior high schools in Batangas were trained for research capability and biodiversity assessment of important key species in Isla Verde. A Focus Group Discussion was conducted to identify the views of the participants towards the activity. A structured questionnaire was used to evaluate the activity. Ninety-five percent of the respondents strongly agreed that the activity was effective and that the training was relevant to their teaching profession. Through this initiative, educating the educators posed a higher impact and effectiveness because these teachers are handling several groups of students in their respective schools. Making them interested and equipped in doing researches in the marine environment, they can influence more individuals to be involved in the same type of research field as well.

STIMULATING INTEREST OF HIGH SCHOOL STUDENTS IN MARINE ECOSYSTEMS THROUGH SCIENTIFIC INVESTIGATION IN ZAMBOANGUITA, NEGROS ORIENTAL, PHILIPPINES

Andringa A, Gervereau K,

Existing marine ecosystem monitoring methods for mangroves, seagrass, and coral reefs can be used to stimulate interest and active learning of high school students in coastal communities. The increased number and ease of access to citizen science programs and the use of smart phone and tablet applications for marine science can be used to enrich the learning process.

Students of the 10th grade of the Zamboanguita Science High School participated in a 7-month program in which they chose to focus on seagrass, mangroves, coral reefs and Marine Protected Areas or marine debris. Classroom teaching and preparation activities were conducted once a week. Working in small teams, the students conducted fieldwork on Saturday mornings on a rotation basis.

This presentation will provide an overview of existing methods that can be easily applied with student in the field. Examples include the “Seagrass Watch” and “Seagrass Spotter” methods used for seagrass monitoring. A slightly modified method was used for mangrove monitoring along with the “Mangrove ID” app for species identification. Students used Remote Video Monitoring to monitor fish behaviour in an local Marine Protected Area. Some student teams conducted interviews with representatives in the community, others measured water quality, and some studied land use around their ecosystem.

To increase awareness of the problems of waste management and marine debris, all students participated in at least one beach clean-up. The data was entered in the Clean Swell app from Ocean Conservancy.

The students report on their learning experiences and provide useful data their data to the Coastal Resource Department, the Bantay Dagat, Barangay Captains. The students share their new knowledge and appreciation of the marine environment with parents, extended family, and other students.
The program also addressed questions such as the development of life skills, swimming and snorkeling skills, and fieldwork safety.

COMMUNITY-BASED MANGROVE REHABILITATION AND AQUASILVICULTURE: A FISHERY LIVELIHOOD AND MARINE CONSERVATION PROJECT IN DAVAO DEL NORTE
Tejada R,

The Philippine National Aquasilviculture Program (PNAP) aimed to ensure resource sustainability, to attain food security and to alleviate poverty of the beneficiaries in the Ten Barangays in Davao del Norte as beneficiaries. It has 3 components, the Mangrove Rehabilitation, Aquasilviculture and Community-based Multi-species hatchery. A total of 626,600 mangroves propagules were planted in 168.04 ha. in different areas from July, 2012 to March, 2015. The beneficiaries received a total amount of P 2,193,300.00 for gathering the propagules (at P1.50/propagule) and for planting at (at P 2.00/propagule). The project team also paid P 906,955.00 for the 362,782 fully grown planted mangroves (at P 2.50/tree) to the beneficiaries of the project. For the aquasilviculture component, there were 32 units of techno-demo sites installed and stocked with tilapia and mudcrab. The 2 hatcheries were made to supply crablets and fingerlings to the community-based aquasilviculture. Trainings were also conducted to Community Organizers, Project Coordinators, SUC Coordinators and Program beneficiaries to enhance their knowledge on mangrove rehabilitation aquasilviculture and hatchery management. This was done in cooperation with LGUs, BLGUs, DENR, PAGRO, CAGRO, CENRO/PENRO. This project had provided additional income to the local communities and helped both in the development and environmental conservation thrusts of the government.

RECREATIONAL ACTIVITIES OF MANGROVE FORESTS IN CAMOTES ISLANDS, CEBU, PHILIPPINES
Andriano B, Nagsuban J,

Recreation is considered a significant activity in mangrove ecosystem of Camotes Islands, Cebu. The study aimed at identifying the different recreational activities, total visit costs and the extent of visits of the different mangrove forests in Camotes Islands. Actual visits and survey questionnaire was administered to a total of 109 local recreationists and using the travel cost method (TCM) to determine the total travel cost of every mangrove recreational site. Result showed that the most popular activities in Bankal Boardwalk, Unidos, San Francisco mangroves were tourism visits, photography, relaxation and picnicking while in TEMAFAS, Poro were walking/jogging, educational visits and entertainment like videoke. In DEMSAMAR mangrove forest of Pilar and in Puertobello of Tudela includes relaxation, enjoyment, educational activities, tour visits, wildlife watching and dating. The total visit costs of each mangrove site ranges from 3,102 to 11,510 while percentage of annual visits ranges from 8 percent to 22%. Proper management and local awareness of the mangrove ecosystem services to the local recreationists should be done to conserve the resources.
Mangroves are essential to both human and environment because it provides different resources and services. Conservation of mangrove ecosystem plays an important role in social and environmental sustainability. This study determined the disaster resiliency, coastal resources, and conservation practices of the coastal community of Mantatao, Calape, Bohol. The study used interview through focused group discussion (FGD) to gather the significant data involving six local fishermen. The researcher prepared guide questions and recorded the response of the FGD respondents. There were different direct and indirect mangrove resources such as timber, fuel wood, fish, shellfish, and others. These resources were the main source of food and income to the local community. Mangrove forest was considered as life saver of the local community when they were struck by the typhoon Ondoy with Storm Signal No. 3, whereas it provides protection from strong winds and storm surges. People’s Organization (PO) initiated the conservation efforts toward mangrove conservation. The local community and the local government unit collaborated with the PO to conserve the local mangrove ecosystem in the area. Mangrove ecosystem provides disaster resiliency and sustainable fisheries to the local community. The conservation efforts done by the PO, LGU, and local community sustained the mangrove conservation program.

The lack of interest and sometimes aversion shown by high school students to seagrass and algae is eliminated when species are demystified through the hands-on examination and viewing of samples through microscopes. Until recently, the cost and need for a laboratory or classroom environment made the use of microscopes impracticable for most high school fieldwork and marine camp applications. There increased availability of a variety of low-cost microscopy tools suitable for use in the field has proved to be a means of exciting students’ interest. Big Blue Network has used one such solution as a marine education and awareness tool working with youth ages 8 to 18, groups from 8 to 50, and in formal classroom setting and informal camps in the Philippines. Curiosity driven learning takes place when students can collect and view specimens in the field. By preparing and examining samples at the microscopic level, students learn the taxonomy of seagrass and how to identify the individual species in a completely natural way. This leads to discussions on seagrass reproduction, their role in the marine environment, and the need for protection. Students also learn about epiphytes and zooplankton in seagrass by viewing them through the microscope. As a result, students have a more wholistic view of seagrass ecosystems from survey work done at the macro level to observing the diversity of life at the micro level. Our experience has shown that students involved in the seagrass ecosystem studies gain interest and motivation to protect these critical areas. Furthermore, they are able to effectively convey their learning by sharing their discoveries with their fellow students. Activities can be structured
according to the age of the students, time available, and location. The examination of physical specimens under microscopes can lead to broader discussions about food chains, ecosystem health, local marine protection measures, food security, water quality including ocean acidification, and climate change impacts. Additionally, most low-cost microscopes can be connected to smart phones, tablets, or laptops to take photos, make videos, and further magnify the specimens. Images can be used to document field data, as well as by students for their own social media posts.

GROWTH, RECRUITMENT, MORTALITY AND EXPLOITATION OF THE INDIAN SQUID Photololigo duvaucelii (D’ORBIGNY, 1835) FROM THE SOUTHWEST VISAYAN SEA
Legaspi J, del Norte-Campos A, Villarta K,

The Indian squid, Photololigo duvaucelii, is considered a commercially important squid species in Panay (del Norte-Campos et al., 2003) due to its high price in the local market, making it as one of the most targeted species of the trawl fishery (del Norte-Campos and Sanchez, in prep.) The present study was carried out to use length-frequency analysis to assess growth and mortality of the species. Over 900 individuals of P. duvaucelii were collected from trawl catches and measured from April 2018-March 2019. At least 200 individuals were measured monthly for length frequency analysis. Growth parameters, mortality and exploitation were estimated using the FiSAT program (Gayanilo et al., 1996). The sizes of the squid caught ranged from 3.1 to 28.1 cm. The von Bertalanffy growth parameters (VBGF), asymptotic length (L∞) and growth coefficient (K) were determined. Recruitment pattern was also determined and correlated with initial studies on the species’ gonad maturity indices. Mortality parameters (Z, F and M) were determined using the derived growth parameters, as well as averaged M and K values from the literature. Exploitation (E) rate was determined and used as a basis for recommending management guidelines

POPULATION BIOLOGY OF SWORDTIP SQUID Photololigo edulis (HOYLE, 1885) FROM THE VISAYAN SEA IN CONCEPCION, ILOILO, PHILIPPINES
Sanchez K, Villarta K, Campos A,

The population biology of the swordtip squid (Photololigo edulis) from Concepcion, Iloilo was studied based from the length frequency measurements for a period of one year. Mantle lengths (ML in nearest 0.1 cm) of at least 200 squid samples caught using boat-operated lift nets or “baskal” were measured monthly from April 2018 to March 2019. A wide range of sizes from minimum of 8.9 cm to maximum of 27.0 cm was observed with mean ML of 17.5 cm which are already considered morphologically mature. Based from the length-frequency data, growth parameters were calculated using Bhattacharya (1967) method. The parameters of Von Bertalanffy Growth Function (VBGF) were determined to be L∞ = 27.83 cm and K = 1.3 yr⁻¹, reflecting the very fast growth of the squid which may last for less than a year. Recruitment pattern was bimodal, with unequal pulses and unequal 7-5 month duration. The results of this study provide scientific basis for the sound management of this cephalopod resource.
SPATIAL DYNAMICS OF VARIOUS SARDINE SPECIES IN THE VISAYAN SEA: INSIGHTS ON POTENTIAL CRITICAL HABITATS

Bagarinao A, Campos W,

Small pelagics contribute over half of total marine capture fisheries production of the Philippines. Of this, sardines make up the bulk. Visayan Sea is one of the major sardine-supporting habitats in the country, where sardines comprise a substantial part of the total landings (>30%). To ensure sustainability of this resource, habitat use and spatial distribution dynamics need to be understood. This study determined the spatial and temporal distribution of biological characteristics (species composition, size distribution, gonad maturity stage, gonado-somatic index) of the catch by employing the GPS-tracking protocol to monitor municipal and small commercial vessels targeting sardines in various major locations within the Visayan Sea for a complete annual cycle. These includes Concepcion and Carles (Iloilo), Roxas (Capiz), Balud, Milagros and Placer (Masbate), San Remigio and Bantayan (Cebu) and Cadiz, Negros Occidental. Fisheries profiling and catch and effort monitoring was conducted simultaneously to GPS tracking to provide information on effort and catch rates. There are seven sardine species identified but only three (3) dominate in the Visayan Sea. Results of the study showed that these species partially overlap in habitat occupied and differ in location and timing of spawning, providing further insights on migratory patterns. Habitat use appears to be dynamic, varying seasonally which may reflect environmental preferences of these species. Results of this study fill in some of the information gaps needed for formulating a sardine management plan for the Visayan Sea.

CRITICAL ENVIRONMENTS BORDERING THE VISAYAN SEA


Shallow coastal habitats are commonly known for their high productivity and their role as nursing grounds for early stages of coastal fish and invertebrate populations. Such areas are considered critical if (1) the concentration of fishing activities is high, (2) early stages of principal resources are caught in large amounts; and/or (3) ecological conditions are degraded. Such areas in the Visayan Sea meeting the first 2 criteria include waters around Igbon Island, Bancal Bay and the northern coast of Carles in northern Iloilo, where overall fishing is most concentrated and where catches of early stages of sardines, blue crabs as well as other species show highest abundances. On the other hand, ecologically degraded areas include Banate Bay, Iloilo and the sand flat off Cadiz in northern Negros, where biomass of lower trophic levels is over 10 times less than usual. There is a need to do similar studies in Asid Gulf.

VISAYAN SEA: STATUS OF FISH STOCKS DURING THE M/V DA-BFAR TRAWL SURVEYS

Mesa S, Ambuan N, Sialagon W, Ampoyos R, Ramiscal R,
Visayan Sea is one of the country’s productive fishing ground and one of the suitable trawlable fishing ground (Armada, 2004). Like any other productive fishing ground, Visayan Sea has been exposed to increasing fishing pressure (Hermes et al, 2004). Trawl operation was then sought to have negative effects on the resources as the gear scrapes the seafloor along its dragged area causing degradation of the marine habitats. These habitat degradation causes further resource alteration, removal, and destruction (Turner, 1999).

M/V DA-BFAR, a research vessel of the Bureau had conducted periodic trawl surveys in the Visayan Sea in years 2003, 2007, 2013, and 2016. A total of 19 track stations were established around Visayan Sea covering the areas of Capiz, Northern areas of Iloilo, Negros Occidental, Cebu, and Asid Gulf in Masbate. Data collection includes catch population on deck sampling, trash composition documentation, sub-sample catch composition, length and weight measurements, and gonadal maturity identification and stages determination. Major species population parameters were determined using the FiSAT routine version 1.2.2 and Standing Stock Biomass (SSB) was calculated using the swept-area method (Sparre and Venema, 1998).

Catch composition showed an increase in the fish families comprising 80% of the total catch from an average of 7 in the previous surveys to 15 families in current and a shift of dominant species is observed from high to low commercial importance. SSB is observed to decrease by 50% from 3.09MT/km² in 2013 to 1.55MT/km² in 2016. Volume of trash collected also increased to 50% comparing years 2013 and 2016. Decrease in average length of major demersal species is also observed. High E values of dominant species *R. brachysoma*, *S. taenioptera*, and *U. assymetricus* is also observed compared to the threshold at E = 0.5 and E = 10.

With the results obtained, it is recommended to strengthen the implementation of fishery law enforcement policies especially on the encroachment of active and commercial dragging gears in the municipal waters and observance of closed season. It is also recommended that responsible disposal of trash that ends up to the sea should be implemented. And lastly encourage proper disposal of used or damaged fishing gears to avoid ghost fishing that became part of the trash component in the sea.

ASSESSING GOVERNABILITY OF VISAYAN SEA, PHILIPPINES

Ferrer A,

The paper identifies and describes the challenges in fisheries governance in the context of the Visayan Sea using the interactive governance approach. Governability of Visayan Sea is assessed by exploring the diversity, complexity, dynamics, and scales of the natural and social systems, the governing system (the steering mechanism), and the interaction of these systems that give rise to governance challenges. Insights obtained from the analysis about factors enhancing or limiting governance can help form realistic or attainable expectations and help identify areas where governance can be improved. This is particularly important in the implementation of the closed fishing season for the sardine fishery in the Visayan Sea, and its designation recently as the first Fisheries Management Area in the country.
THE ROLE OF ATMOSPHERIC AND OCEANOGRAPHIC VARIABILITY IN VISAYAN SEA FISHERIES PRODUCTION

Geronimo R, Mesa S

Visayan Sea is one of the major fishing grounds in the Philippines. It provides for food and the livelihood of thousands of fishers and fishing households. Most of the catches from this fishing ground are small pelagic fishes which are known to be sensitive to environmental variability. Being a shallow basin, it is also highly vulnerable to ocean changes brought about by climate change. Yet little is known at how environmental changes affect overall fisheries production in this area. Using data from the BFAR National Stock Assessment Program and satellite-derived oceanographic and atmospheric variables, we evaluated how fish production in the Visayan Sea responds to various ocean and atmospheric changes. Using available regional climate projection models, we also evaluated how the Visayan Sea could look like in 2050 in terms of physico-chemical changes. Finally, we highlight gaps in understanding how environment affects fisheries production in this vast, vital, and vulnerable fishing ground.

SCLERACTINIAN CORAL RECRUITMENT IN THE TUBBATAHA REEFS NATURAL PARK, CAGAYANCILLO PALLAWAN, PHILIPPINES

Alarcon R, Pagliawan M, Songco A

With the continuous decline in coral reefs, studies in coral recruitment is important to better understand the ecology and resilience of the marine ecosystem. Being one of few global ocean refugia, The Tubbataha Reefs Natural Park is important locus for the study of coral recruitment to shed light on how coral thrive amidst changes in the environment. This study aims to investigate the coral recruitment density and distribution in Tubbataha Reefs in the deep (10 meters) and shallow (five meters) areas. The coral recruitment survey was conducted together with the annual monitoring of reef benthos in the park, using a method modified from Burgeset al. (2009). Only the three major genera per depth were considered in this study: Genus Porites, Pavona and Echinopora in the deep; and Genus Porites, Pavona and Montipora in the shallow. All these genera belong to family Poritidae, Acroporidae, Merulinidae and Agaricidae. The dominance of these families among the coral recruits also coincide with those of the adult colonies in TRNP. Juvenile coral density in the deep was observed to be higher compared to the shallow areas, however, the difference is not significant.

PATTERNS OF CORAL RECRUITMENT IN BONGAO, TAWI-TAWI

Mohammad K, Tarabasa R, Bara A, Sakilan A, Burias D, Amil F, Jumaide N, Muksin H, Halun S,
Coral reefs are one of the most biologically diverse ecosystems on Earth. They play an essential role in sustaining life in the sea, serves as a source of food and pharmaceutical products, and protects coastal areas. Unfortunately, coral reefs are under threat from excess nutrients, rising temperature, ocean acidification, overfishing and coastal development. Given these threats, the stability and recovery of coral reefs are immensely dependent on coral recruitment. This study documented the taxonomic composition and relative abundance of coral recruits on tiles in Bongao, Tawi-Tawi. The coral recruits were identified to the lowest possible taxonomic level, genera or family and high-resolution digital photographs were taken of each coral recruit. The study is still ongoing.

REPRODUCTIVE PATTERN AND FECUNDITY VARIABILITY OF ACROPORA TENUIS COLONIES IN NORTHWESTERN PHILIPPINES
Gomez E, Jamodiong E, Villanueva R, Cabaitan P,

Sexual reproduction of corals plays a vital role in reef recovery and rehabilitation as it provides propagules for natural recruitment as well as for restoration of degraded reefs. Most studies in reef restoration through sexual propagation used acroporids because they are fast growing and highly fecund. Yet, there is still limited information on the reproductive biology and ecology of many important reef-building corals such as the Acropora species, particularly in the Philippines. Here, we determined the reproductive pattern and the spatial variability in fecundity of Acropora tenuis colonies located in Cangaluyan reef (5-7 m depth) and Caniogan reef (1-3 m depth) at the Bolinao-Anda Reef Complex, northwestern Philippines. Results revealed that A. tenuis is a hermaphroditic broadcast spawner with oocytes forming five months earlier than spermaries, i.e., starting in August and in January, respectively. Spatial variability in fecundity was noted wherein largest oocyte size and abundance were greater in colonies found at Cangaluyan than those in Caniogan. Gamete maturity occurred around April on both sites. The oocytes of the colonies in Caniogan were observed to be spent in May, whereas in Cangaluyan some oocytes were spent in May then further in June. Results suggest that differences in environmental conditions between sites might have influenced the spatial variability in fecundity of A. tenuis. These observations further elucidate reproductive pattern of A. tenuis, which is essential for the conservation and management of this coral species.

SIZE AT THE ONSET OF SEXUAL MATURITY AND FECUNDITY OF Favites abdita
Bonilla K, Rodriguez M,

Colony sizes at the onset of sexually maturity of important and common reef-building corals and their corresponding fecundities are indicators of the reef’s status and future health as they add to the genetic diversity of the reef. The current accepted size of coral juveniles is less than 4 cm. This means that coral with diameter greater than 4 cm is sexually mature, capable of producing gametes. However, information on the size at the onset of sexual maturity and fecundity of the common reef-building corals have been lacking. Here, we examined the presence of gametes and its corresponding fecundity at maturity of Favites abdita across different size classes found on the reef. Fragments (1-5 cm) were collected from the center of the colony.
using chisel and hammer. Samples were fixed in Zenker’s Solution, decalcified in 10% buffered HCl solution and stored in 70% ethanol prior to dissection under the microscope. A total of 31 sample fragments were collected with size classes ranging from <1 cm to 15 cm maximum diameter. Thirty-nine percent (39%) of the total samples have oocytes with mean count and volume highest at size classes between 4 cm and 6 cm. F. abdita with <2 cm diameter was found to be sexually mature already. This study will be useful in understanding their population dynamics and their ability to help restore and maintain their populations in the reefs. Ultimately, these findings may guide and enable us to redefine the term juvenile in the future.

CLONAL STRUCTURE AND GENETIC CONNECTIVITY OF THE SCLERACTINIAN Pocillopora acuta IN THE BOLINAO-ANDA REEF SYSTEM
Torres A, Gotanco R,

The widely studied coral Pocillopora damicornis employs mixed sexual and asexual modes of reproduction. Marked by geographic variability, its reproductive strategies - from the asexual modes of colony fragmentation and brooding of parthenogenic larvae to sexual reproduction via hermaphroditic broadcast spawning and/or brooding of internally fertilized larva - are important determinants of dispersal ranges, genetic diversity, and persistence of this ecologically important species. While Pocillopora acuta (previously P. damicornis Type ÖEs) colonies in the Philippines are known to rear planula larvae, there is a paucity of information on the relative contribution of sexually and parthenogenically produced broods in the maintenance of local populations. Using fine-scale spatial sampling and multi-locus genotype (MLG) data from 14 polymorphic microsatellite markers, this study examined genetic diversity, differentiation, and connectivity of four populations (n = 397) of P. acuta in the Bolinao-Anda reef system. Indices of clonal structure and genotypic richness suggest the importance of both sexual and asexual inputs in the maintenance of P. acuta populations in the reef system of about 20 km. Meanwhile, estimates of genetic structure and levels of connectivity among noncontiguous populations will be used to infer the relevant spatial scales of dispersal and recruitment processes that influence the persistence and adaptive potential of local P. acuta populations.

EFFECTS OF PHOTOPERIOD ON PLANULAR SETTLEMENT AND SURVIVAL OF THE BIRDNEST CORAL, Seriatopora guttata (VERON, 2000)
Basaca J, Sotto F,

Light has been regarded as an essential abiotic factor that influences the behavior, settlement, and survival of coral planula. However, there have been no studies to date that evaluate the effects of varying photoperiods to coral planula. Thus, this study investigated the effects of photoperiod to planular settlement and survival of the Birdnest Coral, Seriatopora guttata. Parent colonies were collected from the reef fronting Cordova Island, Cebu, Philippines, and were transferred to the laboratory of the University of San Carlos - Marine Research Station for experimentation. Planulae were collected, exposed to three light:dark photoperiods (i.e. 8L:16D, 12L:12D, and 16L:8D) and monitored for their survival and settlement. Results show that overall settlement and survival was higher in both 8L:16D and 16L:8D
photoperiods than 12L:12D. Survivability of settled planula from these non-ambient conditions still seem to carry through even after exposure since survival was consistently higher even upon transferring to the outdoor wet-laboratory. However, a closer inspection revealed that initial settlement after 12 hours of treatment exposure was uniform and differed only after due to subsequent mortality of the newly settled planulae. This clearly indicates that the length of light exposure during the first 24 hours clearly affect the survival of newly settled S. guttata. This could be a function of both cell cycle progression and the length of light exposure and its effect to the overall photosynthetic ability of the zooxanthellae in the coral.

UNRAVELING THE REPRODUCTIVE CHARACTERISTICS OF THE PALM TREE CORAL, *Clavularia* sp. IN NORTHWESTERN PHILIPPINES

Gomez E, Cabaitan P, dela Cruz D, Harrison P,

Reproduction is a vital process in the maintenance and survival of many marine populations. In the case of hard corals, reproductive biology and ecology have been well studied. Yet, studies on the reproduction of soft corals are limited, especially in the most biodiverse region. Here, we determined the reproductive biology of *Clavularia* sp. in northwestern Philippines by coral dissection and histological analysis. Initial results revealed that there was a smaller female to male ratio among sampled soft corals. Dissection of female samples showed that oocytes were present by August then increase in size through the succeeding months of sampling suggesting oocyte development. Results highlight the need to assess more species of soft corals to further elucidate the environmental cues that drive the soft coral reproductive timing.

CORAL COHABITATION: AN ASSESSMENT OF THE EFFECTS OF SELECTED SOFT CORAL SPECIES WITHIN LUCERO REEF OF BOLINAO ON HARD CORAL SETTLEMENT

Segumalian C, Lalas J, Maningas J, Bonilla K, Baran C, Rodriguez M,

Indo-Pacific region is known to host a wide array of marine biota, comprised by a large percentage of both hard (scleractinians) and soft corals (alkyonaceans) on benthic substratum. Recruitment of reef-building corals is an important factor to consider for coral reef stability and recovery. While several studies on soft coral biology have been published across the region, little is known about their effects on hard coral settlement within the Philippine archipelago. To fill in the knowledge gap, an assessment was conducted on the Lucero reef of Bolinao, Pangasinan. The study aims to determine effects of selected soft coral species on the settlement of nearby hard corals. Site characterization was done through assessment of benthic component of the site. Pre-conditioned settlement plates (10 cm x 10 cm x 6 mm) were deployed near each selected soft coral genus (e.g., *Heliopora*, *Sarcophyton* and *Sinularia*) at a depth of 5 - 8 m. In addition, settlement plates were deployed away from soft coral areas, within the site. Deployed settlement tiles (n = 60) were retrieved after 3 months for microscopic identification of coral recruits. Forty-two coral spats were observed from the retrieved tiles. Only 1 out of 8 retrieved tiles deployed near the vicinity of *Heliopora* showed presence of coral recruits. No recruits were observed on the tiles retrieved near the vicinity of *Sarcophyton* and
Sinularia soft corals. However, various coral recruits were observed on tiles deployed within the control site. Low recruitment density (0.5 recruits/tile) was also observed on tiles deployed near Heliopora as compared to control site tiles (4.22 recruits/tile). Chi-square test showed a significant difference between the recruits of control tiles and treatment tiles (p = 0.011). The result is consistent with the previous studies suggesting that soft corals may produce allelochemicals for defense, and may interfere successful settlement and growth of some scleractinian recruits. Space competition between hard and soft corals is evident in this study thus, presence of alcyonaceans (e.g., Sinularia and Sarcophyton) which are both known to contain toxic secondary metabolites, may inhibit building up of calcifying reef organisms.

REPRODUCTIVE TIMING OF SOFT CORAL *Lobophytum sp.* (OCTOCORALLIA: ALCYONACEA) IN BOLINAO-ANDA REEF COMPLEX, PANGASINAN

Baran C, Rodriguez M,

Coral populations and communities in many regions have been reported to decline due to natural and anthropogenic disturbances. When hard corals’ population collapse, soft corals (Order Octocorallia) may dominate and will serve as an alternative agent to stabilize some degraded reef community. Understanding the timing of reproduction of soft corals can help in understanding soft coral recruitment and recovery on the reef. The soft coral *Lobophytum sp.* is a dimorphic encrusting alcyonacean commonly found inhabiting the reef complex of Bolinao-Anda, Pangasinan. Although descriptive studies are already undertaken in the past decades, detailed information on reproductive activity of any species of Lobophytum in the country is still poorly understood. Here, we described the reproductive timing of *Lobophytum sp.* through monthly sampling (n=6 per month) of colonies (>18 cm) and dissected for the presence and absence of gametes using polyp dissection and histological examinations. The peak of spawning was observed from April to May consistent with the highest sea surface water temperature which may influence the timing of reproduction. The results from this study further advance the understanding of its population crucial to recovery potential and maintenance of a degraded reef.

REMNANT UPSTREAM PATCHES OF *Sonneratia caseolaris* CONFIRM PAST EXTENSIVE MANGROVE COVER IN THE COASTAL FLOODPLAINS OF THE PAMPANGA RIVER DELTA

Garcia M, Buenafe K, Albano G, Cruz G, Corcino R, Rollon R,

The Pampanga River basin (PRB, total catchment area: 1,119,517 ha) is among the only four basins in the Philippines with total catchment areas exceeding one million hectares. The rest of the major river basins of the country are relatively much smaller, mostly 2-4 times less than PRB. In contrast to other basins, PRB forms a vast deltaic floodplain providing large areas for wetlands and coastal habitats to flourish contiguously. Indeed, previous work approximated a historical extent of mangroves amounting to about 100,000 hectares (comprising 10% of the basin, mainly based on historical maps and toponyms associated with mangrove systems). However, the existing available image-based approximations show fragmented distributions of mangroves amounting to only about 800 hectares along coastlines...
and riverbanks, reflecting a loss of >99%. The rest of the former coastal habitats have been converted to mostly aquaculture farms and other coastal development activities. This study provides field data on the upstream occurrence of *Sonneratia caseolaris* and other mangrove taxa in the Masantol area, as well as along the ca. 12-km downstream stretch of the river. Indeed, remnant patches of *S. caseolaris* abound in this far landward area with high frequency, colonizing available spaces (e.g., riverbanks, river pockets, etc.), having willow-like drooping foliage, tall pneumatophores (up to 1.4 m), and reproductively prolific. Such finding is consistent with known environmental requirements of this species (and those of other observed sparsely-occurring taxa, e.g., *Nypa fruticans, Acrostichum spp*.), proliferating at the lower end of this salinity gradient. This study is also a pioneering report of substantial *S. caseolaris*-dominated patches, which may not be common elsewhere in the country. Remarkably though, these remnant patches are not known today as mangroves to locals (who continue to utilize the fruits as condiments and souring agents), likely reflective of the massive deforestation happening already in the distant past, obscuring local memory of the historical distribution of mangroves in the coastal floodplains of the Pampanga River delta.

SONNERATIA ALBA: THE ONLY MANGROVE SPECIES THRIVING IN BARANGAY SAN AGAPITO, VERDE ISLAND, BATANGAS CITY, PHILIPPINES

Infante R, Vacarizas J, Egar A, Persia A, Casa M,

Mangroves are important constituents of the coastal ecosystem in performing a critical role as the frontline of defense against the consequences of climate change. Moreover, mangroves are among the carbon-rich ecosystems and they also provide habitat for different marine organisms. In Verde Island, Batangas, a reference study was conducted in the mangrove area of Barangay San Agapito. Interestingly, Sonneratia alba is the only mangrove species found to be thriving within the mangrove area. Also, *S. alba* is included in the IUCN Red List with status of LC (Least Concern), but its population trend is decreasing. Thus, this study is the first attempt to record and determine the biological characteristics of *S. alba* including the diameter at breast height, the height, and the total number of individual *S. alba* present in the area. This study, therefore, will be a starting reference for future studies in monitoring the changes that possibly affect the growth of *S. alba* within the mangrove area in the succeeding years. This study might also provide baseline information in the formulation of conservation and management methods of *S. alba* in Barangay San Agapito, Verde Island.

CHARACTERISTICS OF THE TOPOGRAPHIC WAKE ON THE LEE OF THE BENHAM BANK SEAMOUNT

Bantay K, Villanoy C,

The Benham Rise (Philippine Rise), despite being situated in oligotrophic waters, is an important area for fisheries in the Philippines. The Benham Bank Seamount (BBS) is the shallowest point in the Benham Rise and the circulation features arising from its interaction with the prevailing currents in the area might help explain the productivity in the region. Here, we present the ADCP, CTD, and underway optics data obtained from the May 2018 research cruise in the vicinity of BBS. The ADCP
data shows that the prominent direction of the current in the area is westward. However, there is an observed current speed reduction and direction reversal on the lee of the BBS, a very clear evidence of a wake forming downstream of the seamount. The in situ chlorophyll and temperature data from CTD and underway optics on the area were analyzed to further investigate the correlation of the observed wake to the characteristics of the water in the area.

NUTRIENT AND PRIMARY PRODUCTION OF THE COASTAL WATERS IN THE VICINITY OF THE COAL POWER PLANT, CULAMAN, MALITA, DAVAO OCCIDENTAL

**Bersaldo M, Avenido P,**

The study was conducted to determine the nutrient and chlorophyll-a concentration of coastal water at Barangay Culaman, Malita, Davao Occidental. Field sampling was done during wet season on November 19, 2017 and November 26, 2017. It was also done during dry season on March 6, 2018 and March 11, 2018. Water samples were collected in the surface (5-10 cm depth) and subsurface (below 1m depth).

Nutrients like nitrate, nitrite, ammonia and phosphates were analyzed in terms of its concentration expressed in mg/L. Chlorophyll-a, was included being the most reliable index of primary productivity in seawater. Nitrate, nitrite, phosphate and chlorophyll-a showed high concentration during wet season while ammonia exhibited the highest level during dry season. The nutrients were found to be high in its concentration with water samples collected from the surface compared to those which were collected from the subsurface.

There were no significant differences in nutrient and chlorophyll-a concentrations between stations except for nitrate. In terms of its concentration between dry and wet season, and between surface and subsurface waters, there were no significant differences in ammonia, nitrate and phosphate. However, significant difference in the concentrations of nitrite and chlorophyll-a between dry and wet season and between surface and subsurface water samples were observed. The prevailing levels of temperature, salinity, dissolved oxygen and turbidity observed during sampling were found to be normal.

PHYTOPLANKTON COMPOSITION AND WATER NUTRIENT LEVELS IN GREEN MUSSEL FARM AT INNER MALAMPAYA SOUND, TAYTAY, PALAWAN, PHILIPPINES

**Baldevieso A, Pedroso F, Golez M, Pinosa L, Carmen F**

This study was conducted to assess the phytoplankton composition and water nutrient levels in green mussel farm in Inner Malampaya sound Taytay Palawan. Sample collection was done weekly from October 2018 to March 2019. The result showed that diatoms (91%) dominate the plankton composition in the sampling area followed by small percentage of dinoflagellates (4%), zooplankton (2%), and cyanobacteria (2%) and ciliates (1%). The genus Coscinodiscus has the highest percentage (97.73%) among the diatom genera, which could be one of the major algal diets of green mussels in the area. There was no significant difference found
in the monthly levels of nitrates (2.24 ± 0.17 ppm), phosphates (0.05 ± 0.01 ppm), and chlorophyll a (0.78 ± 0.13 ppm). On the other hand, the monthly level of particulate organic matter is fluctuating.

SPATIAL AND TEMPORAL DISTRIBUTION OF PHYTOPLANKTON IN SAN PEDRO, LEYTE, PHILIPPINES

Manguilimotan L, Dejeto L, Castanos G, Corado R, Oracion L, Peralta J,

Phytoplankton are photosynthetic microscopic organisms that primarily supports the aquatic food web. The biomass and species composition of tropical phytoplankton in San Pedro Bay located in between the Leyte-Samar Island of the Eastern Visayas Region in the Philippines were examined for four (4) years from 2012-2015. Physico-chemical parameters were also recorded. This study determined the temporal distribution of the organisms and to characterize its dynamics within the San Pedro Bay. Water samples were horizontally collected using bucket method and water sampler. A total of 115 species was recorded under 52 Families that are dominated by Family Skeletonemaceae (192, 600 cells/L), Family Chaetocerotaceae (39,600 cells/L), and Family Coscinodiscaceae (34,600 cells/L). Species composition was highly composed of diatoms (68%) and dinoflagellates (16%) with the species Skeletonema spp. (192,600 cells/L), Chaetoceros spp. (85,500 cells/L), and Coscinodiscus spp. (48,300 cells/L) as the highest cell density. It was observed that in year 2012, the average cell density of phytoplankton reached 25,000 cells/L and significantly decreases on the following year (2013) with 500 cells/L. A significant increase was then recorded in year 2015 with 1,400 cells/L from 572 cells/L in 2014. Meanwhile, physico-chemical parameters has significant change from 2012-2015 specifically: water pH increases each year where it is highest in 2015 with 10pH; nitrate content decreases from 3.33µM to 2.12µM; phosphates from 2.73µM to 0.44µM; and chlorophyll-a from 2.17µg/L to 1.02µg/L. The temporal characteristic of phytoplankton in San Pedro Bay seems to be influenced by the frequent occurrence of typhoon in the area due to its geographical location.

COMPOSITION AND ABUNDANCE OF NET PHYTOPLANKTON DURING THE EASTERN SULU SEA COASTAL UPWELLINGS IN 2012 AND 2013

Metillo E,

Net phytoplankton species diversity, abundance and distribution were studied in the upwelling area in Dipolog Bay-Sindangan Bay off Zamboanga del Norte during the year 2012 and 2013. Phytoplankton species were composed of diatoms, dinoflagellates, and cyanobacteria. A total of 48 phytoplankton species were identified representing 26 genera that belong to diatoms (29 species), dinoflagellates (13 species), and cyanobacteria (4 species). Chain-forming diatoms were the most abundant in both years 2012 and 2013 with Guinardia flaccida as the most abundant in 2012, but replaced by Skeletonema costatum in 2013. Pearson analysis showed that the different phytoplankton species identified were correlated to certain environmental parameters such as temperature, depth, conductivity, dissolved oxygen, and chlorophyll a. During both 2012 and 2013, Dinophysis tripos was found positively correlated with temperature and conductivity while Detonula confervacea was found correlated with salinity. Skeletonema costatum,
Rhizosolenia setigera, Trichodesmium erythraeum were found correlated with depth during the year 2012, while Guinardia flaccida was found correlated with dissolved oxygen, and Bellerochea malleus and Chaetoceros socialis were correlated with dissolved oxygen in the same year. However, Rhizosolenia setigera was inversely correlated with salinity in the year 2012. Total phytoplankton density was slightly higher in 2013 than in 2012. Peak in abundance appeared more offshore in 2013 than in 2012 suggesting horizontal abundance variability between years.

SPATIO-TEMPORAL VARIABILITY AND ASSOCIATION OF DINOFLAGELLATE-DIATOM ASSEMBLAGES ON SELECTED RED SEAWEEDS (RHODOPHYTA)

Beringuela R, Purganan D, Azanza R, Onda D,

Epiphytes could significantly affect the physiology of the seaweed either by complimenting or competing for resources. However, little remains known whether it is the environment, interactions with the host or both that drive the structuring of the epiphytic community. Here, epiphytic diatom and dinoflagellate species assemblages on Acanthophora spicifera, Hypnea pannosa, and Gracilaria salicornia collected during the northeast (February), inter- (April), and southwest monsoons (June) in 2015 along the coast of Lucero, Pangasinan in Northernwestern, Philippines were examined and characterized. Community profiles were then correlated with environmental drivers using multivariate statistics. Results showed strong clustering of communities by season, mainly driven by nutrient availability in the surrounding environment. Within season, minor clustering by algal forms was also observed, which could be associated with the differences in complexity and texture of upright and prostrate seaweeds. Examination of the “thallisphere” using confocal laser scanning microscopy further revealed the close proximity of some of the “resident” epiphytic species with the cortical cells of the host, causing deformities and implying more complex interaction. Our results suggest that epiphytic communities were influenced by both the surrounding environment and the host, with the latter possibly having a stronger control on the thallisphere and thus on the associated communities.

CHARACTERIZING THE VERTICAL PHYTOPLANKTON DISTRIBUTION IN THE PHILIPPINE SEA

Cordero-Bailey K, Bollozos I, Escobar M, Jacinto G, San Diego-McGlone M, David L, Yniguez A

The vertical distribution of phytoplankton in the open ocean shows an increase in biomass at a depth referred to as the Subsurface Chlorophyll Maximum (SCM). This study examines the SCM in the Philippine Sea, utilizing empirical phytoplankton data from two oceanographic cruises conducted northeast of the island of Luzon in May/June 2011 and April/May 2012. In 2011, the mean SCM depth was 100 m with mean SCM concentration of 0.3 ug/L while in 2012, mean SCM was deeper at 120 m and mean SCM concentration of 0.2 ug/L. Functional principal component analysis and K-means clustering using the principal components resulted in three clusters which represented the offshore stations with the deepest SCM, stations within an observed cyclonic eddy with intermediate SCM and stations with shelf or coastal upwelling showing shallow SCM. Diatoms were dominant in all clusters at
both the surface and SCM depth, except at the SCM of the offshore cluster in 2011 which was dominated by the cyanobacteria, Trichodesmium. This N₂-fixing organism is considered to be representative of the intrusion of the Kuroshio recirculation gyre. Correlation analyses between Chl and physico-chemical parameters showed that Chl was negatively correlated to beam attenuation, a bio-optical property that has been used as an alternative proxy for phytoplankton. This suggests that the observed SCMs represent actual increase in phytoplankton biomass. When the influence of the Kuroshio recirculation gyre was dominant in 2011, temperature was found to be a driving factor for chlorophyll in surface waters. In 2012, highly saline waters from the tropical North Equatorial Current (NEC) waters appeared to influence the Chl distribution, particularly at the SCM. These results corroborate the findings of Gordon et al. (2014) and Cabrera et al. (2015) where they observed changes in the oceanic circulation from subtropical North Pacific water in 2011 to tropical NEC water in 2012.

PHYTOPLANKTON DIVERSITY AND ABUNDANCE IN MAQUEDA BAY, SAMAR, PHILIPPINES DURING THE “RED TIDE” EVENT IN 2017
Yap-Dejeto L, Orzal K,

For the year 2017, “Red Tide” bans of the green mussel (Perna viridis) cultured in Maqueda bay started in June and ended in January 2018. Harmful Algal Bloom of the dinoflagellate Pyrodinium bahamense caused a number of cases of Paralytic Shellfish Poisoning. The study identified and quantified the phytoplankton genera present in Maqueda Bay, Samar during this HAB occurrence. Collection of samples was conducted once a month from October 2017 to January 2018. Horizontal towing of a 20 μm sized plankton net and a bucket was used for collecting the samples. The overall average cell density of Pyrodinium bahamense for the whole sampling period was \(0.72 \times 10^3\) cells/L. The highest cell density of P. bahamense was observed in San Sebastian station (1.2 \(\times 10^3\) cells/L) during the sampling in November. Maqueda Bay was observed to have 43 genera in which genus Skeletonema (49 \(\times 10^3\) cells/L) dominated. The overall average cell density of Maqueda Bay was 180 \(\times 10^3\) cells/L with a diversity index (H') of 1.75. This was higher than the 2016 HAB survey of 97 \(\times 10^3\) cells/L. The diversity index of Maqueda Bay and the total average cell density of Pyrodinium bahamense in this study was much lower than the 2016 survey (H' = 2.71 and 17 \(\times 10^3\) cells/L). Several factors that probably affected Pyrodinium bahamense cell densities such as depth, salinity, pH, nutrient concentration, and presence of other phytoplankters in the bay are discussed in the paper.

ZOOPLOANKTON COMMUNITY DURING WHALE SHARK (Rhincodon typus) SEASON IN PINTUYAN, SOGOD BAY, SOUTHERN LEYTE, PHILIPPINES
Granada J, Zurita F, Yap-Dejeto L

Whale sharks feed on zooplankton, but the food preferences and how these influence the whale’s migration patterns are not yet fully understood. Sogod Bay in Southern Leyte, Philippines is one of the bays where whale shark (Rhincodon typus) sightings periodically occur. Thus, zooplankton was assessed in the bay while whale sharks were feeding. Four sampling stations were established and seawater
samples were collected from November 2017 to April 2018, with plankton net and a bucket. Measured physico-chemical parameters were all within normal ranges. Results in this study showed oithonid eggs were the most abundant with relative abundance of 47.32% and density of 12 x10^3 ind./L. The month of November, when whale sharks were actively feeding, recorded the highest mean total density of 15 x10^3 ind./L while April had the lowest with 1.1 x10^3 ind./L. For the whole sampling period, 20 zooplankton classes were observed with 39 identified zooplankton families. The results of this study will contribute to the lack of knowledge on the biology and ecology of whale sharks, which will lead to conservation and ecotourism policies in the area.

SPECIES COMPOSITION, ABUNDANCE AND DISTRIBUTION OF CHAETOGNATHS IN SOUTHERN ZAMBOANGA PENINSULA

Ranises D, Campos W, Felix Jr. L

The species composition, abundance and distribution of chaetognaths in Southern Zamboanga Peninsula were studied based on samples from 8 stations collected during an oceanographic cruise from March 4-8, 2014. Plankton were sampled using double oblique tows to a depth of 100 m using a 60 cm bongo net with a 335 μm mesh size. Of the 1,600 chaetognaths examined, 19 species from 3 genera were identified. *Sagitta enflata* was the most common and abundant species, comprising about 27.1% of the total chaetognaths. The overall mean density was 12.4 ind. m^-3 with values ranging from 5.2 to 22.5. High chaetognath densities were observed in stations located in the northern transect with the highest density value located in the middle station. This is attributed to upwelling, as typically indicated by elevated chlorophyll a concentrations and low temperature. On average, densities in the southern stations were almost two times lower than those in the northern stations. The presence of mesopelagic species (*Sagitta decipiens* and *Sagitta zetesios*) in the sample collected from the station located within the upwelling area is consistent with vertical transport of deeper water. Similarly, the presence of the neritic species *Sagitta bedfordii* in the samples collected from an offshore station could indicate the movement of water offshore as a result of Ekman transport. The overall Shannon diversity (H??) value in the study area was 1.7 with values ranging from 1.13 to 2.06. A t-test found the difference in diversity values between the northern and southern transect to be highly significant (P<0.05). Highest diversity was observed within the upwelling area. The low species richness and diversity in the southern stations may be attributed to the dominance of *Sagitta septata*. Juvenile specimens constitute the bulk of the population in the northern stations while mature *Sagitta septata* individuals dominate the southern stations. The results of this study could be used as baseline information in understanding the dynamics of water movement along the Zamboanga peninsula and also to further monitor the dynamics of plankton assemblages which clearly affects the fishery production in the area.

IMPACT OF INTENSIVE AQUACULTURE ON THE REPRODUCTIVE AND FEEDING POTENTIAL OF A MARINE HERBIVORE IN SEAGRASS BEDS

Bangi H, Dworjanyn S, Rollon R, Meñez M,
Coastal fish farming has been expanding worldwide and this has heightened concerns about its impact on the natural ecosystems and fisheries. We investigated the impact of intensive fish farming on the reproductive and feeding potential of populations of the sea urchin *Tripneustes gratilla* in seagrass beds in Bolinao, Philippines. Sea urchins from locations impacted by fish farming had a high percentage of unusual black gonads (35% - 77.3%) and most of these could not be induced to spawn. The sea urchins from impacted sites also had significantly smaller gonads and feeding structures, and had lower gut contents compared to those from the unimpacted sites. Multivariate analysis showed that these traits together with poor gonad quality are significantly correlated with lower seagrass shoot density at the impacted sites. Overall, results indicate compromised reproductive and feeding fitness in *T. gratilla* directly or indirectly due to chronic eutrophication associated with intensive fish farming.

SCREENING FOR RADIONUCLIDE CONTAMINATION FROM THE FUKUSHIMA ACCIDENT BY IODINE-129 MEASUREMENT IN CORALS FROM THE PHILIPPINES

Limlingan S, Jagonoy A, Siringan F, Dumalagan E, Matsuzaki H, Kusuno H, Bautista A,

Following the Fukushima Daiichi nuclear power plant accident of 2011, excessive amounts of toxic radioactive waste was deposited into the Pacific Ocean, consequently posing health risks to exposed individuals. Subsequent transport of this discharge material via Pacific Ocean circulation could eventually bring the radionuclides within the vicinity of Philippine coastal communities, potentially threatening marine life, local health, and aquatic livelihood. For this reason, a research study was commenced to determine the degree and geographical extent of the contamination relevant to the Philippine setting with the use of iodine-129 as an environmental proxy for human nuclear activities. In this study, we present a time series profile of $^{129}\text{I}/^{127}\text{I}_{\text{stable}}$ isotopic ratios in coral cores from the first of three target sites along the northeastern coast of the Philippines. Coral cores were collected from Baler, Aurora, age-modeled, and subsequently subsampled per annual growth band. From the resulting fragments, iodine was extracted from the coral matrix via multi-stage solvent extraction procedures, and then analyzed via Accelerator Mass Spectrometry (AMS) and Inductively Coupled Plasma Mass Spectrometry (ICP-MS). $^{129}\text{I}/^{127}\text{I}$ ratios from 2016 to the present baselined against peaks from historical nuclear events were used to ascertain the amount of fallout material reaching the Philippines from Fukushima, as well as its significance to the coastal communities.

PROKARYOTIC MICROBES IN THE CTENIDIA OF JUVENILE *Tridacna gigas*

Tejada A, Baquiran J, Nada M, Cabaitan P, Conaco C,
The true giant clam, *Tridacna gigas*, is an ecologically important species and an excellent reef builder. It is a filter feeder that lives in close association with photosynthetic dinoflagellates, prokaryotes, and other microorganisms. The symbiotic community of the clam supports its ability to grow to massive size. However, these partnerships are vulnerable to the changing ocean environment. To understand the contribution of the associated microbial community to giant clam physiology and adaptive capacity under different water quality conditions, we transplanted juvenile *T. gigas* at various distances from a mariculture site in Bolinao, Pangasinan. High-throughput 16s rRNA gene sequencing revealed the diversity of the microbial community residing in the ctenidia of *T. gigas*. Shifts in the microbial community structure in clams grown under different conditions suggest that ctenidial microbes may play key roles in nutrient acquisition and host defense. This work would serve as a reference for future studies aiming to elucidate microbial functions relevant to understanding the response of giant clams to a dynamic marine environment.

LEVELS OF HEAVY METALS, TRACE ELEMENTS AND SEDIMENTATION RATE IN THE MARINE PROTECTED AREAS IN LANUZA BAY, SURIGAO DEL SUR

Seronay R, Capangpangan R,

The presence of high concentration of heavy metals in protected areas are considered indicators of anthropogenic influence. Currently, 19 Marine Protected Areas has been established and locally managed within the local government units in Lanuza Bay, Surigao del Sur that may be threatened by the uncontrolled overflow of turbid waters from siltation ponds of large scale mining companies. Sediment samples and sedimentation rate were taken using the PVC tube sampler and sediment traps respectively inside the MPAs in Lanuza Bay. Heavy metals and trace elements from sediment samples were analysed using standard methods. The mean concentrations of the different metal ions in the 19 MPAs were remarkably low except for those abundant elements such as Al, Fe, P and K and varied among sampling sites. The concentration of total chromium in Adlay MPA in Carrascal and San Pedro MPA in Cantilan exceeded more than twice and almost twice the established PEL value of 90 ppm, respectively. Principal Component Analysis results revealed that most of the metal ions showed positive correlation to the first principal component that accounted for the 54.04% of the total variance while other metals (Co, Ni and Cr) showed positive correlation to PC2 (15.14%). Result of sedimentation rate representing southwest monsoon season inside the MPAs in Lanuza Bay were generally low ranging from 0.36 - 2.63 mg cm-2 d-1. Noticeably, Adlay MPA obtained the highest sedimentation rate (2.632 mg cm-2 d-1) followed by San Pedro MPA (1.23 mg cm-2 d-1). Adlay MPA is located near large scale nickel mining companies currently operating in Carrascal municipality while San Pedro MPA is located in close proximity of Cantilan River mouth. Slightly higher sedimentation rate values were observed in MPA areas located near a river and settlement areas. Elevated level of total chromium and sedimentation rate were recorded in the northern part of Lanuza Bay while the southern part starting from Lanuza MPA up to Tandag MPAs were characterised by lower level of heavy metals and sedimentation rate.
HEAVY METALS IN BIVALVE MOLLUSKS FROM COASTAL MUNICIPALITIES OF CAPIZ

Baranda L,

The study was conducted to determine the heavy metals content (cadmium, lead, nickel, copper, zinc, iron) in different bivalve mollusks from the three coastal municipalities of the province of Capiz; compare the heavy metals content (cadmium, lead, nickel, copper, zinc, iron) in different bivalves mollusks with the maximum permissible limit content (mg/Kg) of heavy metals in seafood set by Joint Food and Agriculture Organization/World Health Organization Expert Committee on Food Additives (JECFA); and find out if there is a difference in the heavy metals content (mg/Kg) with respect to the type of heavy metals (cadmium, lead, nickel, copper, zinc, iron). Three most common and economically important species of bivalve mollusks namely: green mussel (*Perna viridis* L.), Philippine cupped oyster (*Crassostrea iredalei* F.), and Asiatic hard clam (*Meretrix meretrix* L.) were randomly collected from Sitio Guibongan, Brgy. Lonoy, Sapian, Capiz; Brgy. Basiao, Ivisan, Capiz and Sitio Lawis1, Brgy. Baybay, Roxas City, Capiz, respectively. Mature, marketable size of mollusks were cleaned, unshelled, weighed and kept in 4°C temperature. The samples with ice were then transported to the laboratory of University of the Philippines, Miag-ao, Iloilo for heavy metals analysis. Bivalve mollusks tissues undergone dry ashing and digestion for heavy metal contents analysis using Flame Atomic Absorption Spectrophotometer (AAS).

The heavy metals content among the bivalve mollusks were as follows: green mussels: Fe>Zn>Cu>Ni>Cd>Pb; Philippines cupped oyster: Fe>Zn>Cu>Cd>Ni and Pb; Asiatic hard clam: Fe>Zn>Cu>Ni>Cd and Pb.

Cadmium, Lead, Nickel, Copper and Zinc contents, except Iron content, in three species of bivalve mollusks do not exceeded the maximum permissible limit content of heavy metals.

The heavy metal contents (mg/Kg) found in green mussel, Philippines cupped oyster and Asiatic hard clam highly depend in the type of heavy metals. It was found out that Iron was consistently the most accumulated heavy metal in the bivalve mollusks.

SUBLETHAL EFFECTS OF PETROLEUM HYDROCARBONS IN THE MARINE RED ALGA KAPPAPHYCUS SP

Merro S,

The sublethal toxicity of water-accommodated fractions of bunker oil was tested on the photosynthetic and respiration rates and chlorophyll a content of Kappaphycus sp. through a static non-renewal 120-h exposure test using 0 (control), 0.1, 1, 10, 100, and 1000 ppm oil concentrations. Lower oil concentrations resulted to increased rates of photosynthesis after 24 h exposure, with the 1 ppm concentration having a significantly higher mean photosynthetic rate than the control (p=0.006). Respiration rates also increased with an increase in oil concentration after 24 h exposure (p=0.016). Chlorophyll a content of the seaweed was not significantly
affected by the oil concentrations (p=0.801). The results indicate that the presence of petroleum hydrocarbons in the aquatic environment may actually have a positive effect on Kappaphycus sp. as long as these are found in low concentrations.

OCCURRENCE OF MICROPLASTICS IN THE GASTROINTESTINAL TRACT OF COMMERCIAL FISHES FROM CAMOTES SEA, CENTRAL VISAYAS

Acama N, Arceo H,

Plastics are widely used by humans due to its versatility and durability. Globally, around 322 million tons of plastic was produced in 2015 and 30% of these plastics were discarded as waste, which may infiltrate our aquatic environments. A study has reported that the Philippines is one of the highest contributors of plastics to the marine environment with 0.28-0.75 million metric tons of plastic marine debris per year. Among plastic litter, a notable environmental concern in the world for over the last decade are microplastics, and it is primarily because they are widely or constantly encountered in the marine and freshwater ecosystems. Microplastics have been documented in the digestive systems of wild-caught fish; however, in the Philippines there are very limited studies about this. This is of great concern since marine fisheries significantly contribute to fish production in the country, and fish is the main source of protein for most of the population. Thus, this study aims to assess the presence of microplastics in the gastrointestinal tracts of two commercial fishes from the Camotes Sea, Central Visayas, namely, the red tail scad (*Decapterus kurroides*) and the blackspot snapper (*Lutjanus fulviflamma*). Fish samples were collected from two localities: Danao City and Liloan in Cebu, and examined for microplastics. Comparisons in the abundance of microplastic ingestion between different fish feeding habitats, i.e. pelagic and demersal were done. The presence of microplastics in commercial fishes can potentially be transferred via ingestion in humans and it may pose threat to food safety. Future studies could assess the translocation of microplastics into the other parts (muscles, liver, gills) of these commercial fishes.

QUALITATIVE ASSESSMENT OF MICROPLASTICS IN CULTURED OYSTERS IN ANDA, PANGASINAN

Roque R, Ortinero C, Fajardo L,

Plastics are popular due to several properties such as weight, strength and cost and use of plastics is in near inexhaustible applications. Due to its durability, plastic persists and accumulates in marine habitats, accounting for up to 90% of all marine debris. Microplastics are the products of the degradation of larger plastic items into smaller fragments. This study aims to investigate the presence of microplastics in cultured oysters in Anda, Pangasinan where aquaculture production is intensified. Wet digestion of oyster tissues using 1M sodium hydroxide followed by vacuum filtration was employed. Microscopy revealed that microplastic fiber and pellets may be present in cultured oysters, suggesting potential plastic pollution problem in Anda, Pangasinan. Further investigation on fish, water and sediments in the area should be done to confirm microplastic prevalence in the area.
MARINE BIOFILM DEVELOPMENT UNDER DIFFERENT REEF CONDITIONS AND EFFECTS ON CORAL Larval SETTLEMENT

Padayhag B, Nada M, Baquiran J, Sison-Mangus M, Cabaitan P, Conaco C,

Coral larval settlement is a complex process that is crucial for coral recruitment. This process relies on the biogenic settlement cues such as those elicited by microbial biofilm communities. However, the composition of biofilm communities is sensitive to environmental conditions on the reef and such changes may, in turn, affect coral larval settlement. To understand how excess nutrient input from mariculture influences biofilm development and coral settlement, biofilm communities were allowed to develop on glass slides for 4, 7, 11 and 15 days at Tomasa, Lucero, and Malilnep, sites with increasing distance from a fish farming area in Bolinao, Pangasinan, Philippines. Water quality condition varied across sites, with the concentration of nutrients decreasing with increasing distance from the fish farms. Bacterial community composition of the biofilms was determined using 16S rRNA sequencing and the ability of these biofilm communities to induce settlement of Acropora tenuis larvae was assessed. Biofilm from Malilnep, which is the farthest from mariculture influence, had the highest coral settlement rates. In addition, older biofilms (i.e., settlement tiles exposed at the sites for 15 days) were more effective at inducing settlement compared to younger biofilms (i.e., 7 days). Analysis of the microbial community composition in biofilms with different effects on coral larvae settlement will reveal microbiome components that may be critical for this process, as well as bacterial taxa that are sensitive to changes in water quality conditions.

OCCURRENCE OF ANTIBIOTICS IN THE COASTAL WATERS OF MABINI, BATANGAS

Mariano S, Angeles L, Aga D, Jaraula C

The presence of antibiotics in natural waters pose an emerging threat to the immediate environment and communities in contact with it. In the era where most antibiotics are losing effectiveness and multidrug-resistant genes proliferate, the importance of assessing and monitoring antibiotic assemblage and concentration levels in the natural waters is of utmost importance. Mabini, Batangas is an area of interest for the occurrence of antibiotics in its coastal waters due to its proximity from the 'Center of the Center of Marine Biodiversity' which is the Verde Island Passage. It is also a rising site for tourists, hence, the coasts are experiencing recent developments and establishments of resorts that would bring more population in the area. Given the high relief of the area and land use, transport of possible pollutants from higher grounds to the coasts is also perceived to be fast and efficient. Due to the geological characteristic of the area, several submarine groundwater discharge outlets that could serve as a pathway are also present near the coasts. Surface, drainage, and coastal waters were collected for analysis. Duplicates of 500 mL samples were filtered and processed through solid-phase extraction. Extracts were then injected with internal standards and subjected to liquid chromatography-tandem mass spectrometry analysis for the identification and quantification of selected antibiotics. Human and veterinary antibiotics were found to be predominant. The total levels of detected antibiotics are generally lower compared to Bolinao and Manila Bay.
EVALUATING THE EFFECTS OF MARINE PROTECTED AREAS (MPAs) AND FISHING PRESSURE ON FISH PARASITIC GNATHIID ISOPODS IN THE CENTRAL PHILIPPINES

Shodipo M, Sikkel P, Abesamis R

Coral reefs harbour more biodiversity per unit area than any other ecosystem. While larger organisms such as reef fishes and larger reef invertebrates including corals, receive most attention, parasitic organisms dominate biodiversity on coral reefs and have significant impacts on community dynamics. The effects of fishing pressure and loss of live coral due to anthropogenic and climate-induced stressors on larger reef organisms have been well studied. However, the impacts and responses of parasites that inhabit reefs have been largely ignored. Gnathiid isopods are the most common external parasites of coral reef fishes. These highly mobile 'micropredators' are similar to ticks and fleas on land, emerging from the bottom, mostly at night, to feed on the blood of host fishes before returning to the bottom. Thus, they depend heavily on both benthic habitat and fish hosts and can have significant impacts on the latter. Our goal was to compare the abundance of gnathiid isopods in marine protected areas (MPAs) and heavily fished areas in Negros and Siquijor islands in the central Philippines. Analysis of our data thus far indicate that 1) the density of live coral and cleaner wrasses, both known predators of gnathiids, are greater within than outside MPAs; 2) while the density of host fish is similar between MPAs and fished areas, the size and thus biomass of host fish is greater inside MPAs; and 3) while the density of gnathiids overall is not significantly different between MPAs and fished areas, the ratio of gnathiid density to fish biomass is overall higher outside MPAs, whilst gnathiid abundance is higher in MPAs. These data suggest that while human-induced stressors may reduce both predators of gnathiids and host biomass, the reduction is not sufficient to reduce the impacts of gnathiids on the remaining fish hosts, constituting a secondary effect on fish populations in fished areas.

SMALL-SCALE FISHERY OF THE PHILIPPINE NIGHT OCTOPUS OCTOPUS NOCTURNUS IN MALALISON ISLAND, ANTIQUE, PHILIPPINES

Senosa J, del Norte-Campos A,

Many species of octopus are exploited by many small-scale fisheries in the different parts of the country. However, there is little data on the fishery of the octopus nationwide. This study uses the data collected from the monitoring of the octopus fishery in Malalison Island, Antique. It is the first paper that reports the occurrence of the Night Octopus Octopus nocturnus in the country. Catch rate, catch and corresponding value were estimated from the daily records from the speargun and hook and line fishers from April 2018 to March 2019. Results of this paper can potentially provide inputs to the rational utilization and management of this species.
The Pacific Sugar Limpet is a common limpet residing in the rocky boulders of the intertidal zone. Limpets play a fundamental ecological role and serve as keystone species in intertidal communities since these macroinvertebrates feed and graze on algae. However, only a few studies have been conducted regarding peak of recruitment and gonadal development of *P. saccharina* and none for Davao Gulf and surrounding areas. Hence, this study aims to determine the recruitment peak, population density, size at sexual maturity, and gonadal development of *P. saccharina* in Samal Island, Davao Gulf. Quadrats were laid randomly along the intertidal the shoreline and the shell-length measurements were measured using the Vernier caliper and frequency of abundance was also measured. Sampling was done every full moon for 13 months from February 2018 to January 2019. Two measurements were done during the blue moon in March 2018. Representatives per size class were collected and gonads were dissected for determining the size of the shell at sexual maturity. A total of 1,056 limpets were measured averaging 80 individuals per month. FiSAT analysis indicated that the spawning occurs twice for this species particularly during Summer (March-April) and Rainy season (August-September). Observations and results in this study will contribute to the knowledge regarding limpets and will provide information on their population structure and dynamics which can contribute for its future conservation and management.

*Nerita undata* is a common marine gastropod living on rocky intertidal zones of Samal Island, Davao Gulf. They are important species being algal grazers and potential bioindicators. The population dynamics, including the number of individuals, density, size distribution, recruitment period, and size at sexual maturity for *N. undata* are described in this study. Monthly recording was done from February 2018 to January 2019. Size of *N. undata* individuals were measured using a digital Vernier caliper from ten 0.25m² quadrats randomly set along the high intertidal zone. The size frequency distribution was analysed using the ELEFAN-I and von Bertalanffy Growth Function (VBGF) in FISAT software. A total of 1086 samples were measured averaging ~83 individuals per month, with a density of ~16.7 individuals/m². The length and width of *N. undata* shells ranges from 5.22 mm - 27.83 mm and 3.2 mm - 19.51 mm, respectively. The growth rate of *N. undata* species is quite slow, with a K value of 0.33 reaching a maximum length of 28.46 mm. The peak of recruitment occurred during the month of October (intermonsoon). Furthermore, size ranging 17.1 mm - 20.0 mm had the highest number of individuals in October, which suggests that the size at sexual maturity falls within this range.
ABUNDANCE, DISTRIBUTION AND RECRUITMENT OF NERITA Plicata (Linnaeus, 1758) ALONG THE DISTURBED INTERTIDAL SHORES OF SAMAL ISLAND, DAVAO GULF

Consuegra J, Nañola C,

The gastropod Nerita plicata plays a significant role in the tropical intertidal zone being an algal grazer and potential bioindicator. None so far has conducted an investigation about its population abundance and distribution in Mindanao, Philippines. Hence, this study focused on the distribution and population structure of N. plicata in six intertidal areas around Samal Island. Monthly recording of length and width of N. plicata individuals was also done, covering the northeast and southwest monsoon, as well as the inter-monsoonal period. Two to three belt transects were laid parallel to the shore in the high intertidal zone. N. plicata individuals were counted within the 2m x 50m belt transect and measured having longitudinal and vertical axes of 5.07-20.47 mm and 5.07-15.36 mm, respectively. The factors affecting spatial distribution was evaluated using the Mann-Whitney Test and Kruskal-Wallis Test while population structure was analyzed using the FISAT software. Results showed recruitment to peak at April-May and September-October with a K of 0.570 reaching the L of 21.00 mm. Mean abundance is highest at Brgy. Kaputian and lowest at Brgy. Camudmud in both of the monsoons. However, monsoon, site slope, and disturbance factors had no significant effect (p>0.05) on N. plicata abundance around Samal Island. The monsoonal conditions appeared to influence the size-class distribution and no correlation obtained from the statistical analysis may be due to the low number of N. plicata recorded during the study period.

POPULATION STATUS OF tridacna spp. INSIDE AND OUTSIDE THE TAKLONG ISLAND NATIONAL MARINE RESERVE (TINMR), NUEVA VALENCIA, GUIMARAS, PHILIPPINES

Zulueta K, Simbulan M, Malay M,

Giant clams are a conspicuous group of photosymbiotic bivalves belonging to the family Tridacnidae. These bivalves mitigate eutrophication by filtering water and sequestering nutrients, serve as bioindicators for environmental contamination, and are iconic species in marine conservation. Giant clams are mostly categorized as “Vulnerable” in the International Union for Conservation of Nature (IUCN) Red List but the data need updating since the last assessment was in 1996. Moreover, there had long been a confusion between Tridacna noae and the morphologically highly similar species T. maxima. Tridacna noae was previously considered a variant of T. maxima, and was only resurrected as a valid species in 2014. This long-standing taxonomic confusion has caused overestimation of the actual T. maxima densities, potentially underestimating the risk of local extinction of this species. To address these data gaps, surveys of giant clam abundances are being conducted inside and outside the Taklong Island Marine National Reserve (TINMR) in Nueva Valencia, Guimaras Island using the timed survey method. Data such as the size, depth, and coordinates are being gathered as well. Surveys are expected to be completed before May 2019. It is hoped that this study can be useful in comparing and assessing the management of the surveyed sites, and can help develop appropriate population management strategies.
Giant clams are categorized as endangered by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). To help maintain wild populations, proper management strategies, such as the establishment of Marine Protected Areas (MPAs) are needed. However, reports on how MPAs affect populations of giant clams are uncommon, with only one study in the Apo Reef Natural Park (ARNP) - one of the most well-managed protected areas in the Philippines - conducted 35 years ago. Therefore, this study aimed to assess the current status (density and species diversity) of giant clams in the ARNP using three replicate belt transects (5 x 50 m) that were laid at two depths (3-6 m and 8-10 m) at eight sites. The current density of giant clams at ARNP was ~ 126.45 individuals/hectare, which is not significantly different from the 126.10 individuals/hectare recorded in 1984. The highest density of giant clams was observed at 3-6 m depth and no individuals were observed deeper than 10 m. *T. crocea*, rather than *T. maxima*, was the most abundant and most common species in the area. Giant clams were most abundant and diverse in Binanggaan, where more than 100 individuals of *T. crocea* and *T. maxima* were observed to be densely clustered on massive Porites corals. Interestingly, *Hippopus hippopus* and *H. porcellanus*, which were not reported in the past, were observed in the current survey. These findings suggest that long-term (~ 20 years) MPA protection from harvesting contribute to successful recruitment and maintenance of giant clam populations at the ARNP. Thus, the establishment of MPAs may aid in conserving giant clams.

ABUNDANCE AND DIVERSITY OF GIANT CLAMS (BIVALVIA: CARDIIDAE) ON WINDWARD AND LEEWARD FRINGING CORAL REEFS IN CALAGUAS ISLAND, CAMARINES NORTE, PHILIPPINES

Giant clams live in shallow water coral reef ecosystems in the Indo-Pacific region and their populations have been in decline mainly because of overexploitation of their meat for food and their large shells for decorations. Of the 12 recognized clam species, only eight (8) are found in Philippine waters. However, information on the status of giant clam populations is limited for most regions in the country. Here, we quantified the diversity and abundance of giant clams in Calaguas in the eastern part of the Philippines by surveying a total of nine coral reef sites. Three 50 m transects were laid at 2-12 m depth at each site. The species and shell lengths of all clams observed along the transects were recorded. Only *Tridacna squamosa*, *T. maxima*, and *T. crocea* were observed in the surveyed sites, but not all species were present at all sites. *T. crocea*, the smallest among giant clam species, was more abundant at most sites. Higher clam abundance was observed in sites that are relatively protected from wind-wave disturbance (i.e., North and South Balagbag, Pinagtigasan, and Sugod), which indicates successful recruitment of larvae in these reef areas. Giant clams in the Marine Protected Areas of Pinagtigasan and Quinamanokan were larger compared to the same species at other sites, suggesting that effective protection from harvesting is important in allowing the giant clams to
reach reproductive maturity. These findings suggest that giant clam population in less disturbed areas should be prioritized for protection because of their potential for successful reproduction.

ZOOXANTHELLAE DIVERSITY IN GIANT CLAMS VARIES WITH SPECIES AND AGE

Tayaban K, Cabaitan P, Conaco C,

Giant clams (Bivalvia: Cardiidae) harbor zooxanthellae or symbiotic dinoflagellates of the family Symbioniaceae in their mantles. These symbionts provide up to 95% of the energy requirements of the clam, allowing some to grow rapidly to more than a meter in length. Giant clams typically associate with Symbiodiniaceae from the genera *Symbiodinium* (formerly Clade A), *Breviolum* (formerly Clade B), *Cladocpium* (formerly Clade C), and *Durusdinium* (formerly Clade D). As in corals, it is hypothesized that zooxanthellae diversity can be influenced by prevailing environmental conditions, as well as species-intrinsic and growth-related host characteristics. Furthermore, zooxanthellae composition may influence the ability of the clam to tolerate environmental changes. This study examines the zooxanthellae community composition in giant clams of different species and ages to gain a better understanding of their contribution to the ecology of their giant clam hosts.

IN SITU SPAWNING OBSERVATIONS OF THE RESTOCKED GIANT CLAMS *Tridacna gigas* AT THE DNSC-MARINE RESERVE PARK, ISLAND GARDEN CITY OF SAMAL

Edullantes C, Sobradil R, Tabalanza T, Gumanao G,

The population giant clams (e.g. *Tridacna gigas*) in the Philippines has significantly declined over the years. To augment the decline, restocking efforts has been carried out in selected sites of the Philippines. This study documented in situ spawning events of *Tridacna gigas* restocked at the Davao del Norte State College - Marine Reserve Park (DNSC-MRP) at the Island Garden City of Samal. Spawning *T. gigas* were observed on two different occasions, two days and one day before the new moon phase. However, on both occasion, gametes were observed to be released a few hours before the highest tidal mark. A total of 12 and 14 individuals of *T. gigas* were observed to released gametes during the 1st day and 2nd day of observation, respectively. However, there were also some neighboring *T. gigas* that did not spawn during the period which may indicate that some clams may be reproductive inactive. This observation serves as a benchmark to further understand the reproductive patterns of restocked giant clams in supports previous reports on *T. gigas* recruitment showed that the restocked at DNSC-MRP, IGaCoS.
GIANT CLAM RECRUITMENT AT DIFFERENT SITES IN NORTHWESTERN PHILIPPINES

Requimte J, Cabaitan P, Neo M, Conaco C, Sayco S, Calle L, Sy E, Quimpo T, Albelda R,

Giant clam populations have been in rapid decline for the past decades mainly due to overfishing. Conservation and restocking initiatives have been conducted to avoid extirpation of giant clam species. In the Philippines, thousands of hatchery-bred giant clams have been restocked in different provinces of the country, spearheaded by the Marine Science Institute, University of the Philippines to help replenish natural stocks. In recent years, there have been reports of natural giant clam recruits that were likely spawned by the restocked giant clams, particularly Tridacna gigas, at different restocking sites around the country. Yet, very few studies have been conducted to examine giant clam recruitment. In this study, we assessed the existing populations of giant clams in selected locations of northwestern Philippines: (1) Anda, Pangasinan, (2) Masinloc, Zambales, and (3) Bauan and Mabini, Batangas, with the aim to understand the (1) diversity of giant clam species; (2) prevalence of juvenile recruits; and (3) benthic habitat characteristics where giant clams are found. Initial results showed higher abundance of giant clams in Bauan and Mabini, Batangas followed by Anda, Pangasinan and Masinloc, Zambales. Juvenile recruits of T. gigas, T. squamosa and T. crocea were also observed. Further analyses study would provide insights on the influence of reef benthic characteristics on the recruitment patterns of giant clam species. The prevalence of T. gigas recruits would indicate the replenishment of stocks, thus signifying the success of the true giant clam conservation and restocking efforts in the country.

LOCAL ECOLOGICAL KNOWLEDGE HIGHLIGHTS THE PERCEPTION OF WHALE SHARKS AT TWO LOCALITIES IN NORTHERN MINDANAO

Labaja J, Ong S, Snow S, Ponzo A, Araujo G,

The second largest whale shark fishery in the Philippines operated from Guiwanon in Talisayan, Misamis Oriental. These whale shark fishers used to operate in the Bohol Sea, particularly in the waters of Salay, Misamis Oriental, a neighbouring and non-whale shark-fishing municipality. When the species was protected in 1998, fishing operations stopped across the country. Whale sharks are still commonly sighted in these areas. Our study focused on local ecological knowledge (LEK) to understand whale shark-fishers interactions, as well as their perception of shark, ray, and turtle catches over time through semi-structured interviews.

In Mar-May 2017, we anonymously interviewed 40% (n=162) of the BFAR-registered fishers in 11 coastal barangays of Talisayan. In May-Jun, we interviewed 36% (n=259) of the BFAR-registered fishers in 8 coastal barangays of Salay. In Talisayan, 96% of the interviewees were aware that whale sharks are protected in the Philippines. Thirty-four percent of interviewees had their fishing gear damaged by a whale shark with most interactions happening with nets (17%), and lines (36%). Fourteen percent (n=23) said they had experienced whale shark entanglement while 20% (n=32) have witnessed an entanglement with other fisher’s gear. The fishers interviewed in Talisayan knew of other protected species, namely turtles (50%), manta rays (28%), devil rays (8%) and thresher sharks (7%). By-catch of turtles in
lines and nets also occur in Talisayan according to 7% of the interviewees. In Salay, 99% of the interviewees knew that whale sharks are a protected species. Thirty-five percent (n=91) have had their gear damaged by a whale shark with 79% of these instances with nets and 18% with lines. They were also aware of other species that are protected by law including turtles (77%) and manta rays (53%). Twenty-nine (11%) interviewees had caught and released a turtle in their gear. Our interviews in Talisayan and Salay highlight that the whale shark is still a part of their lives as fishing indicators, fishing disruptors, companions at sea, or a missed opportunity. They also highlight the presence of other threatened megafauna constantly exposed to fishing pressure, emphasizing the need for better fisheries management in both localities.

RIDGE TO REEF PARTICIPATORY NATURAL RESOURCE ASSESSMENT IN TBM ANCESTRAL DOMAIN, CORON, PALAWAN

Baobao J,

Tagbanwa indigenous communities in Tara, Buenavista and Malawig Ancestral Domain in Coron, Palawan are heavily dependent on natural resources for their basic needs and livelihoods, both coastal and upland resources. Like other coastal and small island communities throughout the country, fishing is the main source of livelihood for the Tagbanwa, supplemented with forest produce and agriculture, but often not sufficient to escape poverty. The Tagbanwa face significant challenges in protecting and managing the natural resources they depend upon. Illegal fishing, traditional slash and burn farming practices and illegal cutting of forest trees further exacerbate environmental and disaster risks for these communities. A comprehensive ridge to reef participatory natural resource assessment was undertaken in the Ancestral Domain to serve as basis of positioning and provide directions and modalities in managing natural resources and protected area establishment both for upland and coastal ecosystems. The results of the upland forest and mangrove stands of the three barangays are above averagely diverse forests. In terms of seagrass community structure, the surveyed sites have a relatively fair to good conditions with sightings of Dugong dugon, endangered, large, herbivorous marine mammals. Coral cover in the area is generally in fair condition except in one site with only 13% live hard coral cover categorized as poor”. With the prowling climate and human-induced risks in these critical ecosystems, establishments of marine protected area (MPA) with the inclusion of mangrove and seagrass beds and forest strict protection zones are highly recommended. The recommendation is aligned with the results of the perception survey with more than 90% of the locals in favor of establishing an MPA and 89% are agreeable on proper forest management. The high awareness level on environmental protection and management coupled with scientific-based analysis and planning is a big win for the indigenous people towards sustainable development of their ancestral land.
FISHERIES TREND IN BATAN ESTUARY, AKLAN INFERRED FROM LOCAL ECOLOGICAL KNOWLEDGE

Maliao R,

Fishers have detailed knowledge of their resources, their environment, and their fishing practices. These collections of traditional knowledge are collectively referred to as Local Ecological Knowledge (LEK) and have been hailed as crucial in our understanding of the stochastic nature of the fisheries, particularly in the absence of long historical data. In order to understand the trend of fisheries in Batan Estuary, we collected fisheries perceptions from 400 local fisherfolks. We only included respondents that have been fishing in the area for at least 20 years. The survey instrument includes questions regarding their fishing methods, locations of fishing area, catch composition and total catch per species, and variations of these parameters over time. Our results indicated a severe decline of fishery resources, with current average fish catch representing only ~ 10% of their catch in the 1980s. This downward trend is manifested by ~90% of exploited species (finfishes and invertebrates) harvested through 13 fishing methods. This is accompanied with the perceived decline of water quality, mangrove cover and seagrass cover within the estuary. A total of 20 species are perceived to be extirpated, with no catch at least in the last 5 years. This study demonstrates the usefulness of using LEK in the assessment of artisanal fisheries, and its critical role in fisheries management in the absence of long term historical data.

LET’S TALK FISHING: A CONVERSATION STARTER TO PROMPT COMMUNITIES TO TALK AND DO GOOD FOR PHILIPPINE FISHERIES

Ipanag E, Lam E, Edquilag J, Cadiz F, Teves D,

Increasing fishers’ knowledge, belief and intent to address over-fishing as common pool resource problem is decisive to achieve sustainably-managed fisheries and restore ocean health. A wide range of institutions and aid programs work in Tañon Strait - one of the largest marine protected area in Philippines, to build fishers’ awareness in coastal resource management solutions through information, education and communication (IEC) campaigns. Despite almost two decades of intervention, a recent knowledge, attitudes and practices (KAP) survey reveals that index of knowledge on fisheries laws and regulations remain low (Laylo, 2017).

The purpose of Let’s Talk Fishing, a foundational knowledge tool developed by Rare Inc. is to increase awareness and participation among fishers through fun, easy and popular way. Let’s Talk Fishing is a “Fisheries Today” card activity that aims to encourage fishers to participate or continue participating in managing their Marine Protected Areas (MPA) and fisheries management efforts (Rare, 2016). Commonly known as the Fish Card, it is a 45-minute facilitated activity where participants get to experience a five-step facilitation process: invitation, site narrative, comparison, reflection and invitation.

This entertainment education tool is piloted in 17 partner municipalities and cities of Rare along Tañon Strait and 46 US Peace Corps Philippines assisted municipalities. Implementation roll-out is tracked qualitatively through project journaling and photo voice method. Initial assessment reveal that the Let’s Talk
Fishing is most effective when combined with other participation tools and properly designed follow-up plan.

There is increasing demand from site partners to update the tool to incorporate the different ways and contexts where the tool can be used to increase knowledge and participation not only for fishers but for students, key influencers and community members to talk and act to address issues such as marine pollution and mangrove conversion. With the new tool, more coastal communities can be mobilized to do good.

COMMUNICATION AND KNOWLEDGE OF FISHERMEN TOWARDS MARINE BIODIVERSITY PROTECTION AND CONSERVATION IN MABINI, BATANGAS, PHILIPPINES

Medina B, Faytaren A, De Guia L, Saco J,

This study analyzed the communication and knowledge towards marine biodiversity protection and conservation in several coastal areas of Mabini, Batangas. It utilized the descriptive type of research in a quantitative approach. The 200 respondents identified through quota sampling, 40 for each barangay, were selected fishermen in Mabini, Batangas such as Calamias, Gasang, Mainit, San Teodoro, and Solo. Survey questionnaire was used as the major data gathering instrument subjected to reliability test using Cronbach Alpha that resulted to 0.857 which means the questionnaire is reliable. Statistical tools used were frequency count, percentage and rating scale. It was found out that majority of the respondents are 45 - 49 years old, male, married, and high school undergraduate. Moreover, government organization, NGO, academe and cooperatives were conducting seminars, clean up drives and protection and conservation orientations. The respondents were slightly knowledgable about the protection and conservation of marine biodiversity, and lastly, there is no significance relationship in coral reefs, mangroves, seagrass, seaweeds, marine fishes with the respondents’ age, age, sex, civil status and educational attainment, while marine invertebrates had significant relationship with their age, and not significant in terms of sex, civil status and educational attainment.

THE DNA BARCODING PROJECT OF DOST ON MARINE FISHES

Nañola C, Huang H, Huang W, Liao T, Fortaleza M, Bacus M,

The study hopes to provide a validated list of marine fishes in southern Mindanao including Sulu Archipelago. The overall aim is to extend the undertaking to cover the entire country. There are more than 1,500 marine fish species listed for the country. The list was provided by others but unfortunately this has not been validated through molecular techniques. Majority of the reef fishes are discernable by their colors, body shape, fins, scales and others. However, other families are characterized by complex color patterns and sex changes that goes with age, such as the wrasses and parrotfishes. At present, close to 100 reef fishes have been successfully sequenced with voucher and tissue samples that have been stored and catalogued properly. Some insights that have been discovered were low success for the group of parrot fishes and it must achieve 100% query coverage in BLAST.
Citizen science is one of the emerging quantitative research approaches for collecting ecological data, especially in large areas where employing academic monitoring methods can be arduous. Tubbataha Reefs Natural Park is the largest no-take marine protected area in the Philippines, with an expanse of 97,030 hectares of coral reefs and deep sea. Monitoring the whole park is one of the challenges in managing Tubbataha, mainly limited by weather conditions, the distance, and the size of the park. Thus, the Tubbataha Management Office (TMO) developed the Reef Watch form in 2014. It aims to involve scuba divers and dive operators in monitoring the reefs by reporting sightings of pre-identified top predators such as sharks and rays. Through these reports, we estimated the abundance of elasmobranch species (tiger shark, manta rays, and whale shark) using total dive time as proxy for catch per unit effort (CPUE). Further, we also checked the comparability of the sighting reports of manta rays in seven (7) dive sites with those of acoustic data collected by the Large Marine Vertebrates Research Institute Philippines (LAMAVE) in 2017 and 2018. Reports from divers showed that time spent to see an elasmobranch species varied year after year. Divers spent less time spotting whale sharks and manta rays compared to tiger sharks. The acoustic data from LAMAVE revealed that the four manta rays tagged in 2017 often visited Black Rock and Ko-ok dive sites with the same frequency. However, data gleaned from Reef Watch showed that sightings of manta rays were mostly concentrated in Black Rock and Delsan Wreck, while lesser encounters were reported from Ko-ok offered. The latter results may be due to divers spending most of their time diving in Black Rock and Delsan Wreck rather than in Ko-ok. Although Reef Watch could provide an overview of the abundance of certain species, it cannot be used in isolation for determining site preference. Some factors that may have influenced the Reef Watch results are the dive site preference of guests, duration of dives in each site, and the consistency of submission of Reef Watch reports.

Making Coral Biodiversity Matter

Alcantara D, Ang J, Cabreira R, Olsim C, Principe A, Licuanan W,

Most Philippine reefs are less than a kilometer distance from the coastline. This makes coral reefs, and the corals that build them more vulnerable to anthropogenic impacts. While our reefs are easily accessible, few know much about corals, thus hindering conservation action. Many still think they are rocks; others think they are plants; and even local marine scientists still don t have a comprehensive species list and field guide on Philippine corals. Coenomap is a website that aims to bridge that information gap and bring Philippine coral information available to both marine enthusiasts and scientists alike. The first part of the site is already under development. It is a virtual museum of all coral type specimens described by Francisco Nemenzo, the father of Philippine taxonomy. These type specimens are scattered over four collections in three universities. High quality photographs, original descriptions, locality and museum locations, and taxonomic status are now available online for everyone to view and use. Users may also upload their own field
photos of Nemenzo species within the site. The virtual museum is only the first step in potentially creating a comprehensive website on corals to further promote awareness and enhance research on corals in the Philippines.

CATCH OF OTOLITHES RUBER (BLOCH & SCHNEIDER, 1801) (SCIAENIDAE) AND FISHING PRACTICES OF SMALL-SCALE FISHERFOLKS IN SAN MIGUEL BAY, PHILIPPINES

Bergonio E, Espaldon M, Ancog R, Nacorda H

Otolithes ruber (Bloch and Schneider, 1801), one of the major fish catch in San Miguel Bay, commands high market price and its processing is a seasonal livelihood among coastal villages. This study documented fishing practices of small-scale fisherfolks around the Bay and described the O. ruber catch. Fishing trips from 10 September to 19 November 2018 demonstrated that fisherfolks used bottom-set gill nets and commonly explored the middle to the mouth of the Bay off Mercedes and Siruma to catch O. ruber and other species. The “timbog” (“tupak”) fishing method was mostly practiced during daytime, albeit it being prohibited, as this was considered effective, but large catch volumes were recorded when the “patalang” method during the night was employed. The analysis of 434 composite fish samples bought from the fishing trips identified 222 female and 212 male fish individuals with TL of 19.14 + 0.11 cm and body weight of 70.76 + 1.46 g. Majority were already mature to spawning stages and gonads had no apparent lesions. The population’s reproductive capacity, based on the presence of numerous spermatocytes and oocytes, was presumed to be realized, but this may fail due to uncontrolled illegal fishing.

THE MARINE RESOURCES IN PAGASA ISLAND, WEST PHILIPPINE SEA, PHILIPPINES (AFTER TEN YEARS) AND THEIR IMPLICATIONS TO TOURISM?

Gonzales B, Balisco R, Sariego R, Montano B, Gonzales J

The Municipality of Kalayaan is developing a tourism plan under the auspices of the Department of Tourism. The Tourism Development Plan requires the natural environmental profile. Hence, the municipality partnered with WPU to assess/monitor the marine resources of the island, and use the results as reference in crafting the Municipality Tourism Development Plan. This paper aims to: 1.) compare the results of 2008 and 2018 assessments 2.) provide recommendations to proposed municipal tourism development plan based on the assessment results.

Assessments were conducted in ten stations around the island from May 9 to 13, 2018. The assessment followed LIT method of English et al. (1997). Substrate cover was classified as hard corals, soft coral, macroalgae, other organisms, rock/dead corals, rubble, sand, and silt. The same transect lines were used to assessed live coral cover, reef fishes, and macroinvertebrates. The mean hard coral cover of reefs around Pag-asa Island increased from 24.4% in 2008 to 37.6% in 2018 (in ten years). Stations 1, 2 and 9 have significant increase in hard coral cover compared to other stations. The number of fish species and fish families declined from 2008 to 2018. The fish density was higher in 2018 than in 2008. The biomass of fishes found in Pag-asa Island was higher in 2008 than in
2018 survey. Although the fish density in 2018 survey was higher than in 2008, biomass was lower in 2018 than in 2008. Sipunculids, lobsters, and topshells were recorded only in 2008. No crown-of-thorns was noted in 2018. The number of giant clams in 2018 was significantly higher than in 2008.

Recommendations:
Stations 1, 2, 5 and 9 having 'excellent' coral cover are potential dive sites for tourism purposes. Stations 1, 2 and 9 have significant increase in hard coral cover compared to other stations, hence can be candidates for coral and giant clam gardens. No giant clams were recorded in Stations 4, 7, and 10 in both surveys, hence not recommendable for giant clam garden establishment. Recommendations for swimming area, snorkeling, skin spear fishing etc. are provided in this study.

DIVERSITY AND TRADITIONAL USES OF SEAGRASSES IN SIBUTU AND TANDUBAS, TAWI-TAWI, PHILIPPINES
Abduraup Y

Seagrass is a unique angiosperm and are considered one of a valuable component of coastal ecosystems worldwide but are also under global threat because of natural and anthropogenic disturbances. The study aimed to determine the local ecological knowledge (LEK) and community assemblages of seagrasses in Sibutu and Tandubas, Tawi-Tawi, consisting of three sites surveyed in each island municipality. Seagrass community assemblages were determined by figuring the shoot density through calculating the number of shoots of any seagrass species found in the squares. It was found that seven seagrass species of 6 genera were identified in this study, Cymodocea rotundata, Thalassia hemprichii, Halophila ovalis, Halodule uninervis, Halodule pinifolia, Enhalus acoroides and Syringodium isoetifolium. The highest number of seagrass species was recorded in Ambutong Sapal of Sibutu while the seagrass density was highest in Ambutong Sapal of Sibutu and Ungus Matata of Tandubas. Through snowball sampling technique, we explore traditional knowledge concerning on the knowledge of seagrasses and its associated threats, knowledge related to conservation management and uses of seagrasses among locals. It is learned that seagrass beds are not just used as fishing grounds and seaweed farming; this resource has been traditionally used for agricultural, cultural and medicinal purposes both in Sibutu and Tandubas. This study concludes that IEC campaign should be done to disseminate the findings of the study for awareness and conservation purposes.
Do Presence of Mangroves Harbor Higher Fish Diversity Than Its Absence in the Subtropical Rivers of Ryukyu Islands, Japan?

Pantallano A, Nakamura Y, Bobiles R,

Mangrove ecosystem is one of the most biologically and fishery important ecosystem in the tropical region; however, its importance especially in Japan (the northern limit of mangrove distribution in the Indo-Pacific region), has not been well evaluated. Because most mangroves are distributed in the southern part of Japan, the assessment of how the presence or absence of mangroves affects the assemblage structure of fishes was conducted in the Ryukyu Islands. Specifically, daytime fish sampling was conducted in mangrove-rich and mangrove-free rivers in Ishigaki Island (24°N) and Okinawa Island (26°N) in 2015 and 2016 using seine net (n = 20 in each river in each year). The mean species richness and abundance of fishes in mangrove-rich rivers were higher than those in mangrove-free rivers. Mangrove-related food feeders (e.g., benthic invertebrate and detritus) were more abundant in mangrove-rich than mangrove-free rivers while mangrove-unrelated food feeders (e.g. zooplankton feeders) showed no difference between the two types of rivers. Cluster and ordination demonstrated that the fish assemblage structures were markedly different between mangrove-rich and free rivers. Of all the fish collected (88 species), half of the species (45 species, 51%) occurred exclusively in the mangrove-rich rivers such as Apogon amboinensis, 9 species (10%) in the mangrove-free rivers and 34 species (39%) were common in both types of rivers such as Caranx papaensis and Zenarchopterus dunckeri. Commercially important fishes (e.g., Lutjanus fulvus and Lutjanus argentimaculatus) showed higher abundance of juveniles in mangrove-rich rivers than in mangrove-free rivers, indicating that rivers with mangroves can provide important nursery habitat, especially to those commercially important to fisheries, than rivers without mangroves.

Fish Community Assemblage in Old Growth and Replanted Mangrove Forests

Quiroma J, Ticzon V,

In spite of its importance, very little is known about the mangrove-associated fish assemblages in the Philippines. The study aimed to address this data gap and characterize mangrove associated fish communities in two different biogeographic regions of the country. Mangrove associated fish communities in old growth mangrove forests of Del Carmen, Siargao and old growth and replanted mangrove stands in Calatagan, Batangas were characterized via stationary visual fish census. Results showed that mean abundance, species richness and species diversity is higher in old growth mangrove forests of Del Carmen, followed by old growth and replanted mangrove forests of Calatagan. Moreover, current results support the suggestion that fishes belonging to Apogonidae along with those that belong in family Atherinidae, Gobiidae, Hemiramphidae, Terapontidae, Siganidae are common denizens of mangrove ecosystems. Subsequently, it is necessary to point out the occurrence of invasive black chin tilapia (Sarotherodon melanotheron) in mangrove forests of Calatagan. On the other hand, analysis of similarities also revealed significant difference in fish communities between the study areas. Reef
associated fish species such as *Apogon ceramensis*, *Pomacentrus simsiang*, *Sphaeramia orbicularis* and *Siganus fuscescens* contributed most of the observed differences. Possible reasons for this dissimilarity are the inherent site-specific geographical and environmental differences; continuity and extent of mangrove cover; and age of mangrove stands. Consistently, 85% of the fish observed across study sites were reef associated. This strongly supports the idea of connectivity between mangroves and reefs. Furthermore, the results highlight the significance of old growth, contiguous mangrove forests in maintaining diversity and abundance of fishes in mangroves and associated ecosystems.

**SPECIES RICHNESS AND SPATIAL DISTRIBUTION OF ESTUARINE FISHES IN MAINLAND PALAWAN**

**Palla H, Kunishima T, Kobayashi H, Maeda K,**

The estuarine fishes of the Philippines are sparsely studied, and many of those that were previously identified need urgent re-description. Previous studies mainly deal on the medium to large size individuals from commercial and reef fisheries, but rarely on the small-size and non-food fishes that inhabit the intertidal pools, sandy and muddy flats located along the estuarine areas. Accordingly, some of the earlier described species have been categorized as either threatened or endangered despite of data deficiencies. Palawan is known as the country’s last frontier, yet little is known about its estuarine ichthyofaunal diversity. This study aimed to enhance the current records on the biodiversity of fishes in the Philippines. Nine river mouths were surveyed along the South China Sea side and the Sulu Sea side combined on mainland Palawan in 2015, 2016 and 2018. Specimens were caught using scoop nets and those that escaped were photographed underwater. Specimens were identified by gross examination of their morphology and meristic characters and validated through molecular method. In total, 102 species, 65 genera and 28 families were recorded. Species richness was highest in Malatgao river estuary on the Sulu Sea side and Panagurian river estuary on the South China Sea side. Generally, more species were recorded on the Sulu Sea than the South China Sea. Species richness are likely related to the environmental and geomorphological conditions of the estuary. The previously declared extinct species *Pandaka pygmaea* was recorded only in one estuary on the Sulu Sea side while its congener *Pandaka trimaculata* occurred on both side of Palawan.

**SMALL-SCALE SPATIAL PATTERN OF COMMUNITY STRUCTURE OF MANGAL-ASSOCIATED MALACOFAUNA IN REFORESTED MANGROVE FOREST OF ISLA KAPISPISAN, NEW WASHINGTON, AKLAN**

**Alcedo J, Manial R,**

Baseline monitoring of malacofauna diversity accumulated within Isla Kapispisan, New Washington, Aklan was carried out to better understand the efficacy of mangrove reforestation as a tool for diversity restoration. A total of 47 molluscs species comprising 28 gastropods and 19 bivalves were found in the area out of the 2,621 individuals gathered in 5 sites using line transect method. Agglomerative Cluster Analysis based on species abundance revealed 3 unique site clusters. Each cluster reflects a unique molluscan community structure, with 2 clusters belonging
to the main island while the 2 clusters are coming from the adjacent islets. The clusters in the main island are dominated by Cerithidea cingulata and Terebralia sulcata while the adjacent islet is abundant in Cerithium corallium. The community structure of mangal-associated malacofauna in Isla Kapisian exhibits significant variation at a scale of kilometers. This result indicates habitat characteristics and consequently, molluscan recruitment could vary even at small spatial-scale. Implications on how mangrove ecosystems should be managed, taking into account the distribution and zonation patterns of its associated malacofauna.

RECOLONIZATION OF MANGROVES AND ARBOREAL MOLLUSC ASSEMBLAGES IN ABANDONED AQUACULTURE PONDS
Mendoza L,

The demand for lands to construct aquaculture ponds induce mangrove loss. When aquaculture ponds are abandoned, a natural colonization process will take place to recover mangrove forest. Sediment compaction along with the remnants of feed in the sediment from past aquaculture activities may either facilitate or constrain the growth of mangroves along with mangrove-associated mollusc species. In this study, we determined and assessed the recolonization of mangroves in abandoned aquaculture ponds and the viability of mangrove-associated arboreal molluscs as restoration indicator. Vegetation, organic matter (in the sediments) and mollusc assemblage were assessed and compared in mangrove-colonized ponds (4- and 20-yr stands) and natural mangrove stands traversing seaward to landward transect. A total of 8 and 12 species of mangrove and molluscs respectively were recorded. In terms of vegetation, the 20-yr old colonized stands and natural mangroves have the highest number of taxa (S = 5) while the 20-yr colonized stand has the highest number of mangrove trees (116 trees). In terms of relative abundance (RA), the species Littoraria scabra scabra L. (23.68 %) was the most dominant followed by Nerita planospira (15.98 %). The 20-yr old mangrove-colonized stands has the highest OM (36 %). The presence and dominance of mangrove-associated species can be a useful restoration indicator in rehabilitating abandoned aquaculture ponds.

Rhincalanus nasutus GIESBRECHT 1888 (CALANOIDA, COPEPODA) DISTRIBUTION IN THE UPWELLING REGION OF NORTHERN ZAMBOANGA PENINSULA, PHILIPPINES
Agustin B, Campos W,

Rhincalanus nasutus is reported to be a tropical upwelling copepod species. This herbivorous, large-bodied (> 4mm) calanoid is associated with wind-driven upwelling conditions and is reported to be an indicator of oxygen minimum zones. This study investigated the distribution of R. nasutus off the coast of the Northern Zamboanga Peninsula wherein monsoon-driven upwelling is reported to occur during the Northeast monsoon season. Zooplankton samples were collected in five nighttime stations with three depth strata (0-65 m, 65-135 m, 135-200 m) using a North Pacific (NORPAC) net with twin 0.45m-diameter rings fitted with 100 and 200 μm mesh nets coupled to an opening and closing mechanism. Zooplankton samples were dominated by copepod comprising 75.89 - 95.91 %, and R. nasutus ranked eighth most common taxon with a mean overall density of 1,502.24 ind·m³ and mean
overall relative abundance of 1.46%. A total of 557 R. nasutus specimens were identified, staged, and measured. Copepodite stage 5 had the highest contribution to the overall R. nasutus abundance with females having higher occurrence compared to males, however, adult stages were absent from the samples. Also, C5 stages were found mostly in deeper waters while young C1-C3 stages were predominantly found in the top most layer. Multiple linear regression analysis showed that overall densities were not influenced by environmental factors. However, water parameter vertical profiles and principal component analysis show that samples were taken from strata with differing environmental conditions. Therefore, the distribution of R. nasutus life stages may be influenced by depth, salinity, and dissolved oxygen to some extent.

ABUNDANCE, DISTRIBUTION AND SPECIES COMPOSITION OF CYCLOPOID COPEPODS ALONG A TRANSECT TRAVERSING THE UPWELLING ZONE OFF NORTHERN ZAMBOANGA PENINSULA, PHILIPPINES
Jaspe B, Campos W, Metillo E, Noblezada M,

Cyclopoids are small-sized zooplankton and preferred prey of sardines. It is thus important to study their abundance, species composition and distribution in an area which is considered to be the largest sardine fishing ground in the Philippines. This study was conducted to provide insight on the relationship between oceanographic processes like upwelling and zooplankton production and predation. Zooplankton samples were collected in six stations along a transect extending from the coast to about 50 km offshore in Dipolog Bay on the northeast coast of Zamboanga Peninsula in Mindanao during the Northeast monsoon. A 100 μm NorPac net was hauled vertically to sample successive depth strata (0-65 m, 65-135 m, 135-200 m). Cyclopoids were the second most abundant taxa (12.2%) out of 28 major groups of zooplankton, with an overall mean density of 503.6 ind./m³. Forty two (42) cyclopoid species were identified from Dipolog bay with Oncaea clevei (25.4%) being the highest, followed by Oncaea scottodicaloi (13.6%), Triconia conifera (9.2%), Oncaea media (7.2%) and Corycaeus dahli (7.0%), respectively. The high abundance of cyclopoids in the uppermost layer (732.9 ind./m³) at 0-65 m and low abundance (220.2 ind./m³) in the deepest stratum at 135-200 m is attributed to the abundance of phytoplankton in upper euphotic zone where there is high intensity of light. The cyclopoid density was lowest at Station 2 (237.3 ind./m³) and highest in Station 4 (938.3 ind./m³), the margin of upwelling zone. The increase in cyclopoid density as a response to phytoplankton build-up in upwelling zone can be seen on the margin because of the drift that disperses them.

DEEP-SEA ICHTHYOPLANKTON ASSEMBLAGES ON AND OFF A SEAMOUNT: THE HYDRODYNAMIC EFFECTS ON LARVAL FISH DISTRIBUTION BY THE KUROSHIO FLOW-SEAMOUNT INTERACTION
Acabado C, Chen C,

The Kuroshio runs for approximately 3000m along the western border of the North Pacific Ocean at a speed ranging from 1.0 - 1.5m sec⁻¹. This major current brings warm tropical water which sustains the fisheries on the eastern coasts of Taiwan and Japan. The complex underwater topography along the eastern coastline of
Taiwan is brought about by a chain of volcanic islands and underwater seamounts, which pierce through the core of the Kuroshio. The existence of these underwater impingements results in a variety of hydrodynamics around this area, and has been a subject of physical oceanographic study. Roughly 10km north of Lyudao is a conical guyot with its shallowest depth at ~200m. This seamount is subjected to several seamount-induced hydrodynamics including upwelling, trapped gyres and Kelvin-Helmholtz instabilities. To explore the effects of the Kuroshio flow-seamount interaction on ichthyoplankton assemblages, zooplankton samples were collected using a 50-cm diameter plankton net with a mesh-size of 200µm. The net was towed vertically from 150m depth up to the surface on a stationary boat (R/V Ocean Researher III) on the seamount and four off-seamount stations. The zooplankton density and biomass on the seamount were a magnitude higher than the adjacent stations (2230.7 ind.m\(^{-3}\) and 47.5 ml 100m\(^{3}\), respectively). Ichthyoplankton only comprised <1% of the zooplankton, but similarly showed to be highest on the seamount (309.0 ind.100m\(^{3}\)). The assemblages were dominated by the deep-sea families of Myctophidae (mainly *Symbolophorus* and *Diaphus* spp.) and Gonostomatidae (*Cyclothone*). Pelagic carnivores such as Carangidae and Scombridae were also fairly dominant. Reef fishes such as Pomacentridae, Leiognathidae and Nemipteridae were fairly abundant on the seamount station. The presence of highly carnivorous groups and larvae of reef and deep sea families of fish may indicate the function of the seamount as a nursery ground and a feeding oasis in the oligotrophic, open ocean.

ABUNDANCE AND COMPOSITION OF FISH LARVAE CAUGHT BY LIGHT TRAP AND PLANKTON NET ALONG THE BONGAO CHANNEL, BONGAO, TAWI-TAWI

**Julkanain A**, De Leon C, Muallil R, Tambihasan A,

The abundance of larval fishes can provide information that can be used for fisheries management, population and connectivity studies. And larval fishes have a major influence in reef fish population and recruitment variability, which can also be affected by numerous factors such as moon phases and ocean currents. At Bongao Channel, Tawi-Tawi, 549 individual larval fishes were caught in both light trap and plankton net with only 15 distinguished fish families were identified and 3 families unidentified: Clupeinae (Sardines), Pomacentridae (Damselfishes), Monacanthidae (Leather jacks), Labridae (Wrasses), Apogonidae (Cardinal fishes), Pomacanthidae (Angelfishes), Engraulidae (Anchovies), Hemiramphidae (Half-beaks), Syngnatidae (Seahorses), Bleniidae (Combtooth Blennies), Antennariidae (Frogfishes), Serranidae (Groupers/Soapfishes/Seabasses/Perchlets), Carangidae (Jacks), Pempherididae (Sweepers), and Leptobromidae (Beach Tailors). The influence of moon phases on larval fishes was examined in relation to their abundance in the Bongao Channel. Comparisons were also made, among larval catches during the four moon phases, with gears, time-periods and sites. The analyses for total larval fishes all showed variation in abundance during four moon phases, but peaks in their abundances were not concurrent for most of the fish families. Although the larval catches during New Moon were significantly higher than the catches during Full Moon, there are not many differences on the catches between 1st quarter and 3rd quarter. Fish larvae of Family Clupeinae were found in all of the catches without considering the influence of the moon phase, location and time-periods. Although
this study is an introductory to future researches on larval fishes in Tawi-Tawi, it provides insight on the potential protection of the Bongao Channel.

ABUNDANCE AND DISTRIBUTION OF ICHTHYOPLANKTON AND SARDINE LARVAE (FAMILY CLUPEIDAE) DURING NORTHEAST AND SOUTHWEST MONSOONS IN EAST SULU SEA AND ZAMBOANGA PENINSULA

Nepomuceno L, Camu D,

East Sulu Sea and Zamboanga Peninsula are known fishing grounds and spawning areas for sardines. Since 2009, consecutive studies were conducted by M/V DA-BFAR on the area to determine hotspot for sardines. Ichthyoplankton survey which focuses on the larvae of sardines (Family Clupeidae) during the northeast and southwest monsoons was conducted as a follow-up survey of M/V DA-BFAR before and after Close Season for sardines. The survey follow the same 39 sampling stations established in 2011. They were classified into three zones namely: Area I (Jolo/Basilan), Area II (Southwest Zamboanga Peninsula) and Area III (Northwest Zamboanga Peninsula) and demarcated into within municipal waters and outside municipal waters. Northeast monsoon survey was conducted on April 21 to 24, 2016 while the southwest monsoon survey was conducted on October 23 to 26, 2016. Plankton net with a diameter of 50cm and mesh size of 363 microns was used during sampling. Surface horizontal tow and oblique tow were the types of tows used.

Results of the study showed that fish eggs were abundant during April than October while fish larvae were abundant during October than April. Fish eggs were abundant outside municipal waters during April and within municipal waters during October except in Area I where they were found abundant outside municipal waters. Fish larvae on the other hand were more abundant in the municipal waters during April and outside municipal waters during October. Highest mean density of fish larvae was observed outside municipal waters of Area II during April and outside municipal waters of Area I during October survey. Sardine larvae on the other hand were more abundant on April survey than October survey. Highest density of sardine larvae was observed within the municipal waters of Area II during April and outside municipal waters of Area I during October survey. Majority of the sardine larvae were under preflexion stage particularly during April sampling. Larvae under flexion stage were more abundant during October with some portions under post-flexion stage.

FISH COMPOSITION AND BIOMASS STRUCTURE IN RELATION TO PHYTOPLANKTON AND ZOOPLANKTON ASSEMBLAGES IN MANILA BAY, PHILIPPINES

Bendaño A, Perez M, Torres Jr. F, Borja V, Jose E, Furio E, Lopez G,

The relative abundance of fish, phytoplankton and zooplankton abundance is based on 2017 and 2018 survey in Manila Bay. Trawl fishing survey was done along 16 pre-established dragging stations adapted from earlier study of MADECOR and National Museum, 1995 using a commercial trawler rigged with high opening otter type net. Biological oceanographic data such as phytoplankton and zooplankton was collected using a plankton net. The net is vertically towed from bottom to surface along the 16 oceanographic sampling stations. Data on fish, phytoplankton and
zooplankton was analysed by monsoon winds. Results shows that fish composition and relative abundance is directly affected by phytoplankton and zooplankton dominance. Increase of sardines (*Sardinella fimbriata*) biomass during southwest monsoon (Habagat) is probably due to high density of phytoplankton (especially *Coscinodiscus* sp. and *Skeletonema costatum*) and zooplankton (*Paracalanus* sp., Copepod nuptii, and Copepodite). In addition, high biomass of anchovy (*Encrasicholina devisi*) during northeast monsoon (Amihan) is further associated with the increase density of *Pseudo-nitzchia* sp., and *Chaetoceros curvatus* (phytoplankton) and *Oithona* spp., and *Eutherpina acutifrons* (zooplankton). Distribution of fish biomass and phytoplankton inhibit almost similar pattern during southwest and northwest monsoon. Canonical Analysis (PCA) shows that fish biomass and phytoplankton density is moderately correlated during two monsoon winds.

**ABUNDANCE OF CORALLIVORE GASTROPOD DRUPELLA SPP. IN THE BOLINAO-ANDA REEF COMPLEX, NORTHWESTERN PHILIPPINES**

**Manaid J, Sayco S, Conaco C, Hoeksema B, Cabaitan P,**

Large populations of the corallivore gastropod, *Drupella*, have been reported on many reefs throughout the Indo-Pacific, where their uncontrolled predatory activity has led to severe coral mortality. The potentially devastating impact of *Drupella* outbreaks on coral reefs provide cause for populations of this gastropod to be monitored. However, information on the status of *Drupella* populations in Philippine reefs are limited. In this study, we present the initial results from *Drupella* surveys conducted across eight coral reef sites in Bolinao, Pangasinan, Philippines (Balingasay, Cangaluyan, Caniogan, Cory, Lucero, Magsaysay, Malwest, and RDG). The diversity and abundance of *Drupella* were quantified from three 25 m transects at each site. Two species, *D. cornus* and *D. rugosa*, were observed with *D. cornus* found at greater abundance at all surveyed sites. The highest numbers of *Drupella* were recorded in Balingasay and Lucero, indicating that these sites may be susceptible to possible outbreaks. This study suggests that regular monitoring of *Drupella* and other coral predators is essential in order to mitigate population outbreaks that pose a threat to coral reef health.

**VARIABILITY OF KUROSHIO GEOSTROPHIC FLOW IN EASTERN LUZON USING SATELLITE ALTIMETRY DATA**

**Bobis D, Villanoy C, Repollo C,**

Kuroshio is the northward current that comes from the bifurcated North Equatorial Current (NEC). An important role of the Kuroshio is net meridional transpacific heat flux across the mid latitudes that can potentially affect climate change on a global scale. Quantifying these flows will significantly improve the prediction for regional circulation. Satellite altimetry measurements provides a means to investigate the detailed evolution of the Kuroshio on interannual to decadal timescales. The objective of this research was to describe the temporal and spatial variability of the Kuroshio Current in eastern Luzon using merged altimetry data. The gridded area bounded by 5° to 25° N and 115° to 128° E was considered for this study. Monthly averaged data from 1993 to 2016 were used to describe the spatial and temporal
variability. Results show that the Kuroshio is affected by the bifurcation latitude of the North Equatorial Current (NEC) and the reversal of the Asian Monsoon Cycle. In general, the Kuroshio moves going in a northwesterly direction. Lower sea level anomalies, deeper thermocline and warm water were observed during these periods that may be an effect of the Northeast Monsoon. Higher sea level anomalies were observed during the period of June to October. The NEC location moves northward of the 20° N latitude, thus the Kuroshio was seen more to the northeastern of the Luzon. This can also be the effect of the Southwest Monsoon during this period.

NUMERICAL MODELING OF THE GENERAL CIRCULATION OF CARIGARA BAY
Wang M, Villanoy C,

The potential negative effects of harmful algal blooms (HABs) in the Philippines extend beyond the local aquaculture livelihood, activity, and community of the affected areas, bearing consequences at the national scale. With the aim of creating and implementing preventive measures, these events are studied further to better understand the phenomena. HABs often occur due to the interaction of several variables, including hydrodynamic conditions, nutrient availability, and the biological characteristics of the algal cysts and cells themselves. A 2-dimensional model created with Delft3D software is used to study the hydrodynamic conditions of a known HABs site using a curvilinear grid located in the embayment north of Leyte Island extending into the sea west of Samar Island. Bounded by the Samar Sea in the north, the Visayan Sea in the west, and the San Juanico Strait in the south, the model's major semi-diurnal and diurnal tidal constituents of said boundaries are refined and are extrapolated from previously recorded water level data from the Philippine Internal Seas Model. The water level outputs of the model are compared with data from the tide stations in Calbayog, Catbalogan, and San Juanico for verification. Upon the development of the model, information on the general circulation of the area will allow the determination of the relative contributions of major forcings of the water flow.

MODELING AND RETURN PERIOD ANALYSIS OF WAVES GENERATED IN THE PHILIPPINES BY CYCLONES FROM 1980-2013
Rodrigo S, Villanoy C, Bilgera P, Corong J, Cabrera O,

A multitude of cyclones affect the Philippines annually, often damaging coastal zones and coral reefs. Despite their frequency, few studies model storm-generated waves at a national scale. This study thus aims to map the coastal areas and coral reefs prone to wave damage from cyclones and determine the probability of their recurrence. Cyclone track data from 1980-2013 was downloaded from the Joint Typhoon Warning Center best tracks archive. Their wind fields were generated using Deltares software called DelftDashboard. Each cyclone that passed within 3 degrees of the Philippine area of responsibility was run on a 2-dimensional hydrodynamic and wave model of the whole country with bathymetry taken from GEBCO 08. The hydrodynamic component was developed on the Deltares software Delft3D-FLOW while the wave component using a Simulating Waves Nearshore model under Delft3D-WAVE. A return period analysis was performed and maps were generated of the wave heights that will likely recur at frequencies of every 5,
10, 20, and 30 years. Through this analysis, we identify which coastal areas and reefs are prone to cyclone-generated wave action and how often such events are likely to occur. This may aid areas around the Philippines to better prepare for such scenarios.

**MAPPING & MODELING COASTAL WASTE WATER CIRCULATION AND DISPERSION AROUND BORACAY ISLAND, AKLAN PHILIPPINES**

**Bilgera P, Villanoy C, Rodrigo S,**

Boracay Island, known for its fine white sand beaches, is among the world’s top tourist destinations bringing a record high of 2.1 million tourists in 2017. Though tourism is its main economic activity, it is also the main threat to its environmental and public health. Increased tourist influx together with unregulated development and construction in the island, led to serious water quality problems. Moreover, Boracay’s wastewater discharges are very close to the shore affecting water quality in its nearshore region and increasing risk of exposure to pathogens. Thus, understanding and mapping the circulation and dispersion of coastal waste water in Boracay is critical especially for the local government and decision makers to protect human and environmental health. To do this, a 3d hydrodynamic model with 5 layers of 20% thickness per layer was developed in Delft3d, an open-source integrated modelling suite used to “simulate hydrodynamics, sediment, transport, morphology and water quality” (Delft3d Modelling Guide, n.d.). The layered hydrodynamic model was also coupled with DelftWAQ, one of Delft3d modules that simulates water quality. The water level and currents produced by the model was then validated using observed data from CTD, ADCP, and USV (unmanned surface vessels with attached sensors).

**CITIZEN SCIENCE SHEDS LIGHT ON THE DISTRIBUTION, THREATS, AND ECOLOGY OF THREATENED MARINE TURTLES IN THE PHILIPPINES**


Enlisting the general public as citizen scientists can help monitor ecological and environmental factors, respond to crises or inform management action on a local, regional or global scale. This powerful and cost-effective tool has been successfully employed on large marine vertebrates to understand abundance and distribution, threats, connectivity and migration, and population demographics.

Green turtles have unique facial scute patterns that can be used for stable, long-term, mark-recapture studies through photographic identification (photo-ID). This makes it an ideal candidate species for citizen science programmes that recruit the public to collect photo-ID data across multiple sites. Photo-ID and other data (e.g. nesting, fishery interaction) can also be extracted from historical social media posts that are readily available online (e.g. ©YouTube, ©Facebook, etc.).

Here, we used historical reports submitted to Marine Wildlife Watch of the Philippines (MWWP) between 2012 and 2018 to understand the distribution of green turtle incident records in the Philippines (nesting, poaching, fishery interactions, others), and photo-ID data obtained directly from the diving and snorkelling community, coupled with dedicated online searches on social media platforms, to understand residency and habitat use.
There was a total of 185 confirmed reports with green turtles submitted to MWWP through Facebook, including 62 fishery interactions, 56 strandings, two poaching, one from a market, and nine involving hatchlings. Through active data extraction from Instagram, YouTube, Facebook and Flickr, we had a total of 286 green turtle encounters in Apo Island Protected Landscape and Seascape, Negros Oriental, of which 146 had unique left facial scute identifications, and 157 had right IDs. Through a combination of social media and direct diving community contributions, we identified 82 green turtles in Balicasag Island, Bohol, 47 in Dauin and Zamboanguita, Negros Oriental, and 30 in Moalboal, Cebu. These data will be integrated into a national catalogue of marine turtles, and as technology and artificial intelligence evolve, automation of the system will facilitate data extraction. Our results highlight the need to involve the public in data collection, particularly on endangered species. They can provide essential information on threats and distribution in a cost-effective way, thus facilitating management and policy interventions.

COMBATTING OCEAN PLASTIC IN DIGITAL AGE: CITIZEN SCIENCE THROUGH SOCIAL MEDIA

Sacra R,

The call to end ocean plastic problem has become a global trend. The abundant marine wildlife of the Philippines is no exception to the threats land-based threats, particularly ocean plastic. In fact, Philippines ranked as the third marine plastic producer in the world. The UNDP Philippines, through the SMARTSeas PH project, launched CleanSeas Pilipinas. One of the campaign platforms is the digital media. The goal is to create online for a and communities, engage influencers, and expand reach of thought leadership content. Hence, three social media sites and a website were used as platform to start information dissemination, stir discussion on marine plastics, and influence groups and individuals. The campaign adopted the hip culture theme in translating ocean plastic issues and solutions more effectively, e.g., internet memes, romanticized key messaging, and visual impacts. Social media analytics were used to determine the following: a) organic reach of the messages; and b) number of people engaged in the discussion. Majority of the followers are youth and young professionals. On the other hand, the website started to introduce two features: 1) commitment typeform; and 2) open map data. Similar with the followers and engagement in the social media, most of the responses and commitments the campaign received came from college students to young professionals. The open map data provided an avenue to establishments, local movements, and other groups to showcase the change of behavior in their daily practices and operations. The website also served as part of the monitoring mechanism of the campaign. The result of the campaign will be reported to the UN Environment as part of the country’s commitment to the CleanSeas global movement, which started last 2017.
THE OFFSHORE SEGMENT OF THE EAST ZAMBALES FAULT AND ITS IMPLICATION TO COASTAL GEOHAZARD IN LINGAYEN GULF, NORTHWEST LUZON, PHILIPPINES

Flores P, Siringan F, Maac-Aguilar Y, Daag A, Abigania M, Marfito B, Sarmiento K, Gabuyo M,

The Philippines is situated in a tectonically active region. However, offshore faults remain relatively unstudied, which poses a threat to coastal communities. The East Zambales Fault (EZF) is an active sinistral strike-slip fault, and its offshore extension was mapped by acquiring closely spaced single channel high-resolution seismic profiles. Age of previous movements were constrained by a lone radiocarbon date and sequence stratigraphic principles. The EZF continues ~57 km into the gulf following a north-northwest trend with a slight dip to the east, and an eastward bending that starts at the far eastern coast of Anda, Pangasinan. High-resolution seismic profiles have shallow penetration which can hinder the identification of the main fault trace and its splays. In this study, the main trace was identified as the boundary between the karstic terrane to the west and the fluvio-deltaic deposits to the east due to its projected continuity with the onshore trace. For the main trace, only surface displacements can be measured due to the absence of internal reflectors on the west side, which range from 2.3-5.4 m. Possible splays of the main trace show at least 4 movements since the Last Glacial Maximum (>18 ka). The maximum defined vertical motion is ~16 m and the incremental vertical displacements range from 1.5-10 m. The strike slip nature of the offshore EZF are indicated by the presence of synthetic and antithetic faults, which form extensional and contractional features. In some sections, normal and reverse drag geometries are also associated with the same fault trace.

AN INTEGRATED APPROACH TO COMMUNITY-DRIVEN MARINE CONSERVATION IN MALAPASCUA ISLAND, NORTHERN CEBU, PHILIPPINES

Genisan A,

People and the Sea (PepSea), a SEC-registered (CN201625259) community-driven marine conservation NGO based on Malapascua Island, northern Cebu was established with a vision to support local communities, businesses and other stakeholders in identifying innovative ways to manage their marine environment and have a positive economic impact. PepSea’s activities in the community are anchored to an integrated approach to achieve meaningful community development and sustainable marine resources management: Science, Education, Alternative Enterprise, and Solid Waste Management. The Science Program involves citizen science and participatory monitoring of the coastal and marine resources in 19 different sites around the municipality of Daanbantayan. Results from these assessments are used as baseline data for all the survey sites, and can be useful for the local government in crafting effective resource management plans. The Education Program helps shape the minds of children and the youth to become increasingly aware of their dependence on the environment and encourages them to participate in activities that widen their understanding of the relationship between the environment and human interaction. We teach conservation education lessons with the Grade 5 kids in two Elementary schools on the island, and couple this with the weekly EcoHeroes club activity to empower children to care more for their
environment. Our Alternative Enterprise, the Inato Homestay, provides an additional source of income to twenty families, and a communal social insurance that helps these families be more economically resilient. The program not only provides economic benefit to the family, but ecological as well, since availability of these homestay rooms helps in reducing the pressure on resources (e.g. land) needed by the increasing tourist arrival on the island. Our Solid Waste Program has the most tangible results in the community - cleaner beaches and streets, and a collective effort within the community in segregating their garbage. In 2018 alone, People and the Sea removed 50.7 tons of garbage from the island through conducting regular cleanups (Debris Free Thursdays, beach/pathway cleanups and launching the waste collection and education program). This integrated approach is a proven holistic way toward community-driven marine conservation on an island setting.

THE DEVELOPMENT OF KATUNGGAN IT IBAJAY ECO-PARK

Measures N, Loma R, Montilijao C, Primavera J,

The Katunggan It Ibajay Eco-Park is a diverse 44 hectare basin mangrove forest that contains up to 27 species of the 35 found in the Philippines and is estimated to be 700-800 years old. It is located in Barangays Bugtongbato and Naisud, Ibajay, Aklan. Initiatives for the preservation and development of the Eco-Park have been significant since the 1980s. Extensive research, training programs, and multiple efforts by private and government bodies have been made to help develop the Eco-Park. It has been a basis for education in mangrove conservation and rehabilitation. The Eco-Park is an attraction to the public that shows how important preservation and biodiversity are in maintaining coastal ecosystems. The Eco-Park’s boardwalk plays a major role in public access to the mangrove forest. In late May of 2018 a survey was conducted to assess the structural integrity of the Eco-Park’s boardwalk. The focus of the assessment was to collect information showing the present conditions of the Eco-Park’s boardwalk. The collection of data was performed through a qualitative approach with the use of empirical observations. Pictures were taken along with GPS coordinates to mark critical spots. The results showed that the boardwalk consists of 26% Bamboo and 74% Mahogany, and has a total length of 1,250 meters. The assessment presented a substantial overview of the boardwalk’s condition and highlighted areas for improvement that could potentially enhance Ibajay economically and environmentally. This information was to help motivate and push through further development for Katunggan It Ibajay and was presented to the municipal government of Ibajay. A meeting was held with the Mangrove Eco-Tourism Board (METB) of Ibajay to discuss the potential future developments for the Eco-Park to further promote its identity as an attraction and as a unique location in terms of species diversity on the island of Panay.
UNDERSTANDING A COMPLEX RELATIONSHIP: AN ASSESSMENT OF MARINE WILDLIFE TOURISM WITH ENDANGERED MARINE TURTLES AT APO ISLAND PROTECTED LANDSCAPE AND SEASCAPE

Dollano J,

Apo Island Protected Landscape and Seascape (AIPLS) is one of the best examples of a marine protected area in the Philippines yet no work has been done to understand the population dynamics of foraging green turtles (Chelonia mydas) and their behavioral responses to anthropogenic stimuli. Classified as an endangered species, green turtles are protected in the Philippines and internationally. With the continuous growth of tourists snorkeling with the turtles in 2018 (>54,000), this study represents the first assessment of the potential effects of in-water tourists on green turtles. Here we characterize the species’ behavior in the presence and absence of tourists, and assess the tourists’ compliance to management guidelines. Behavioral observations, habitat surveys and photographic identification (photo-ID) were conducted daily from November 2017 to January 2019. We recorded >9,500 total encounters with individual green turtles with a mean 22 individuals identified per day. To expand our understanding on the presence and site fidelity of the resident turtles, the photo-ID catalogue was integrated with systematic yet opportunistic, photo-ID data collected since 2013 by a resident dive operator and online citizen science searches. We recorded the longest photo-ID match dating back to 2007 through social media extraction. In order to find the balance when managing MPA resource-use, community livelihood and species conservation, the implications of this study provide tools for effective in-water tourist management whilst considering the protection of endangered marine turtles.
The Blue Carbon Session will introduce the blue carbon concept and the results of research and development endeavors on the topic. It will include presentations from the BlueCARES Project and the IAMBlueCECAM Program. Papers on blue carbon submitted to PAMS15 will be presented in this special session. The presentations will be grouped into three – Innovate, Integrate, Impact – following the tracks of the conference.

ABOVE-GROUND BIOMASS MAPPING OF SEAGRASS MEADOWS USING THE INTEGRATED REMOTE SENSING AND FIELD-BASED METHOD

Cruz C, Tamondong A, Quides R, Garcia M, Cruz J, Guihawen J, Blanco A,

Seagrass meadows are globally significant carbon sinks. It has received attention for its potential role in mitigating carbon emissions. However, when this ecosystem is damaged, an enormous amount of carbon is released back to the atmosphere, adversely contributing to climate change. With the increasing awareness of the carbon sequestration effectiveness of the seagrasses and, in contrast, continuing loss of this habitat due to anthropogenic factors and effect of climate change, it is important to monitor and quantify the amount of carbon being sequestered by seagrasses. Accurate assessment of the status of seagrass ecosystem is a challenge. Most of the monitoring programs are through field-based assessment. However, while they are still desirable, they are time-consuming, limited, expensive, and difficult. With the recent advancement of technologies, seagrass meadows can be monitored and assessed using remote sensing approach which is characterized by its rapidity and observing over a large area. The aim of this study was to develop methodologies for accurately mapping various seagrass parameters needed for carbon stock modeling using the combined remotely-sensed data and ground-based measurements. Multi-scale remote sensing images such as those acquired by the satellites and drones were used to map the extent of the seagrass meadows. Then, seagrass biophysical parameters such as the percent cover, leaf area index (LAI), and above-ground biomass (AGB) were mapped using multiple linear and non-linear regression analyses. Field techniques which include geotagging using handheld Global Positioning System (GPS), quadrat method, and coring were conducted to calibrate the classification processes and validate the output maps.
Results showed that remote sensing is an effective way for large-scale monitoring of the carbon sequestration potential of seagrass meadows.

**BULK CARBON AND NITROGEN ISOTOPE COMPOSITIONS OF SEDIMENTARY ORGANIC MATTER IN A MANGROVE ECOPARK IN KATUNGGAN IT IBAJAY (KII) AND ITS IMPLICATIONS**

Bejasa K, Miyajima T, Dimalanta W, Jaraula C,

Carbon sequestered from atmospheric carbon dioxide that is converted into organic carbon (OC) through photosynthesis in coastal environments (i.e. saltmarshes, mangrove forests, seagrass meadows) is collectively considered as “Blue Carbon”. The isotopic character of organic carbon is acquired during distinct biosynthetic processes and isotopic signature of the source carbon. With additional information from nitrogen content and $\delta^{15}$N, we study core sediments (n=21) from upstream and downstream sites across the biogeographic zones of the mangrove forest in Katunggan It Ibajay Ecopark, Aklan, Philippines. The 44.22 ha. ecopark is home to 28 mangrove species, to which 80% of the total mangrove species in the country is represented. We study the bulk carbon and nitrogen elemental and isotopic compositions from mangrove biomass and sediments. Biomass C concentrations of plant parts (leaf, bark, roots) of Xylocarpus granatum, Ceriops tagal, and Avicennia marina were relatively the same across species and parts (Average C content = 33.6 $\mu$mol C/mg), whereas N concentrations varied (N content range = 0.252 to 1.051 $\mu$mol N/mg; Average C:N ratio = 75.3). The variable N concentrations are indicative of contributions from fungi and bacteria present in the barks and roots of the mangrove species. This is supported by the bulk $\delta^{13}$C and $\delta^{15}$N range of -30.12‰ to -26.41‰ and -1.84‰ to 4.93‰ respectively, which is a slight $^{15}$N enrichment caused by the presence of fungi and bacteria in the biomass samples.

In the sediments, OC is generally higher upstream (1.2-2.2%) compared to downstream (0.3-0.8%), with ~0.13% average recalcitrant OC (more stable and retained in matrix) consistently higher than the ~0.07% average labile OC (easily leached out from matrix). In the upstream sediments, the carbon content (0.952 to 7.354 $\mu$mol C/mg) and nitrogen content (0.045 to 0.220 $\mu$mol N/mg) are generally higher than downstream sediment contents (0.246 to 0.800 $\mu$mol C/mg; 0.012 to 0.032 $\mu$mol N/mg). Within the sediment cores for both sites, the C and N contents and their corresponding C:N increase with depth. The sediment bulk isotope data showed a predominantly mangrove-sourced organic matter as expected with a $\delta^{13}$C and $\delta^{15}$N value range of -28.22‰ to -26.75‰ and 0.09‰ to 3.26‰ respectively (Average C:N = 25.6). As in biomass samples, sediment $^{15}$N enrichment is evident due to the possible contributions from fungi and bacteria present in the sites. All this data is implicative of the current situation at the study site and its effect on the surrounding ecosystems.
CARBON STOCK ASSESSMENT IN MANGROVE AREAS IN TAWI-TAWI, PHILIPPINES

Muksin H, Saddari F, Burias D, Bara A, Amil F, Jumaide N, Halun S,

Mangroves are productive ecosystems that sustain coastal communities by providing a range of goods and services such as food, storm protection, nutrient cycling, trapping of sediments, nursery and habitat. Mangroves are also known as natural carbon sinks by sequestering carbon in their biomass and sediments for years. This study assessed carbon stored in the vegetation and sediments of mangroves in island municipalities of Tawi-Tawi. Abundance and species composition of the mangrove forests were determined at each sampling site. Sediment samples were obtained through coring. Vegetation carbon were calculated using allometric equations in the literature. The sediments were oven dried and weighed (gDW) and organic carbon was determined through Loss on Ignition (LOI). Initial results show that sediments are a significant carbon stock in mangrove ecosystems.

CARBON PRESERVATION AND ESTIMATION OF BELOWGROUND BLUE CARBON IN BAKHAWAN ECO-PARK, KALIBO, AKLAN

Munar J, Siringan F, Clemente J, Aguilar J, Orizar I, Lagumen M, San Diego-McGlone M,

Mangrove forests are known for their carbon sequestration potential and ecosystem services. Estimation of its carbon stocks is important to assess its contribution to the reduction of greenhouse gases from the atmosphere. Here we report the assessment of belowground carbon in Bakhawan Eco Park, Kalibo, Aklan. Meter-long sediment cores were collected from six zones, each zone identified by dominant mangrove population and relative age of mangrove trees. Litter traps were also deployed in each zone to assess the contribution of plant litter to the soil. Sediment cores were analyzed for their downcore variation in carbon content, water content, bulk density and grain size. Loss on ignition (LOI) analysis and CHNS elemental analyzer were used to measure total organic carbon (TOC) content. Water content and bulk density was measured from their dry weights. Grain size distribution was measured using sieving method. Mean organic carbon content belowground was 6.26%, mostly composed of labile carbon (3.92%). Mean litter input was measured at 0.63 g/m2 for leaves and 0.23 g/m2 for twigs. Zones dominated by Avicennia have higher litter production (0.84 g/m2). Distinct characteristics between the different zones were also observed, especially in terms of their potential for blue carbon storage. High carbon content (10.11% TOC) was measured in elevated zones less exposed to tides. Conversely, zones located seaward and exposed to tides have lowest soil carbon (4.34% TOC) regardless of litter input. Initial belowground carbon estimates (based on LOI method) indicate 448 Mg/ha C in Bakhawan Eco-Park. Zones located seaward show a shift from a sandy base to mud indicating a prograding mangrove forest over time. This supports historical accounts that the mangrove forest in Bakhawan Eco-Park have expanded since the 1990s through reforestation and natural processes.
LIVING ABOVE AND BELOW GROUND CARBON STOCK ASSESSMENT OF MANGROVES IN TANDOG ISLAND, TAKLONG ISLAND NATIONAL MARINE RESERVE, GUIMARAS, PHILIPPINES

de los Santos K, Sadaba R,

Mangroves are a group of halophytic plants that are known for its wide array of ecosystem services. Recently, it has been known that mangroves are effective in sequestering carbon relative to other ecosystems that could reach three times the capacity compared with tropical rainforests. This vast carbon potential is situated along intertidal zones which enables the community to be a key agent in the oceanic carbon cycle. Tandog Group of Islands are protected islands and are part of the Taklong Island National Marine Reserve (TINMR), Nueva Valencia, Guimaras. The area has an extensive mangrove cover with minimal anthropogenic disturbances. This study specifically aimed to (a) determine the area and map out the selected mangrove patches, (b) assess the species composition and community structure, (c) determine above and below ground biomass and carbon stock of live vegetation, and (d) convert the total carbon density into carbon dioxide equivalents. This study is only limited to the estimation of living biomass (above and below ground) based on published allometric equations to avoid damage to the mangroves. The marine protected area has 14 species of mangroves, however, only three were present within sample plots and are monogeneric – genus Rhizophora. The average stand basal area (SBA) was 16.20 m² ha⁻¹ which can be attributed to the thin growth form of the species that are dominant in the area. However, the forest has a high tree and wildling density which is a good indicator of a healthy community structure with good regeneration potential. The Shannon-Weiner Index showed very low diversity (0.19) consistent with published literature. The total area of the site is 4.09 ha with a total C stock of 886.1 Mg (216.7 Mg ha⁻¹) which can be translated to 1,504.6 Mg of CO₂ potential. The relatively low amounts of stored carbon could possibly be attributed to an almost monospecific stand composed of Rhizophora genus. The said members of the genus accumulate lesser biomass due to their slender growth form with a relatively smaller diameter at breast height.

CARBON STOCK IN SEAGRASS MEADOWS OF TAWI-TAWI

Burias D, Bara A, Jumaide N, Amil F, Sakilan A, Halun S, Mohammad K, Tarabasa R, Muksin H,

Climate change is a global phenomenon linked to the increased in amount of carbon dioxide that is mainly caused by anthropogenic activities. Seagrasses sequester carbon that would otherwise remain as atmospheric CO2 and aggravate climate change. This study assessed the amount of organic carbon stored in the vegetation and sediments of seagrass beds in the island municipalities of Tawi-Tawi. Abundance and species composition of seagrasses were determined in thirty 0.25 m² quadrats randomly placed along three 100-m parallel transects at each sampling site. Aboveground and belowground biomass, and sediments were oven dried and weighed (gDW) and organic carbon was determined through Loss on Ignition (LOI) method. The organic carbon in belowground seagrass biomass was higher than aboveground seagrass biomass across species and sites. Sediment carbon accounted for ~90% of the carbon stock in the seagrass meadows. This study illustrates the importance of seagrass beds as carbon sinks.
CO-EVOLUTION OF LANDSCAPE, FOREST AND SOIL IN A PLANTED MANGROVE ECO-PARK IN KALIBO, AKLAN


Aklan River continuously deposits its high sediment yield to form a delta along the northeastern Panay coast. Sediments entrained by the longshore current form as sand spits, beach ridges, and coalesced mouthbar deposits, such as in Bakhawan Eco-Park of Kalibo, Aklan. Natural growth of mangrove trees and planting efforts since the 1990s at the Aklan river mouth stabilized and enlarged the mangrove forest by at least 627.07%, and has flourished to 121 hectares today. The spatial evolution of enlarging sand bars combined with the biological transformation by maturing mangrove forests is also reflected in the evolution of soil deposits as mangrove ecosystems thrive. Carbon inventory in the sediments drastically increased and the molecular composition significantly changed. Since then, the carbon footprint of this parcel of land is an intricate balance of ecosystem services, community livelihood, and changing land-use. Based on remotely-sensed data, the land area of the forest on average increase by 52.42% every five years since 1985. Biological surveys indicate that the center of the mangrove forest is dominated by Rhizophora, and is surrounded by mixed mangrove species, a product of the preferred tree-planting specie because of the ease of planting Rhizophora propagules in the earlier years of management before science-based decisions ensued in the last few decades. Sediments across planting zones in the forest were described based on physical characteristics (i.e. grain size, color, mineral, organic matter content). Belowground carbon was estimated at 31,011.69 Mg using the bulk density analysis and loss on ignition method. Average total organic content was at 6.46%, which was mostly comprised of labile carbon at 3.92%. Overall dry bulk density was 1.01(±0.23) g/cm³. Biological markers from mangrove biomass were analyzed and compared with those from sediment samples to further describe and quantify labile stored carbon. Elemental analysis generated a carbon to nitrogen (C:N) ratio of 109.3 for mangrove biomass (i.e. leaves, barks, and roots from Avicennia marina, A.officinalis, and Rhizophora species), much higher compared to most mangrove deposits in the literature. The C:N ratio of planted mixed-species zones and sandbar (16.4, 17.0, and 18.7) were consistent with a mixture of riverine- and mangrove-derived organic matter. δ¹³C and δ¹⁵N values of sediment samples ranged from -28.75% to -26.11%, and -1.09% to 1.37% respectively. For biomass samples, δ¹³C and δ¹⁵N values ranged from -30.82% to -27.85%, and -10.70% to 1.83%, respectively. Analyses of Pb-210 and Po-210 will be used to estimate accumulation rate. Integration of landscape and forest cover will form a bigger picture regarding the evolution of the mangrove forest soil, and quantification of carbon stock.
LARGE-SCALE AND WIDE-AREA MAPPING AND ESTIMATION OF BLUE CARBON: CHALLENGES AND OPPORTUNITIES
Blanco A, Baloloy A, Argamosa R, Alcantara J, Candido C, Dumalag J, Tamondong A, Cruz C, Nadaoka K,

The critical need to accurately map the spatio-temporal distribution of blue carbon exists. This is not only to establish the baseline but also for monitoring and assessing the dynamics of blue carbon at various scales. Remote sensing of mangrove forest and seagrass meadows using satellites and drones are considered effective but mainly limited to above-ground biomass (AGB). Results show that AGB estimates from the analysis of various images and LiDAR point cloud data yield satisfactory results. In certain cases, the AGB estimates can be used to quantify below-ground biomass. These can be further improved with the synergistic use of radar, optical, and LiDAR data and utilization of spatio-temporal data analysis and geosimulation.

In addition, the use of field and laboratory spectroscopy for estimating soil/sediment carbon content directly from core sample is being explored. The use of machine learning (ML) algorithms for large-scale and wide-area mapping and estimation is promising as demonstrated by previous studies, including that for mangrove forest soil carbon. The ML analysis of core data together with a range of geospatial and environmental variables provided soil carbon estimates for every cell location. Furthermore, such studies demonstrated the value of spatio-temporal analysis of previous data to determine the potential carbon presently stored in the soils by considering potential gains and losses over time due to mangrove growth and disturbances, among other factors. The ML approach requires large amounts of various data. The field, laboratory, and remote sensing approaches for mangroves and seagrass implemented by a few groups need to be complemented by data and information contributed by citizens and the blue carbon network.

THE BCNET: A BRIDGE OVER TROUBLED WATERS IN CLIMATE CHANGE MITIGATION
Fortes M, Blanco A, Nadaoka K,

The Blue Carbon Network (BCnet) is a system linking institutions and organizations in the Philippines (and the Coral Triangle region). It aims to conduct, promote and provide research, technical assistance and education services in support of the missions of partners concerning blue carbon resource assessment and conservation in response to environmental uncertainties. It comprises three clusters: Luzon Cluster (with 36 members), Visayas Cluster (with 13 members) and Mindanao Cluster (with 15 members). As a system, BCnet also provides a platform that will oversee the implementation of the activities of the Blue Carbon Project of the Coral Triangle, monitor their outputs and update partners on the progress of the Blue Carbon Strategy. The strategy will be a set of policies and actions based on blue carbon science and ecosystem services the project will be generating to enhance the conservation of coastal ecosystems thereby mitigating the impacts of human activities and global warming - the project’s contribution to the Philippine climate change mitigation and adaptation goals. BCnet operates within the framework of some sustainability principles and guides to action.
CHALLENGES IN BLUE CARBON STUDIES

Nadaoka K,

Following a brief overview of the recent status of blue carbon (BC) studies, the importance of understanding of the BC change dynamics under various environmental drivers will be emphasized. In this regard, several topics will be addressed as challenges in BC studies. 1) BC change dynamics may be governed not only by local conditions but also by distant conditions in various spatial scales like those in inter-connectivity among mangrove areas, seagrass beds, coral communities, etc., and land-coastal-ocean connectivity. The latter may be regarded as the green and blue carbon linkage system (“G-B Link”). For quantitatively analyzing these processes, an integrated multi-scale model system should be developed with associated field measurements and RS. 2) As the substrate conditions may govern the mangrove and seagrass growth and the bottom sediment layer acts as a big reservoir of organic carbon, interactive sedimentary processes with the growth of mangroves/seagrasses should be clarified and modeled with associated SOM/SOC dynamics modeling. 3) Episodic disturbances like flood and storm surge by a super typhoon may cause abrupt changes/damages in the above- and below-ground parts of BC ecosystems. Considering increasing trend of super typhoon magnitudes, future increase in the risk of the abrupt change/loss of BC ecosystem should be quantified. 4) Natural recovery/re-generation processes of BC ecosystem should be highlighted, in addition to usual mangrove planting practices, for realizing resilient and biologically diverse BC ecosystems. In relation to this, mangrove/seagrass “re-generation potential map” should be developed. The map may be applied as a visual tool for supporting policy making to improve re-generation potential of a degraded BC ecosystem. 5) Holistic coastal ecosystem rehabilitation programs based on socio-ecological system (SES) approach like a “bay-scale silvo-fishery system” should be implemented. These topics are the challenges in the ongoing 5 years project “Comprehensive Assessment and Conservation of Blue Carbon Ecosystems and Their Services in the Coral Triangle (BlueCARES)” funded by JST and JICA.

A WORKING 3-TIER FRAMEWORK FOR MANAGEMENT INTERVENTION OPTIONS FOR PHILIPPINE COASTAL HABITATS


Considering the 50-yr history of coastal resource management (CRM) in the country, vis-a-vis the lessons learned from decades of mangrove planting initiatives, a 3-tier framework is being developed, enhanced by new insights derived from the ongoing collaborative research program on blue carbon (IAMBlueCECAM/BlueCARES). Such framework provides details of a three-filter science-based process in designing spatially-explicit habitat management interventions: (1) prerequisite filters - top level parameters determining whether intervention in specific areas may be pursued [e.g., mangroves may be planted at all, or already beyond the distribution limits, etc.]; (2) purpose filters - set of purpose criteria [i.e., bio-physical protection, coastal fisheries and other ecosystem services, and atmospheric carbon emission mitigation measures] to determine the specific location, size and distribution of efforts, and; (3) site-specific filters - set of site-specific conditions for species assemblage matching
optimizing desired intervention results. This paper will discuss in detail the parameters under these 3-step filters, which may not be explicit enough, at present, in the long-established CRM process. A system of maintenance, monitoring and evaluation, and adaptive mechanism should also be put in place, the results of which should loop through the 3-tier framework, for strategic reviews and/or possible policy changes. To ensure success and sustainability of the intervention program, it would be of extreme importance that stakeholders and the general public be consulted, and provided opportunities to participate in all aspects of the 3-tier process.

HYDROLOGIC-HYDRODYNAMIC IMPACT ANALYSIS OF LAND COVER CHANGE ON TROPICAL COASTAL MANGROVE ECOSYSTEMS: AKLAN, PHILIPPINES

Hernandez B, Herrera E, Yoshikari M, Nadaoka K,

Mangrove forests thriving in intertidal zones in tropical and subtropical regions of the world offer a range of ecosystem services including carbon storage and sequestration. They can regulate detrimental effects of climate change due to carbon releases two to four times greater than that of mature tropical rainforests. Moreover, they are effective natural defenses against storm surges and tsunamis. However, their proliferation depend significantly on the prevailing hydroperiod at the coast. In the Philippines, these coastal ecosystems have been severely threatened with a 50% decline in areal extent observed from 1918 to 2010. Highest decline occurred in 1950 - 1972 when national policies encouraged the development of fisheries and aquaculture. With the intensive land use conversion upstream, changes in the freshwater-saltwater envelope at the coast may considerably impact mangrove growth conditions. This study compares two dynamic watersheds in Aklan, Philippines: (1) a small rural watershed in Ibajay with a natural riverine species-rich 44-hectare mangrove forest; and (2) a developing urban watershed in Kalibo with a 220-hectare mangrove forest replanted for over 30 years. Both mangrove forests are sustainably conserved and declared as protected areas. Hybrid land cover classification technique was used to classify Landsat images for years, 1990, 2010 and 2017. Digital elevation model utilized was Interferometric Synthetic Aperture Radar (IFSAR) with 5-meter resolution to delineate the watersheds. Using numerical modelling techniques, the hydrologic and hydraulic analysis of the influence of land cover change to flow and sediment dynamics was simulated. While significant land cover change occurred upland, thereby increasing runoff and sediment loads, the mangrove forests abundance adjacent to the coasts for the two watersheds, was somehow sustained. However, significant alteration of the coastline was observed in Kalibo through the years probably due to the massive land-use conversion upstream and significant replanting of mangroves downstream. Understanding the hydrologic-hydraulic response of these watersheds to changing land cover is essential to helping local government and stakeholders facilitate better management of these mangrove ecosystems.
ABSTRACTS FOR POSTER PRESENTATIONS

MARINE AQUARIUMS IN THE PHILIPPINES: AN EVALUATION OF PRACTICES AND THE DEVELOPMENT OF A CONTEXTUALIZED FRAMEWORK FOR QUALITY ASSESSMENT
Bengzon R, Pandan J,

As a megadiverse country, the Philippines holds a special responsibility towards biodiversity conservation and education efforts. As such, zoological institutions, such as marine aquariums, are especially significant in carrying out this responsibility. However, the evaluation methods and frameworks available to assess Philippine marine aquariums are limited, and no contextualized and comprehensive checklist exists as of the moment. With this, the study aimed to develop such a framework given the Philippine context, and in accordance with international codes regarding standards for zoological institutions. Through review of related literature such as codes of ethics, management manuals, and conservation strategies, a framework was created featuring 8 categories, namely Welfare, Management, Acquisition, Education, Conservation, Partnerships, and Public Perception. Each category was elaborated with its own set of indicators to be rated from a scale of -3 to +3. In addition to the creation of the framework, third-party evaluations of two prominent marine parks in Luzon and interviews with visitors of the institutions were also conducted. While the study is not comparative in nature, the researchers found there to be large discrepancies in the quality of the two aquariums, highlighting the lack of a Philippine-based standard. The long-term goal of the study is for the developed framework to be used in the future by evaluating bodies of Philippine zoological institutions, as a standardized method for assessing their conditions. At the same time, the framework may also be used as a guide for the establishment of marine aquariums, providing a comprehensive list as to the features that make for a world-class marine aquarium.

SHALLOW WATER BENTHIC FEATURES IMAGED BY SIDE SCAN SONAR IN SELECTED SITES IN THE PHILIPPINES
Flores P, Munar J, Tinacba E, Gabuyo M, Sarmiento K, Primavera K, Siringan F,

Side scan sonar (SSS) can provide an almost photo-realistic acoustic image of the seafloor, making them an effective tool in mapping and characterizing the seafloor. In this study, seabed features identified from the images acquired by the Cmax and Humminbird SSS in the shallow water (<200 m) environments of Batangas, Mindoro, Palawan, Pangasinan, and Zambales are reported. Ripple marks appear as undulations in the image and it signifies that sediments are being reworked or redistributed. It also indicates the direction of water flow as these features are oriented transverse to the main flow. Outcropping rocks are easily identifiable in sonar images because they appear as bright regions with very sharp shadows. In shallow water environments, these rock boulders are often associated with coral reefs because corals do not thrive in sandy or muddy environments and only attach to hard substrates. Submarine groundwater discharge also produce a unique signature in SSS images and appear as a cloud-like or plume-like feature. Manifestations of biological activity in the water column is also visible. A sea turtle
that submerged as our survey boat passed by was imaged as a bright circular feature in the sonar image. Shallow water environments are essential as they provide us with fishing grounds and eco-tourism sites. However, these sites are susceptible to anthropogenic pressures; and the use of SSS can aide in the monitoring and sustainable management of marine resources.

AUTHENTICATION OF PROCESSED PHILIPPINE SARDINE PRODUCTS USING HOTSHOT DNA EXTRACTION AND MINIBARCODE AMPLIFICATION

Labrador K, Agmata A, Palermo J, Follante J, Pante M,

Authentication of fish products in the international and domestic markets is highly important as one of the mitigating measures against species fraud. Sardine products are cured and subjected to extreme conditions, hence making fish authentication extremely challenging. Molecular tools may provide solutions to such research limitation but are often reliant on expensive proprietary kits. Currently, no reports have been made on the authentication of sardine products in the Philippines. This study investigates the species identity of canned and dried sardines sold in local markets. We used hot sodium hydroxide and tris (HotSHOT) DNA extraction protocol and cytochrome oxidase I (COI) minibarcode amplification to identify samples from selected brands of locally-produced canned and dried sardines. To validate, fresh representatives based on advertised and suspected identities of the processed samples were genotyped as well. Success rate of amplification improved from 0 % to 64 % when the minibarcode was amplified as opposed to using the full-length COI barcoding region. Phylogenetic analysis allowed for the successful identification of processed Sardinella lemuru. Meanwhile, substitution was detected on samples marketed as dried tawilis since they were identified as different Sardinella species; however, the 100 % sequence similarity shared with several congeners highlights the limitation in the resolving power of minibarcodes when working with samples that have very low interspecific genetic distances. Regardless, coupling HotSHOT extraction with minibarcode amplification proved to be effective on processed sardines. This protocol can be used as a monitoring tool to identify not only processed sardine products, but other fishery products that have underwent extreme postharvest processing as well.

SURVEILLANCE OF INFECTIOUS PATHOGENS IN MARICULTURE:

ESTABLISHMENT OF GENE MARKER FOR MOLECULAR DIAGNOSIS OF VIBRIOSIS IN ASIAN SEABASS, LATES CALCARIFER

Caipang C, Pakingking R, Apines-Amar M,

Surveillance of infectious disease agents in the marine environment is one of the measures being employed to ensure biosecurity in marine cages and pens. Vibriosis is one of the major bacterial diseases in mariculture systems and this disease is caused by several species of Vibrios. *Vibrio harveyi* is a halophilic Gram-negative bacterium that is ubiquitous in the aquatic environments and can infect fish, shrimp and shellfish either in the culture systems or in the wild. The Asian seabass, *Lates calcarifer* is a popular species for mariculture in most tropical countries and is also susceptible to *V. harveyi* infections. To facilitate accurate molecular identification of the bacterial pathogen during pathogen surveillance, it is necessary to utilize
species-specific gene markers that could differentiate closely related species. The dnaJ gene is a good gene marker that could identify closely related Vibrios compared to using other gene markers including 16s RNA. We obtained partial sequence of the dnaJ gene of Vibrio harveyi, which was isolated from diseased juvenile Asian seabass. It was distinct from the dnaJ gene of other Vibrios but was closely related with the dnaJ gene of V. rotiferianus and V. campbellii having at least 90% nucleotide identity. Conventional PCR and the loop-mediated isothermal amplification (LAMP) assays were developed for the molecular detection of this pathogen and both assays showed specificity and high degree of sensitivity. The LAMP assay 10 times more sensitive than conventional PCR in detecting the bacterial pathogen from infected samples and has a potential for on-site detection. These results indicate that the dnaJ gene is a suitable candidate to identify V. harveyi in Asian seabass and both conventional PCR and the LAMP assay can be used for routine surveillance to detect this pathogen in the marine environment.

SCREENING OF HOST-DERIVED PROBIOTIC CANDIDATES FROM A MARINE FISH AND THEIR POTENTIAL USE IN AQUACULTURE

Caipang C, Lazado C, 

Though recently used in aquaculture, most of the probiotics that fish farmers use are from terrestrial origins. Because of the differences in the environment of the fish and the probionts, the beneficial effects of terrestrial probiotics may be affected; thus, it is important to use host-derived probionts to ensure better colonization of the gut. Using a cold-water marine fish, Atlantic cod (Gadus morhua) as a model, host-derived probiotic candidates were isolated from the gut and further characterized in vitro and in vivo for their potential to be developed as probiotics in aquaculture. The isolates exhibited differences in their antagonism to the bacterial pathogens under varying conditions. The probionts were able to adhere on gut epithelial cells and adhesion was segment-dependent. Transcriptional responses of gut epithelial cells to the candidate probionts showed differential regulation of some immune-associated genes. There was no mortality of fish during the pathogenicity experiment, confirming the safety of the candidates. A feeding trial was conducted by incorporating the candidate probionts in feed. The probiotics-fed fish had better serum-mediated bacterial reduction capacity against pathogenic bacteria than the control. Oral administration of the probiotic candidates through feeding modulated the expression of immune-associated genes in the gut. These series of studies clearly indicate that host-derived probionts can be isolated from a marine fish and has the potential to be developed further for applications in aquaculture.
ESTIMATION OF THE VERTICAL PHYTOPLANKTON DISTRIBUTION IN THE
PHILIPPINE SEA

Cordero-Bailey K, Bollozos I, Escobar M, Jacinto G, San Diego-McGlone M,
David L, Yniguez A,

The vertical distribution of phytoplankton in the open ocean shows an increase in
biomass at a depth referred to as the Subsurface Chlorophyll Maximum (SCM). This
study examines the SCM in the Philippine Sea, utilizing empirical phytoplankton data
from two oceanographic cruises conducted northeast of the island of Luzon in
May/June 2011 and April/May 2012. In 2011, the mean SCM depth was 100 m with
mean SCM concentration of 0.3 ug/L while in 2012, mean SCM was deeper at 120
m and mean SCM concentration of 0.2 ug/L. Functional principal component
analysis and K-means clustering using the principal components resulted in three
clusters which represented the offshore stations with the deepest SCM, stations
within an observed cyclonic eddy with intermediate SCM and stations with shelf or
coastal upwelling showing shallow SCM. Diatoms were dominant in all clusters at
both the surface and SCM depth, except at the SCM of the offshore cluster in 2011
which was dominated by the cyanobacteria, Trichodesmium. This N2-fixing organism
is considered to be representative of the intrusion of the Kuroshio recirculation gyre.
Correlation analyses between Chl and physico-chemical parameters showed that
Chl was negatively correlated to beam attenuation, a bio-optical property that has
been used as an alternative proxy for phytoplankton. This suggests that the
observed SCMs represent actual increase in phytoplankton biomass. When the
influence of the Kuroshio recirculation gyre was dominant in 2011, temperature was
found to be a driving factor for chlorophyll in surface waters. In 2012, highly saline
waters from the tropical North Equatorial Current (NEC) waters appeared to
influence the Chl distribution, particularly at the SCM. These results corroborate
the findings of Gordon et al. (2014) and Cabrera et al. (2015) where they observed
changes in the oceanic circulation from subtropical North Pacific water in 2011 to
tropical NEC water in 2012.

DRAFT LINKAGE MAP FOR THE SEA CUCUMBER HOLOTHURIA
(METRIATYLA) SCABRA GENERATED FROM DDRAD SEQUENCING

Valera J, Macahig D, Tabardillo J, Ravago-Gotanco R,

The sandfish Holothuria (Metriatyla) scabra Jaeger, 1833 is the most commonly
cultured tropical sea cucumber species primarily due to the high commercial value
of its dried form known as trepang or beche-de-mer. Despite its rapidly growing
economic value, genetic information related to sea cucumbers remain scarce and
unexplored. Genomic resources such as genetic linkage maps provide the
groundwork for mapping putative loci associated with beneficial traits such as growth
rates. In this study, we harnessed restriction site-associated double-digest sequenc ing
(ddRADseq) technology to identify polymorphic single nucleotide polymorphism (SNP) markers and develop a draft linkage map from a single full-sib population of H. scabra. The mapping population was generated from a single-cross of two broodstocks sourced from Masinloc, Zambales and Bolinao, Pangasinan. A
total of 92 individuals comprising 2 adults and 90 progeny categorized equally into
fast- and slow-growth categories were sequenced on the Illumina HiSeq 4000
SNP discovery and genotyping were conducted using the STACKS platform. Downstream mapping analysis performed using OneMap resulted in the construction of 34 robust linkage groups with 1162 total anchored markers and an estimated map coverage of 95.25%. The sandfish linkage map showed a total map distance of 19,680.7 cM with an average resolution of 16.13 cM. This linkage map will serve as baseline information for further genetic studies on sea cucumbers such as quantitative trait loci (QTL) mapping, marker assisted selection and comparative genomic analysis.

SYNTHESIS OF N-DOPED BIOCL FOR PHOTOCATALYTIC DEGRADATION OF ORGANIC POLLUTANTS IN WATER

Escayo S, Garlan M,

The demand for clean water has been rapidly increasing over the years and has become a worldwide issue. Fortunately, advanced water treatment technologies offer ways to remove contaminants in water. In this study, nitrogen-doped bismuth oxychloride (N-doped BiOCl) photocatalysts for degrading organic pollutants in water were synthesized via hydrothermal method using selected nitrogen precursors (ethylenediaminetetraacetic acid, urea, ammonium hydroxide). The nitrogen precursor was added into the reaction mixture containing bismuth nitrate in HCl solution to prepare a N-doped BiOCl photocatalyst with a fixed dopant ratio of 1:5 (N:BiOCl). Thermogravimetric analysis (TGA), FT-IR spectroscopy and diffuse reflectance spectroscopy (DRS) were conducted to investigate the thermal stability, functional groups and optical properties of the material, respectively. The photocatalytic activity of the samples was measured based on the decolorization of methylene blue and methyl orange under UV irradiation. All N-doped BiOCl exhibited significant photocatalytic activity towards methyl orange and methylene blue. In conclusion, structural modification of N-doped BiOCl using various nitrogen precursors enhanced the overall photocatalytic activity of the material towards organic dyes. However, further studies are required to assess its potency towards larger organic pollutants (eg. pesticide, antibiotics, etc.) commonly found in water).

TATAK-PINOY! AN INVENTORY OF MODIFIED METHODS IN THE SEAWEED INDUSTRY OF THE PHILIPPINES


The production of seaweeds in the Philippines sprung during the 1970s where wild harvesting was the most common method to collect this commodity. The first guidebook for seaweed farming however was created in the 1980s and today there are four (4) planting methods that are well documented and used. Be that as it may, seventeen (17) modified techniques have emerged from these four (4) techniques due to the ingenuity and creativity of the local Filipino seaweed farmer to adapt to the changing nature of their environments. Some of which utilizes local materials since most farms are remotely isolated from major cities. These alterations were cleverly crafted to adapt to geographic and environmental factors and adopted for its effectiveness in growing out seaweed cultures.
Stock assessment and reproductive biology of the blue swimming crab, Portunus pelagicus, in Malampaya Sound, Northern Palawan was conducted last February 2017 until September 2018. There were two major gears used for blue swimming crab fishery, Crab Pot and Gillnet locally known as “Bukatot” and “Matang Kwatro” respectively. Handpicking and Fish corral or “Baklad” have occasional and seasonal by-catch of blue swimming crabs. Two landing sites, Brgys. Old Guinlo and New Guinlo, in the Municipality of Taytay were monitored to collect fishery dependent data such as total catch, fishing effort and length/weight measurements of the blue swimming crabs. Monthly blue swimming crab samples were also collected for reproductive biometry.

Results showed that from March 2017 to August 2018 (One and a half year) the total catch was 59,302.87 kilograms (or 59.3 Metric Tons) of blue swimming crabs from the two landing sites covered by the study. Monthly production show that seasonality of blue swimming crab is during the month of July. The average monthly CPUE for Crab Pot was 1.7 kilograms/crab pot/day while the average CPUE for gillnet is 26.3 kilograms/gillnet/day. Monthly reproductive biological sampling was conducted from February to September 2018 (1 year and 8 months). A total of 1,113 male and 958 female blue swimming crabs were brought to the laboratory for analysis. Results showed the sex ratio of female to male as 1:1.16 with males slightly higher in number. All four stages of ovarian development and the three stages of male gonads were observed throughout the duration of the study which means that the blue swimming crabs spawned all year round with spawning peaks on the months of April (57%) and September (77%) for female and male respectively. The Female Gonado-Somatic Index (GSI) monthly mean values ranged between 0.41% to 4.76% with a highest value in the month of February. While the male GSI month mean values ranged from 0.13 % to 0.46% with the highest value in the month of March. Ovigerous crab is also observed all year round with the highest percentage of 40.68% during the month of March. The fecundity of ovigerous crabs ranged from 179,697 - 1,130,058 eggs, with average fecundity of 487,425 eggs. The smallest berried blue swimming crab is 9.7 cm. The carapace width at first maturity was computed as 12.5 cm. for female and 11.5 cm. for male. Estimate of growth parameters of blue swimming crabs showed t asymptotic carapace width (CW,aû) was 18.71 cm, the curvature parameter, K(year-1) was 1.3, total mortality coefficient, Z(year-1) was 6.20, natural mortality coefficient, M (year-1) was 2.42, the fishing mortality coefficient, F(year-1) was 4.24, and the exploitation rate, E (year-1) was 0.64. Since the exploitation rate computed is above the threshold value of 0.50 year⁻¹, blue swimming crab stocks in Malampaya Sound could be considered as overexploited.
CEPHALOPODS IN THE TRAWL FISHERY OF THE SOUTHWEST VISAYAN SEA

Campos A, Sanchez K,

Aside from setting straight the taxonomic identity of cephalopod species in the region, this paper provides species-specific data on catch rates, catch and value of species caught by trawl from the southwest Visayan Sea. Fishery landings in Concepcion, Iloilo being monitored daily (April 2018-March 2019) show 5 invertebrate species (4 of which are cephalopods) in the catch (constituting 40% of the entire catch). The cephalopods include 3 squid species (*Photololigo duvaucelii*, *P. edulis* and *Sepioteuthis lessoniana*), and the cuttlefish *Sepia papuensis*, which is reported for the first time in Panay. The 2 most abundant squid species show clear seasonality in their catch rates, i.e. lowest during the rainy months, while *S. lessoniana* was caught on a more even rate during the year. The cuttlefish, on the other hand showed very low catches during the summer months. Although catch rate for the other invertebrate species, the Asian Moon Scallop *Amusium pleuronectes*, was even lower, it is right now, caught only by this fishery all over Panay. Total annual catch and corresponding value are likewise estimated, and these proved much higher than reported in fisheries statistics for the region.

PRELIMINARY ASSESSMENT OF THE REPRODUCTIVE BIOLOGY OF FLYINGFISH (CHEILOPOGON SP.) FROM CATANDUANES ISLAND, PHILIPPINES

Arcilla M

The reproductive biology of flyingfish, *Cheilopogon sp.*, from Catanduanes Island during the peak seasons in March to May 2017 was investigated. Morphological and histological examinations of the gonads, changes in the gonadosomatic index (GSI), sex ratio and maturity stages as well as length frequencies of both male and female fishes were recorded. Results showed that the total body length and weight for both sexes ranged from 23.9 to 27.8 cm and from 109.6 to 178.1 g respectively. The sex ratio of 1 M: 1.1 F is not significantly different from the expected ratio of 1:1 (df = 1; \( \chi^2 \) (0.05) = 3.841). Higher GSI was observed in females compared to males. Male GSI peaked in March at 11.05% while female GSI peaked in April at 12.72%. During the study period, only three developmental stages were observed morphologically namely maturing, mature and spent stages. This was further confirmed by the histological examination of the gonads. Mature individuals of this species are found during March to May which coincides with the peak fishing season in the area. Knowledge of the reproductive biology of this species will aid fisheries manager to device management plan in order to avoid overexploitation and eventual depletion of this resource in local waters.
LENGTH-WEIGHT RELATIONSHIP (LWR), GONADOSOMATIC INDEX (GSI) AND FECUNDITY OF JOHNIUS BORNEENSIS (BLEEKER, 1850) FROM LOWER AGUSAN RIVER BASIN, BUTUAN CITY, PHILIPPINES

Calagui L, Tagarao S, Masangcay S,

Length-weight relationship (LWR), gonadosomatic index (GSI) and fecundity of Johnius borneensis (Bleeker, 1850) collected from Lower Agusan River basin was studied from the months of May 2017 to January 2018. Throughout the sampling period, a total of 304 specimens with 185 female and 119 males were examined and analyzed. The overall sex ratio is 2:1 with female preponderance. Strong correlation coefficient \( r^2 > 0.5 \) was observed in the regression analysis between the length and weight of fish specimens. LWR of females showed positive allometric growth \( (b > 3; p=0.0000) \) which was significant in relationship while male specimens followed negative allometric growth \( (b < 3; p=0.000) \). Ovarian GSI showed to peak in reproduction during September. The month of September was considered as one of the spawning season of Johnius borneensis, hence, it had a short reproductive period. Female GSI value was usually higher than in males. Highest number of spawning and fecund individuals was noted in September. Both fecundity-length and fecundity-weight showed low correlation coefficient except in September \( (r^2=0.622, p=0.001) \) with a strong relationship between fecundity and body length. Similarly, fecundity-weight relationship shows low correlation. It is highly recommended that fishing be strictly restricted during April and September for them to propagate their population in the area.

MOLLUSK GLEANING FISHERY IN BANATE BAY INTERTIDAL FLAT, EASTERN PANAY, PHILIPPINES

Villarta K, Burgos L, del Norte-Campos A, Lapara S,

The gleaning fishery in the intertidal areas of Banate Bay was monitored monthly from March 2018 to February 2019. In general, gleaning activities in the area mostly involve people who are not engaged in regular jobs or other fishing activities, e.g. housewives. Gleaners usually bring with them mesh bags or baskets to store their catch, and rakes / trowels or knives / bolo-"guna" which they use to either dig bivalves from the substrate or scrape off from rock boulders which are exposed during the low tide. With favorable weather conditions, gleaning is conducted 2 to 6 hours per day depending on low tide durations. Catch data of gleaned mollusks were logged daily by local data recorders which were then further analyzed to attain values for overall mean daily catch (kg), mean fishing effort (days and hours) and mean catch rate (kg h\(^{-1}\)). A total of 13 species were recorded throughout the duration of the study with Modiolus metcalfei emerging as the top species (~60% of total mean daily catch; mean daily catch = 6.6 kg; catch rate = 2.1 kg hr\(^{-1}\)). Other dominant species include Scapharca inaequivalvis, Katelysia hiantina and Atrina pectinata with mean daily catches of 1.10 kg, 0.96 kg, 0.75 kg, respectively. Whereas values slightly varied between months, catch rate and catch volume were relatively high from May to July (catch rate all spp = 4.02 kg hr\(^{-1}\)) and from October to December (catch rate all spp = 3.38 kg hr\(^{-1}\)), which coincide with results from a previous investigation (del Norte-Campos et al. 2005) conducted in the area. Along with the current study, additional investigations on the reproduction and population dynamics
of the different species may be needed to further understand the dynamics of this fishery and impacts these activities can have the species ecology.

TRIAL OCEAN NURSERY REARING AND GROW-OUT OF STICHOPUS CF HORRENS

Caasi O, Soy R, Catbagan T, Meñez M,

*Stichopus cf horrens* is one of the commercially important tropical sea cucumber species used as food and component of various pharmaceutical and nutraceutical products. The culture technology for this species is being developed due to its high commercial value and overexploitation of natural stocks. A field experiment was conducted to determine growth and survival of hatchery produced juveniles in relation to stocking density. Juveniles (3 months post-fertilization, 4-10 mm) were stocked in replicated (n=4) densities of 100 (T100), 200 (T200), and 300 (T300) in bottom-set fine mesh net enclosures for 30-days. Results show that survival was significantly highest in T300 (52.2%) and lowest in T100 (27.2%). Conversely, average wet weight of the juveniles was significantly higher in T100 (4.3 +/- 1.9 g). Coefficient of variation in weights was significantly lower, however size range of juveniles was wider (0.5 g - 12.0 g). A significant inverse relationship was observed between average weight and survival. Subsequently, larger juveniles (20-87 g) were stocked in a replicated (n=4) density of 25 in net enclosures (1 m x 1 m) to grow them to larger sizes. Monitoring was done every 30 days for 6-months to estimate growth rates and survival. Mean weight was 30.47 +/- 6.77 g which is significantly lower after 6-months. Negative growth rates were observed in the replicates, which indicate shrinking among individuals. Thickened algae were observed to clog the nets which may have affected the feeding of *S. horrens*. Nonetheless, a high survival rate was observed at 98%. Based on the results, ocean nursery rearing in mesh net enclosure may be suitable for *S. horrens*. However, studies on the effects of density, food availability and environmental factors on the growth of larger juveniles and adults are needed to develop ocean-based grow-out culture systems for this species.

EFFICACY OF SARGASSUM SPP. EXTRACT AS SUPPLEMENTAL FEED DIET TO STICHOPUS CF. HORRENS JUVENILES

Soy R, Capinpin E, Meñez M,

*Stichopus cf. horrens* is one among the high value tropical sea cucumber. However, little is known about the culture production and ecology of *S. cf. horrens*. One fundamental factor affecting the growth of the juveniles is the appropriate food. This study presented the results on feeding and behaviour of 7 month-old *S. cf. horrens* juveniles reared in aquaria. Growth response of *S. cf. horrens* juveniles was evaluated under replicated (n=3) treatment combinations of Sargassum spp. extract and sand substrate. All juveniles survived until the end of the experiment. Result showed that juveniles in treatments with Sand substrate + *Sargassum spp.* extract (7.51±1.75 g) and *Sargassum* only (7.51±1.24 g) did not differ with those juveniles without supplements, Sand only (7.53±2.04 g) and control (juveniles only) (7.51±1.14 g). There was also no significant differences in absolute growth rate of the juveniles in all the treatments (Kruskal Wallis test, p=0.66). In terms of behaviour, *S. cf. horrens* were only active during night time. They started to emerge at 4:00 PM
and started to hide in the shelter at 6:00 AM. The study showed that *Sargassum*
extract did not enhance the growth of the juveniles after 15 days of culture. The
amount of food supplement provided may not be enough to promote faster growth of *S. cf. horrens* juveniles. Results suggest that juveniles can grow and survive either
with or without sand substrate as long as sufficient amount of biofilm is present in
the tank.

SUSTAINABILITY ASSESSMENT OF BLUE SWIMMING CRAB (PORTUNUS
PELAGICUS) FISHERY IN THE MUNICIPALITIES OF SIBUTU AND SITANGKAI,
TAWI-TAWI

**Ebbah J, Romero F, Paalan S,**

A study on sustainability assessment of blue swimming crab fishery was conducted in
the municipalities of Sibutu and Sitangkai for 12-month period (February 2016-
January 2017). Aside from fishing, seaweeds farming, business and trade, crab
fishery is one of the sustenance livelihood industries of the natives in the
municipalities. The study aimed to assess the fishery of species in terms of sizes,
volumes, catch rates and areas of collection. It further, aimed to assess the extent
of illegal unregulated unreported (IUU) trade of the species in the area and come up
with management and policy recommendations for the sustainability of the blue
swimming crab fishery. The study was conducted in three (3) phases: (1) independent study. A survey questionnaire was developed to gather information from as many key informants as possible including fishermen and traders. The questionnaire was divided into different parts. A detailed monitoring sheet was used to record data on blue swimming crab fishery profile. (2) data gathering; and, (3) validation of data gathered. A total 60,339.50 kg production weight of the species sampled for the whole duration of study with an estimated market value of 3,016,975.00 PhP local market. 10,276.50 kg sampled in September (peak month) and 1,315.00 kg in April (lean month). This findings followed the recruitment pattern higher peak during NE monsoon, lower peak SW monsoon (Romero, 2009). During test fishing, April was the productive month of the species with 132 sampled species, 35 male (26.51%) and 97 female (73.48%), 18 of the female crabs bearing eggs. Female crab maturity carapace-width ranging from 10.5 cm to 15.5 cm. with a sex ratio of 1:2.77; 1:1.85; and, 1:2.21 male to female for three test fishing periods. To improve and sustain blue swimming crab fishery in the municipalities, this study recommends a 6-month period of “closed season” for gill nets crab fishery in the municipalities starting February to July. hence, February, March and April are observed to be the breading month period of the species.

AGE AND BODY SIZE RELATIONSHIP AND SEXUAL MATURITY OF BIGNOSE
UNICORNFISH (NASO VLAMINGII) COLLECTED IN DAVAO GULF

**Clavel Z, Nañola, Jr. C,**

In estimating population parameters such as mortality, birth, and maturity, basic
information such as fish aging and growth are needed in discerning fluctuations of a
fish population. One of the common reef fishes harvested in the coastal areas of
Davao Gulf is the bignose unicornfish, *Naso vlamingii*. A total of 209 *N. vlamingii*
individuals from wet markets and landing sites around Davao Gulf were collected
from May 2018 to December 2018. Among the samples collected, shortest standard
length recorded during the sampling was 14 cm, the longest was 35 cm. The length-weight relationship calculated from the collection was $W=0.0424x^{2.8648}$, with high correlation value of $R^2=0.95$. Von Bertalanffy values were obtained using the FiSAT software, generating the following values: $L_\infty= 37.28$, $K = 0.840$. Exploitation rate value was obtained also via FiSAT software ($E=0.36$). Out of the 209 samples collected, 79 were successfully extracted of their gonads, from which the identified sex ratio was 1.14:1 (M:F). Size-at-sexual maturity for females is at 20 cm and 23 cm for males. Size at age data shows rapid growth for early years and gradually decreasing as it ages. Age at first sexual maturity was at age 4 of its life span. This study serves as the basis for the fishery management of *N. vlamingii* in Davao Gulf.

**DUPLEX PCR FOR SIMULTANEOUS DETECTION OF WHITE SPOT SYNDROME VIRUS (WSSV) AND PATHOGENIC VIBRIOS IN SHRIMP MARICULTURE: A STEP TOWARDS DEVELOPMENT OF DNA CHIPS FOR DISEASE DIAGNOSTICS**

Aguana M, Caipang C, Caipang C,

Viral and bacterial pathogens are the major causes of shrimp diseases. Among these pathogens, luminous Vibrios and the white spot syndrome virus (WSSV) have led to serious economic damage due to massive mortality of the cultured stock. Using previously standardized PCR assays for the detection of pathogenic Vibrio spp. and WSSV in shrimp, the present study developed a duplex PCR for simultaneous detection of these pathogens from shrimp aquaculture in the Philippines. Shrimp farms located in three different areas in Central Philippines were visited for the collection of samples for pathogen detection. The PCR primers targeting the ribonuclease P (RNase P) gene of Vibrio spp. were successful in amplifying the gene in all Vibrio isolates with the highest percentage of detection in the luminous colonies and lowest in the non-luminous and yellow-forming colonies. Direct colony PCR of 30 bacterial isolates showed amplification of the RNP gene of Vibrio harveyi, regardless of the phenotypic characters. WSSV was detected from both apparently healthy and infected shrimps. A duplex PCR method for simultaneous detection of both pathogens from shrimp taken from various culture sites was optimized. This duplex PCR assay can be used to further develop a DNA chip for disease diagnostics in shrimp culture.

**INFLUENCE OF PHOTOPERIOD AND AERATION ON THE GROWTH, SURVIVAL, AND EARLY SPAT SETTLEMENT OF THE HATCHERY-REARED GREEN MUSSEL Perna viridis MERO F**

Hatchery management strategies for the culture of pediveliger to spat in the Philippine setting have not been fully developed. Hence, in an attempt to induce early spat settlement and improve mussel seed production in the country, this study aims to determine the influence of photoperiod and aeration, on the growth, survival and settlement of green mussel *P. viridis*. Pediveligers were exposed in 24L:0D h (light: dark), 12L:12D h and 0L:24D h conditions for the photoperiod experiment. Three aeration intensities were also tested - mild (10 liters hr$^{-1}$), moderate (20 liters hr$^{-1}$) and strong (30 liters hr$^{-1}$). Highest growth and survival rates were observed in
P. viridis spats grown in 0L:24D hours photoperiod. There was no significant difference in the settlement rate of larvae exposed to different photoperiods. Mild aeration has shown to improve the growth of P. viridis larvae but higher survival and settlement rates were attained in the strongly aerated conditions. Therefore, when the larvae starts to settle, it is recommended to expose them to darkness and provide a strong aeration to be able to attain high survival and settlement rates, and bigger spats.

A PUTATIVE NEW SPECIES OF LOBOPHORA (DICTYOTACEAE, PHAEOPHYCEAE) FROM CENTRAL PHILIPPINES
Calaguining A, Santiañez W

We herein contribute to the understanding of the diversity of the brown seaweed genus Lobophora in the Philippines by describing the morphology and molecular phylogeny of a putative new Lobophora species collected from Cebu, central Philippines. Similar to several areas in the Pacific, pseudo-cryptic diversity is also apparent in the Lobophora from the Philippines. Hence, it is likely that extensive sampling within the Philippine archipelago will yield new additions to the seaweed flora of the country

MORPHOLOGY AND PHYLOGENY OF A PUTATIVE NEW SPECIES OF DICTYOTA (DICTYOTACEAE, PHAEOPHYCEAE) FROM CAMOTES IS., CEBU
Tabonda A, Santiañez W,

Dictyota species, characterized by flattened, ribbon-like, and branched thalli, are conspicuous floristic components of Philippine coasts. They commonly grow attached on hard substrata or epiphytic to seagrasses or other larger seaweeds. However, little is known on the diversity of Dictyota species in the country. Herein, we fill this gap by describing the morphology and phylogeny of a putative new Dictyota species from Camotes Is., Cebu. The results of our current work points to the need to revitalize and conduct a more detailed assessment on the diversity of the seaweed resources of the Philippines.

MORPHO-ANATOMY OF SEAGRASS SPECIES IN COASTAL WATERS OF BURGOS, ILOCOS NORTE
Taculog K, Pascual P,

A study on the morpho-anatomy of seagrass was conducted specially in the waters off the coastal barangays of Burgos namely: Ablan, Bobon, and Paayas. A total of eight (8) species of seagrass belonging to six (6) genera and two (2) families were identified in selected coastal barangays of Burgos, Ilocos Norte specially in Ablan, (18°31.32’ N 120°36.613” E), Bobon, with a (18°30.30’ N 120°34.50” E) and Paayas, with a (18°31.48” N 120°34.88” E), for a 3 month sampling period from January to March 2018. Identified seagrass species were shown in Table 1. Based on the simple morphological examinations, of 8 seagrass species were identified in the three stations as follows: Cymodocea rotundata, Cymodocea serrulata, Halodule pinifolia, Halodule uninervis and Syringodium isoetifolium.
belonging to family Cymodoceaceae and *Enhalus acoroides*, *Halophila ovalis* and *Thalassia hemprichii* belonging to family Hydrocharitaceae.

Five species of seagrass were found in station 1 namely *Cymodocea rotundata*, *Halodule pinifolia*, *Syringodium isoetifolium*, *Enhalus acoroides*, and *Thalassia hemprichii*. In Station II, all of the 8 seagrass species were found and in Station III only 7 species were found namely *Cymodocea rotundata*, *Cymodocea serrulata*, *Halodule pinifolia*, *Halodule uninervis*, *Enhalus acoroides*, *Halophila ovalis* and *Thalassia hemprichii*.

Of all the seagrasses found in Burgos, Ilocos Norte the most abundant occurring species is the *Thalassia hemprichii*. On the other hand, all seagrass species identified are present in all the 3 stations except for *C. serrulata*, *H. ovalis* which were absent in Station I and *S. isoetifolium* which were absent in Station III during the sampling period. Morphological observations shows that the leaf blade characteristics such as tip and margin characteristic was one of the main feature which describes seagrasses taxonomically. However, the size measurement and degree of colors and calcification tend to show variation among the species (eg. Rhizome, leaf tip and leaf sheath). Anatomical observation showed that the pigments that are present in the leaf are manifested by the availability of light and its location. Ecological observations such as the type of sediment and wave action may contribute to the occurrence of a seagrass species.

**MORPHOLOGY OF SOME LOBOPHORA SPECIES (PHAEOPHYCEAE: DICTYOTALES) FROM NORTHERN PHILIPPINES**

*Mendones S*, Santiañez W,

Recent assessments on the brown algal genus Lobophora suggested that it is more diverse than previously thought. Considering that the identities of the Lobophora collections in the Philippines are yet to be verified, we have reassessed the taxonomy of *Lobophora* specimens housed at G.T. Velasquez Herbarium of The Marine Science Institute, University of the Philippines. Based on our morpho-anatomical observations, we report here four Lobophora species; two of which have already been reported (*L. variegata* and *L. nigrescens*), while the other two (*L. obscura* and *L. petila*) are new additions to the seaweed flora of the Philippines. Similar to other studies on the genus, our results also suggest that the diversity of Lobophora in the country has been underestimated and that a thorough taxonomic survey is needed to account the full extent of its biodiversity.

**LARVAL DEVELOPMENT OF THE MARINE DEMOSPONGE, HALICLONA AMBOINENSIS**

*Nada M*, Baquiran J, Cabaitan P, Conaco C,

The onset of reproduction and larval release in many marine invertebrate species are known to be regulated by environmental cues. However, knowledge on pre-settlement behavior and development of sponge larvae is still limited despite the recognized importance of sponges in reef processes. Here, we describe the behavior and development of larvae of the brooding sponge, Haliclona amboinensis.
Gravid sponge colonies were observed between the months of June-August, coinciding with the time of the year when seawater is warmest. Sponges released parenchymella larvae from brood chambers in the mid-morning, further indicating that light and temperature may serve as cues to initiate hatching and larval release. Larvae were phototactic and exhibited a short pre-competency period before settling unto the undersides of coral rubble and undergoing metamorphosis. This behavior suggests that the sponge has a limited dispersal potential. This work contributes to existing knowledge on the reproductive biology of this marine sponge species and can be expanded by future studies aiming to understand how environmental processes and perturbations may influence the reproductive success, settlement and dispersal of sponge larvae.

ZOOXANTHELLAE COMPOSITION OF RESTOCKED TRIDACNA GIGAS IN DIFFERENT SITES IN LUZON, PHILIPPINES

Tayaban K, Cabaitan P, Conaco C,

The true giant clam, *Tridacna gigas*, has been successfully reared at the Bolinao Marine Laboratory of the Marine Science Institute in response to the need to enhance local stocks that had been depleted due to overexploitation. Since the early 1980s, *T. gigas* individuals have been restocked in different locations across the Philippines that are known to experience variable climatic conditions. Whether the symbiotic community of dinoflagellates hosted within the tissues of these restocked giant clams has changed over the years as a response to prevailing environmental conditions remains unknown. This study examines the zooxanthellae community composition in *T. gigas* individuals restocked in different sites in Luzon (Bolinao, Alaminos, Mabini, and Masinloc) to provide insights into the adaptive capacity of giant clams and their potential resilience to environmental perturbations.

CORAL DIVERSITY, REEF CONDITION AND REEF-ASSOCIATED FISHES IN PURARAN, BARAS, CATANDUANES

Arcilla M, Tatel C,

A study on coral diversity, reef condition and reef-associated fishes in Puraran, Baras, Catanduanes was conducted to assess the condition of the area which is considered as a popular surfing site in the province. Assessment of the benthic community was done using photo-transect method. A total of 111 frames were used for the analysis using the CPCe software. Fish abundance, diversity and biomass were determined using fish visual census (FVC) technique of English et al. (1997). A total of 13 genera belonging to 8 families of corals were identified mostly dominated by *Favia sp.* and *Favites spp.* Encrusting *Montipora* and *Porites* are also common in other parts of the reef, while *Merulina*, *Leptoseris*, *Pavona*, *Goniastrea*, *Pocillopora* and *Acropora* are minimal. Other encrusting corals and massive corals are also present. Diversity index ($H'$) is high at 2.3. Massive and sub-massive structures are the dominant growth forms in the area forming a fringing reef. Coral cover was “fair” with 26.5% live corals. However, dead corals are relatively high at 58.8% and these are covered with filamentous algae indicating absence or inadequate herbivory. Consequently, the area is also covered with 28% *Halimeda* and macro and coralline algae, which could also be a consequence of low coral cover. Interestingly, coral bleaching and other coral diseases are not present in the
area. Reef-associated fish species appeared to be moderately abundant with ±860-1020 indi/1000m². Non-target fishes dominate the area while target fishes rank second in terms of density. Indicator fishes have lowest density which is a consequence of the habitat condition. Fish diversity index was found to be “very poor.” Pomacentridae is the most diverse group averaging 10 species followed by Labridae with 8 species. All other reef fish groups have low diversity ranging from 1-3 species. This was the first assessment of the site and insights from this study will help in developing management measures which will help improve the coral condition of the area.

BRITTLE STARS (ECHINODERMATA: OPHIUROIDEA) IN THE COASTAL AREAS OF CALATAGAN AND LIAN, BATANGAS
Marza N, Aurellado M,

Brittle stars (Echinodermata: Ophiuroidea) comprise the largest group among extant echinoderms. However, shallow-water ophiuroidean studies in the Philippines are scarce with the most recent records dating back to Clark and Rowe’s monograph of Indo-Pacific echinoderms in 1971. This study aims to identify the species located in the coastal areas of Calatagan and Lian, Batangas, as well as to compare past literature studies with the results using Sorensen Index. Brittle stars were collected and specimens are either dried or relaxed in 4% magnesium chloride before preserving in 70% ethanol. Preliminary data acquired in Calatagan coasts identify a total of 11 species under genera Ophiocoma, Ophioplocus, Ophiolepis, Ophiarthrum, Ophiomastix and Macrophiothrix with possibility of cryptic species occurrence especially under the genus Ophiocoma. This study could provide a checklist for biodiversity assessment and taxonomic identification for future research.

INFLUENCE OF FARMER DAMSELFISH ON HERBIVORY IN PROTECTED AND NON-PROTECTED CORAL REEFS IN ANILAO, BATANGAS
Aurellado M, Fabellon J, Ticzon V,

Farming territorial grazers are known to defend their territories from competitors such as other damselfishes and roving herbivores. Because territorial farmers and roving herbivores have contrasting effects on the benthic community, examining their interactions is important in understanding how shifts in reef fish composition could affect coral reef resilience. This study examined territoriality of the jewel damselfish Plectroglyphidodon lacrymatus and herbivory inside and outside their territories. The study was conducted in three sites in Anilao, Batangas, namely: Twin Rocks Marine Sanctuary, and two other non-protected areas such as Dead Palm Reef, and Layag-layag. Aggression of P. lacrymatus was measured by counting the number of attacks made to a model replica of the surgeonfish Ctenochaetus binotatus and an object control. Underwater video cameras were also deployed inside and outside P. lacrymatus territories to quantify grazing pressure. P. lacrymatus was more aggressive towards the surgeonfish model than the object control but this aggression did not differ among the three sites. Incidentally, grazing activity of other herbivores was much higher outside than inside P. lacrymatus territories and was mainly attributed to surgeonfishes (75%). However, grazing
activity was higher in Twin Rocks Sanctuary than the other two sites which could be
due to the higher biomass of roving herbivores in this marine reserve. These results
suggest that the presence of farming damselfishes can influence the distribution of
grazing activity on coral reefs. This study also underscores the importance of marine
protected areas in maintaining populations of functionally important groups such as
roving herbivores.

ASSESSMENT OF MARINE INVERTEBRATES IN MACONACON, ISABELA
Gallo V, de Peralta G,

Studies on fishery resources in the coastal towns of Isabela are limited. As such, a
study was conducted to identify and provide an inventory of all the economically
important crustaceans, molluscs and echinoderms, as well as the method or fishing
gear used in gathering these species. Of the ten (10) barangays in Maconacon,
Barangays Aplaya, Diana, Eleanor, Fely, Malasin and Minanga were selected for
the study. There were twenty seven (27) interviewed gatherers ranging from 13-63
years old. Based on the interviews, there were eleven (11) identified species of
crustaceans (e.g. slipper lobster, crabs, shrimp), eighteen (18) species of
echinoderms (e.g. sea urchin, sea cucumber) and twelve (12) species of mollusks
(e.g. octopus, squid, triton shell). Of the forty-one (41) species identified, there were
nine (9) identified fishing gears used to gather these species such as spear gun
(pana), tridents (tarapang), fish net (sigay) crab pot (tallakeb), scoop net (sayop)
and hand gathering (dakma) for crustaceans, “kantok”, hand picking (pulot), and
compressor for echinoderms and “panpandong” for mollusks. Gatherers are affected
by bad weather (amihan) during the months of October to February resulting to
difficulty in gathering these fishery resources.

THE USS ALBATROSS PHILIPPINES EXPEDITION AND THE PIRE PROJECT:
A HISTORICAL GENOMIC ASSESSMENT OF FISH POPULATIONS.
Lopez I, Kenton M, Garcia E, Carpenter K, Bucol A,

In 1907 the USS Albatross arrived in Manila to begin a two-year biological survey of
the marine species of the Philippines. The expedition, now considered a great
undertaking, collected over 79,000 fishes representing a comprehensive assortment
of fish families from over 1000 stations throughout the Philippine islands. These
specimens were morphologically identified, catalogued, and housed in the United
States National Museum. Unlike most museum specimens world-wide that are fixed
in formalin and preserved in ethanol, Albatross collections were both fixed and
preserved in ethanol, allowing for potential genetic analysis. Over the years,
researchers have studied these specimens and reinforced the hypothesis that the
Philippines is the center of marine biodiversity. However, no previous study has
examined the genomic architecture of these specimens. The Philippines
Partnerships for International Research and Education project: “Centennial Genetic
and Species Transformations in the Epicenter of Marine Biodiversity” is a joint effort
between governmental and academic institutions of the Republic of the Philippines
and the United States. The purpose of the project is to compare the genomic
composition of fish populations collected by the Albatross with that of their
corresponding contemporary populations to address the project’s central question:
have genetic and species-level changes taken place over the past century of intense
fisheries exploitation and habitat degradation in the Philippines. A previous PIRE project studying population genetics of marine populations in the Coral Triangle successfully demonstrated the feasibility of this type of collaborative research in the Philippines. The current PIRE project has identified 124 candidate species from 104 stations throughout the Philippines where genomic diversity of historical and contemporary populations can be compared. Albatross and contemporary collections of a minimum of 20 species illustrating different levels of fishing pressure and habitat degradation are being analyzed using next-generation sequencing and bioinformatic software.

SEAGRASS COMMUNITY STRUCTURE IN TWO SELECTED AREAS IN CALATAGAN, BATANGAS, PHILIPPINES
Tabuga A, Padul E, Alub M, Saco J,

Seagrasses are specialized marine flowering plants that can form dense underwater meadows and are an important shallow marine habitat. Although they often receive little attention, they are one of the most productive ecosystems in the world. They perform a wide spectrum of biological and physical functions in the marine environment. It provides shelter in fish and invertebrate, and primary foods for sea turtles and dugongs. Due to increasing anthropogenic threats to seagrass ecosystem, humans and marine animals are in danger of losing benefits from them. Because of their ecological importance and global distribution, seagrasses is an important study system for understanding how coastal habitats work and respond to environmental changes. This study assessed the seagrass community structure in selected areas in Calatagan, Batangas that will serve as baseline information in the area. Line transect-quadrat method was used in determining the seagrass community structure and cluster analysis was used to determine similarity among sites and similarity, structure, and zonation of seagrass species on each site. Shannon Index of Diversity was used to determine species diversity among sites. Four seagrass species were identified on the two selected sites. Enhalus acoroides and Thalassia hemprichii was found at the Barangay 2, Poblacion (site 1), while, Halodule uninervis, Cymodocea serrulata and T. hemprichii were found at Stilts Calatagan Beach Resort, Barangay Sta. Ana (site 2). E. acoroides was the dominant species in site 1 while T. hemprichii in site 2. The differences in the community structure between sites might be attributed to only one species, T. hemprichii present on both sites, thus, showing low similarity index. In addition, the physical attributes of the area might also be attributed to their difference wherein site 1 has sloping topography with muddy substrate while site 2 has an intertidal flat with the sandy-bedrock substrate. Interestingly, the site 1 which is in close proximity with seaweed farms has relatively low percent seagrass cover while the site 2 which is a resort has relatively high percent cover.

INVENTORY OF COMMERCIALY IMPORTANT CORAL REEF FISHERIES IN PUBLIC MARKET BONGAO, TAWI-TAWI PHILLIPINES
Enojario M, Muallil R, Tambihasan A, Ong Y,

Tawi-Tawi is the southernmost province of the Philippines with vast coral reefs that are teeming with marine flora and fauna. Coral reef fisheries provide a major source
of livelihood in the province but the prevalence of illegal and destructive fishing activities undermines the sustainability of these valuable resources. In this study, a species inventory of commercially important fishes was conducted at the central market and fish warehouses of Bongao, Tawi-Tawi, every three days or about twice a week from January to December 2018. A total of 51,262 reef fishes were recorded of which 434 species belonging to 155 genera and 50 reef fish families were identified. The most dominant families in terms of number of species are Lutjanidae (40 species), Acanthuridae (36), Labridae (34), Serranidae (30), Carangidae (30), Scaridae (27), Lethrinidae (25), Nemipteridae (24). Were the top eight families with the most species. The most abundant species recorded are *Siganus guttatus* (2133 individuals), *Scolopsis taeniopterus* (2010 individuals), *Siganus margaritiferus* (1922 individuals) and *Gerres oyena* (1772 individuals). We further compared the species found in the markets of Tawi-Tawi with those recorded in Palawan (Gonzales 2013) and Panay island (Motomura 2017). We found more species recorded in Tawi-Tawi for some of the major families considering our short study period.

**FISHERY DEPENDENT SURVEY OF MARINE INVERTEBRATES IN DIVILACAN, ISABELA**

**Batacan S,** Bugarin K, de Peralta G,

Divilacan is a remote town in Isabela teeming with fishery resources. A study was conducted to identify and provide an inventory of the marine invertebrates (crustaceans, molluscs, and echinoderms) which are present in the area as well as the fishing gears used in gathering these species. Out of the eleven (11) barangays, Barangays Dicatian, Dimapula, Dipudo, and Dimasalansan were selected as these were near the coast. There were 25 selected individuals who were interviewed with age ranging from 25-54 years old. There were a total of 38 species of marine invertebrates of which there were nine (9) crustaceans (e.g. lobsters, crabs, shrimp), twenty (20) echinoderms (e.g. sea urchin, sea cucumber), and twelve (12) molluscs (e.g octopus, squids, nautilus). There were 14 identified fishing gears being used in gathering these species such as the spear gun (pana), trident (tarapang), crab pot (tallakeb), fish net (sigay) and scoop net (sayop), hand picking (pulot/dakma), and “panpandong”. Of all the species of marine invertebrates in the area, some were identified to be economically important such as: crustaceans (e.g. *Panulirus ornatus*, *Portunus pelagicus*), echinoderms (e.g. *Holothuria scabra*, *H. fuscogilva*, *S. horrens*) and molluscs (*Tridacna spp.*, *Loligo vulgaris*, *Octopus vulgaris*). Lack of buyers in some marine invertebrate species and bad weather conditions were the problems that affect the gathering of these species.

**PRELIMINARY INVENTORY OF FISH AND INVERTEBRATES IN VERDE ISLAND, BATANGAS CITY, PHILIPPINES**

**Sabban E,** Sanchez L, Velasco D, Vacarizas J,

Verde Island is an isle found at the center of the Verde Island Passage (VIP) wherein the marine research center, VIP CORALS or the Verde Island Passage Center for Oceanographic Research and Aquatic Life Sciences conducted a preliminary inventory of marine species such as fish and invertebrates. Three sites for fish and
three sites for invertebrates were selected to collect and preserve the top three dominant species. Fish collection was done at a depth of 5-10m at coral reef areas by manual catching while invertebrates were collected from seaweed and seagrass beds. The fixation and preservation method were done by storing specimens for one day in formalin, then sequentially increasing the concentration of ethanol daily until a final concentration of 70% ethanol. Preliminary results showed that fish collected from the three different sites where from the families Chaetodontidae, Tetraodontidae, Labridae, Cirrhitidae, Acanthuridae, Pomacentridae, Scaridae, Centriscidae, Balistidae and Bleniidae while invertebrates were dominated by Holothuriidae and order Ophiurida. The species were catalogued using the Specify6 database. Upon checking the IUCN statuses of the identified specimens, several were found to be Not yet Evaluated (NE) and Data Deficient (DD) while other species were identified to be of Least Concern (LC).

AN OVERVIEW OF PLANKTON DIVERSITY AND ABUNDANCE IN BORACAY ISLAND, MALAY AKLAN, PHILIPPINES: SUPPORT TO ECOSYSTEM STATE ASSESSMENT

Noblezada-Payne M

Boracay Island is one of the most well-known tourist locations locally and internationally. The island is famous for its “powdery” white beaches, serene environment and diverse coastal resources such as mangrove, seagrass and reef which attracted over 2 million local and international tourists generating billions of pesos to the Philippine economy annually. However, the island ecosystems has been damaged and degraded as a result of stresses associated with unplanned development and mass tourism. The severity of such degradation being apparent and uncontrollable triggered some action and motivation to rehabilitate and prevent further damage. In line with this, this study is conceived to contribute in promoting science-based management and conservation efforts for sustainable tourism in the Philippines and areas such as Boracay using plankton diversity and abundance. Preliminary results show an interesting pattern of distribution of plankton groups with gelatinous (salps and siphonophores) dominating the areas near reef, seagrass and mangrove, while areas with observed strong currents mostly comprising of crustaceans and appeared to be well sorted, lastly the sandy beaches comprising mostly of algae. As for the phytoplankton, a total of 33 genera were identified dominated by diatoms (24 genera), cynophycean (1), silicoflagellate (2) and dinoflagellates (6).

SPECIES ABUNDANCE OF SEAGRASS AND ITS ASSOCIATED FAUNA IN BALAYAN, BATANGAS

Catapang M, Cudiamat M, Sison M,

Seagrass meadows are important marine ecosystem which provide habitat for fishes and macroinvertebrates. They also prevent sedimentation and control soil erosion in coastal environment. This ecological study assessed the taxonomic profile of seagrass in Balayan, Batangas and its associate species. It made use of descriptive quantitative research design and specifically utilized line transect and quadrant
sampling to determine the structure of seagrass ecosystem, species identification of seagrass and its associates, herbarium and mounting of specimen were done.

The findings revealed that there are two (2) species of seagrass present in the sampling site: *Enhalus acoroides* and *Thalassia hemprichii* of the Family Hydrocharitaceae. *E. acoroides* is identified as the most dominant species in the ecosystem with a relative density of 57%. Associate species include sea stars *Protoaster nodosus* and *Archaster typicus* and brown seaweed *Sargassum macrocarpum*.

The findings suggest that management of the remaining patch of seagrass meadows be done for the conservation of the two species present. A seagrass management framework was proposed for conservation and protection of the ecosystem.

SUBSURFACE ZOOPLANKTON POPULATION OF SURIGAO-DUMAGUETE-SANTANDER TRIANGLE, PHILIPPINES: INITIAL RESULTS

**Genson F,** Sotto F, Balala A,

Zooplankton are vital component of an ecosystem as they serve several functions, for instance as food, by forming a link between the primary producers, phytoplankton and the plankton-feeding fish. A research cruise conducted on November 19-21, 2017 by a group of Marine Scientists from UP-MSI, Silliman University and University of San Carlos on-board the BRP Gregorio Velasquez collected subsurface plankton samples from eight legs/stations established along the Surigao-Dumaguete-Santander Triangle by flow-through-system (flow rate of 5 liters in 44 seconds). The unfiltered seawater was collected using a 210 cm long, 55 cm wide, and 100-mL volume plankton net cod-end and sieved through a 20 μm mesh net lining the cod-end. Initial results identified 44 taxa in eight phyla namely; Protozoa, Cnidaria, Chaetognatha, Annelida, Mollusca, Echinodermata, Arthropoda and Chordata. Among these, copepods dominated the population (76%), with calanoid copepods as the most abundant (65.9%). The dominance of copepods at the subsurface zooplankton population in Surigao-Dumaguete-Santander Triangle is a common observation in several studies due to its trophic role in an aquatic system, as food by planktivorous fishes. Highest zooplankton population was recorded at the Station 9 (398, 437.50 indiv/l), located towards the Surigao Strait while least at Station 4 (123,750 ind/l), between south of Dumaguete and northwest of Siquijor. Subsurface water temperature and salinity at the triangle did not show correlation with the density of zooplankton.

PRELIMINARY REPORT ON THE FISHERY AND ECOLOGY OF THRESHER SHARKS (ALOPIAS SP.) IN TAWI-TAWI, PHILIPPINES

**Muallil R,** Hapid M,

Thresher sharks (family Alopiidae) are highly migratory pelagic predators. Their populations have been drastically declining mostly due to extensive fishing for their fins for international market. In 2007, the International Union for Conservation of Species (IUCN) listed all the three species of thresher sharks as vulnerable to extinction. The three species were further listed in Appendix 2 by the Convention on
the International Trade in Endangered Species (CITES) of Wild Flora and Fauna during their 17th Conference of Parties (CoP17) meeting in Johannesburg, South Africa in 2016. In Tawi-Tawi, in the southernmost waters of the Philippines, thresher shark fishing has been existing for decades. This study is the first attempt to describe the fishery and ecology of thresher sharks in Tawi-Tawi based on landing surveys and key informant interviews. The fishery is generally small-scale (e.g. involves small number of municipal fishers), highly seasonal (i.e. less than a month in a year) and the fishing grounds are exclusively along the Sibutu passage, which connects the Sulawesi (Celebes) Sea to the Sulu Sea. Thresher sharks are generally hunted for their fins which are sold to buyers in Bongao, Tawi although the meat is also locally consumed for food. This study is the first scientific reports about thresher sharks in Tawi-Tawi and therefore provides valuable insights for effective conservation of these protected species.

REPRODUCTIVE BIOLOGY OF THE CRUCIFIX CRAB CHARYBDIS FERIATUS (LINNAEUS, 1758) IN TIGBAUAN, ILOILO, WESTERN PHILIPPINES

Golez M, Baylon J, Niño M, Segovia J,

This study provides baseline information on some aspects of the reproductive biology of *Charybdis feriatus* from Brgy. Atabayan, Tigbauan, Iloilo, Philippines from May 2017 to April 2018. A total of 204 (118 female; 86 male) crabs were collected. Monthly percentages of ovigerous crabs, gonad index (GI), and gonad developmental stages were analyzed for the determination of sexual maturity, fecundity and breeding season. The total female to male sex ratio was 1.4:1 (x^2 = 5.02; p < 0.05). Gonad developmental stages were established based on the macroscopic and histological appearance of the gonads. In females, seven stages were identified namely: (I) Immature, (II) Early maturing, (III) Late maturing, (IV) Mature, (V) Spawning, (VI) Spent, and (VII) Resting. Two stages were identified in males namely: (I) Immature and (II) Mature. Size at sexual maturity (CW50) was estimated at 82 mm CW in females and 70 mm CW in males. The size of ovigerous crabs ranged from 83.84 - 121.58 mm CW. Fecundity was significantly correlated with CW size and ranged from 474,145 - 1,531,886 eggs (r^2 = 0.7162, n = 7). Monthly variations in GI (%) values, percentage of ovigerous crabs, and gonad developmental stages showed that this species breeds continuously throughout the year. The peak reproductive activity observed in the months of June to August was associated with the high GI (%) values, and abundance of mature and ovigerous crabs. Information obtained from this study can help in the conservation and management of the local natural stock, as well as in the development of hatchery operations on this crab species.

OBSERVATION ON THE DUEL BEHAVIOR OF SHARPNOSE PUFFERFISH (CANTHIGASTER VALENTINI) BACHELOR MALES

Calle L, Juinio-Meñez M, Cabaitan P,

The *Canthigaster valentini* is a pufferfish found in the Indo-Pacific region. They grow up to 90 mm in length and females mature at 38-41 mm. They are known to have a harem social system where there are three social classes: territorial males, territorial females and bachelor males. Territorial females tend only one single
territory throughout their lives, whereas territorial males cover and maintain more than one territories of the females. Bachelor males do not own a territory. They are usually found to be near the territories of territorial males to sneak an opportunity to mate with the females. Two *C. valentini* individuals with an estimated length of 40-50 mm were observed to be dueling in the giant clam ocean nursery area in Silaqui Island, Bolinao. They were identified as males using morphological characteristics. The two individuals were observed to have successive behaviors which involved circling, caudal fin flexing, depression posture, frontal display, and attacks. These behaviors were repeated for 8-10 times with the whole pattern ending with attacks and starts with the circling. The dueling lasted for about 15-16 minutes and one individual succeeded by biting the posterior of the belly and locking. The locking behavior lasted for about 6-7 minutes but the loser was able to escape and leave the dueling area. They were found hovering separately after the fight at about 15 m distance from each other. Some of the behaviors such as circling and frontal display were previously observed by Gladstone (1985) in *C. valentini*'s territorial disputes. However, we suggest that the behavior observed was in between bachelor males since territorial males do not use pronounced amount of energy and time to ward off bachelor males due to their superior status. It is recommended that these species will be further tagged and monitored to understand more of the observed behavior.

**COMPARISON OF EPIBIONT COMMUNITIES ON LIVE AND EMPTY SHELLS OF TRUE GIANT CLAM TRIDACNA GIGAS**

**de Guzman I**, Cabaitan P, Sayco S, Conaco C,

The high topographic complexity of coral reef ecosystems provides habitat for a wide variety of marine organisms. Giant clams (*Tridacnidae*) contribute to this complexity by providing suitable substrate to different types of epibionts. However, it is unknown whether there are differences in epibiont communities on live or empty shells of giant clams. In this study, surveys were conducted to compare the species richness, abundance and surface cover of epibionts on the shells of live and dead true giant clams, *Tridacna gigas*, at different marine habitats (i.e., sandy areas, seagrass bed, and coral reef). Among the three habitats, significant differences in species richness (*p*=0.016) and abundance (*p*=0.010) of epibionts were only recorded in coral reef areas wherein live shells exhibited higher epibiont richness while empty shells had higher epibiont abundance. Surface cover of epibionts did not differ between live and empty giant clam shells. Results imply that empty giant clam shells in coral reef areas can also function as settlement substrates for epibionts to enhance biodiversity of the area.

**BEHAVIORAL DIFFERENCES IN POPULATIONS OF PLECTROGLYPHIDODON LACRYMATUS (PERCIFORMES: POMACENTRIDAЕ) IN RESPONSE TO PREDATION RISK**

**Manogan D**, Cabaitan P, Stiefel K, Pineda R, Naval P,

The presence of predators is known to impact the behavior of prey animals, and their impact is altered by habitat parameters. In the marine ecosystems, many coral reef habitats have been degraded with reduced coral cover, substrate complexity and abundance of predators. Yet, few previous studies have examined the influence
of the variability in the benthic assemblage structure and abundance of predatory fish on the behavior of reef fishes. This study examined the variability in the boldness-aggressive behavior of *Plectroglyphiodon lacrymatus* in two reefs with contrasting reef condition and abundance of predatory fishes. *P. lacrymatus* is a farmer damselfish, which was abundant in reefs with fewer predatory fish and lower coral cover (e.g., Bolinao, Pangasinan), and was less abundant in reefs with higher coral cover and more predatory fish (e.g., Bauan, Batangas). Video-based surveys were conducted in situ to record the interaction between *P. lacrymatus* focal individuals and predatory fishes at the two reef sites. Another experiment was conducted to examine the variability in boldness-aggressiveness behavior of *P. lacrymatus* if a predator fish model, i.e., grouper *Cephalopholis microprion*, is placed inside their farms. Boldness is defined as the behavioral response to risky situations, measured by the number of bites taken per minute, whereas aggression defined as the inclination to be aggressive towards another individual was assessed both by the time the organism spent hiding and time spent one body length away from the stimuli. Initial results revealed that *P. lacrymatus* individuals were more bold and aggressive in high-risk environments, i.e., Bauan, compared to farmer damselfishes in low-risk environment, i.e., Bolinao. Results highlight the role of the environment in shaping reef fish behavior and the importance of fish behavior in indicating the conditions of reefs.

FISHERY DEPENDENT SURVEY OF FISHING GEARS AND FISHES CAUGHT ALONG MACONACON, ISABELA

**Emperador P, de Peralta G,**

The fish fauna of the Philippines has been focusing on researching its freshwater systems. There is limited study on fishes found in some isolated coastal areas in the Philippines such as Maconacon, Isabela. This study mainly aimed to provide a baseline data on the fishing gears and fishes caught along Maconacon, Isabela. The study was conducted in 7 coastal barangays of Maconacon (Aplaya, Canadam, Diana, Eleanor, Fely, Malasin, and Minanga) from October 2017-January 2018. Data gathering was conducted through an interview among the fishermen with the use of questionnaires. Five (5) main types of gears were identified with gillnet being the most dominant. The dominance of gillnet may be due to its ability to target different fish species with specific sizes which are preferred by the fishermen and less effort required in operating it. There were 6 orders identified with 24 families and 31 species of fishes and 2 species of crustaceans caught by the respondents. The highest contributing species in terms of family is the family Carangidae and Lutjanidae. The fishermen’s profile along the study area were identified and their monthly income was ₱5,000. It was found that the municipal fishermen along the selected barangays were facing problems such as high cost of operation, lack of government support and lack of fishing gear materials.

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government support and lack of fishing gear materials.

RARITY OF THE “COMMON” CORAL POCILLOPORA DAMICORNIS IN THE
PHILIPPINES
Torres A, Rondolo I, Gotanco R,

Extensive phenotypic plasticity and intraspecific variability generally confounds
identification of the common reef-building cauliflower coral *Pocillopora damicornis*,
a species complex of several mitochondrial lineages that has been recently formally
delineated into five species. With the revision of species boundaries, this study
surveyed genetic lineages within *Pocillopora damicornis* sensu lato (Veron and
Pichon 1976) in the Philippines. Employing a PCR-RFLP assay of the mitochondrial
control region and sequencing of the mitochondrial open reading frame (ORF) for
lineage identification, we examined 1,002 *P. damicornis* s.l. colonies from 25
locations across the Philippine archipelago to characterize the distribution of
Pocillopora species in the region. Results confirm the occurrence of *P. acuta*
populations in the Philippines and reveal the rarity of *P. damicornis* s.s. Of the
colonies assayed, 73% (n = 726) were reclassified as *P. acuta* while no *P.
damicornis* sensu stricto (Schmidt-Roach et al. 2014) was detected among the
samples. Sequencing the ORF for a subset of the samples (n = 152) corroborates
these findings and further reveals the presence of at least three *Pocillopora* species
(*P. verrucosa, P. meandrina, and P. brevicornis*) among the samples unresolved by
the PCR-RFLP assay. A minimum-spanning haplotype network of Pocillopora ORF
(n = 57 unique DNA sequences; 854 bp length) suggests the limited distribution of
*P. damicornis* to colder water environments of higher latitudes. This study highlights
the need to revisit the distributional ranges of this extensively studied species
complex and the necessity of using genetic information for taxonomic identification
where morphological identification is unreliable.

CATCH TREND OF DOLPHIN FISHES, CORYPHAENA HIPPURUS LINNAEUS
AND CORYPHAENA EQUESILIS LINNAEUS MONITORED BY NATIONAL
STOCK ASSESSMENT PROGRAM IN REGION XII, PHILIPPINES
Donia E

This paper reports on the catch trend of dolphin fishes based on stock assessment
in Sulawesi Sea, Moro Gulf and Sarangani Bay monitored by National Stock
Assessment Program in Region XII. This study was conducted to determine the
abundance of the two species under family Coryphaenidae; *Coryphaena hippurus*
Linnaeus and *Coryphaena equesilis* Linnaeus. *Coryphaena hippurus* or the common
dolphin fish was the most dominant species rather than *Coryphaena equesilis* other
knows as pompano dolphin fish. Results shows during the years of operations, high production was observed in 2015 for *Coryphaena hippurus* Linnaeus and 2014 for *Coryphaena equesilis* Linnaeus. However, a decreasing trend for both species was observed in 2016. It was shown in the analysis of fish samples caught an average of 65.3% immature in Sulawesi Sea and 79.4% immature in Sarangani Bay which did not even reach its length at first maturity.

**SPECIES ASSOCIATION ANALYSIS BETWEEN ECONOMICALLY IMPORTANT BIVALVE GAFFARIUM PECTINATUM AND SNAIL TEREBRALIA SULCATA ALONG SONNERATIA MANGROVE PEG ROOTS**

Querijero B, **Cudiamat M**, Duman L, Apolinar A,

Mollusks are ecologically significant in playing an important role in mangrove ecosystem structure dynamics. Abundance and diversity of mollusks have been historically used as an indicator of ecosystem health and local biodiversity in mangroves. Despite their ecological and economic importance, there are few specific quantitative data on the ecology of mollusks in mangroves and many of these species are suffering from the threat of extinction. Thus, there is an urgent need to examine the biology, ecology and as well as the socio-economic value of these macrobenthic communities to understand the impact of disturbance for future conservation and fishery management.

This study aimed to assess the relationship between two economically important mollusks: *Gaffarium pectinatum* (bivalve) and *Terebralia sulcata* (snail) and *Sonneratia* stand of mangroves in a community-managed mangrove forest in Calatagan, Batangas. Twenty (20) 1 x 1 m quadrats were established purposively from an overwashed mangrove forest characterized by a sandy-muddy substrate. A total individual species of 280*G*. pectinatum and 346*T*. sulcata were collected non-quantitatively by hand from the roots and substrate around the stand of *S. alba* mangroves. Species association analysis was carried using Pearson correlation and linear regression model. The model reveals that as the number of *Sonneratia* peg root increases the abundance of the mollusks also increases which shows direct relationship between the mangrove and mollusks. The statistical analyses show that the two molluscan species are significantly associated with *S. alba*. The results of the study can serve as basis for future conservation planning and sustainable aquasilviculture activities. Further studies may also be done to determine the indicator value of these molluscan species.

**TEMPORAL PATTERNS IN PREDATORY FISH ABUNDANCE IN RELATION TO BENTHIC COVER IN THE BOLINAO-ANDA REEF COMPLEX**

**Campos C**, Cabaitan P, Quimpo T, Requilme J, Sayco S, Albeda R, Calle L, Gomez R, McGlone M, Sy E, Manogan D,

The Bolinao-Anda Reef Complex (BARC) is a heavily degraded reef site due to chronic disturbances such as mariculture and fishing. Large-bodied predatory fishes that play pivotal roles in reef ecosystems through top-down control are particularly susceptible to fishing, which may be exacerbated by habitat loss. As such, understanding the link between predatory fish abundance and benthic cover in the BARC is essential to gauge the sensitivity of predatory fishes to degrading habitat
conditions. Here, we examined patterns of piscivore abundance in relation to benthic cover in the BARC over an 8-year period (2010-2017) using underwater visual census and phototransect method. Results suggest that there were temporal differences in the abundance of the top four species (*Cephalopholis urodeta, Labracinus cyclophthalmus, Epinephelus merra* and *Lutjanus decussatus*), with the highest abundance recorded during 2014 and 2015, while the lowest was recorded during 2016. These fluctuations in fish abundance were likely associated with the variations in hard coral cover as the 2016 bleaching event greatly reduced coral cover in the BARC. The dependence of predatory fish abundance on coral cover may be associated with shelter use as fish use corals for resting and ambush sites. This suggests that aside from direct extraction due to fishing, predatory fishes in the BARC are also sensitive to changing habitat conditions, and without proper management interventions, predatory fish communities in the area may continue to decline.

**INTRASPECIFIC COMPETITION BETWEEN BLUE CORALS HELIOPORA COERULEA**

Ligson C, Cabaitan P, dela Cruz D, Harrison P,

Intraspecific competition among corals is poorly investigated despite its relevance to the generation of phase-shifted reef ecosystems with altered benthic composition and function. More reefs are becoming dominated by a variety of non-coral organisms, or with few to single calcifying and non-calcifying coral species. For example, in Mallinup and Cangaluyan reefs of the Bolinao-Anda Reef Complex, northwestern Philippines, several areas have been dominated by the non-scleractinian blue corals *Heliopora coerulea*, wherein overlapping adjacent colonies are common. Yet, the outcome of interactions between *Heliopora* colonies is not well understood. The goal of this study is to understand how intraspecific competition in blue corals takes place over a short period of time. We followed allogeneic responses between 10 adult digitate blue coral colonies (mean diameter = 34.2 ± 5.3 cm) ex situ by establishing all 45 possible between-colony combinations in replicates, with additional 10 isogeneic contacts. All pairs were photographed every two weeks to monitor rejection responses, such necrosis, bleaching, suture, and outgrowth. Competition outgrowth was measured periodically to compute for competitive index to describe the aggressiveness of each colony. After four months, initial results reveal that blue coral colonies have different and changing levels of competitiveness that is not fixed through time. Moreover, the blue corals exhibited a non-transitive network of dominance among the colonies. Majority of the allogeneic responses resulted to outgrowth with few notable bleaching and necrosis in one or both of interacting partners, while most isogeneic contacts resulted to fusion.

**SPATIAL AND TEMPORAL BEHAVIOUR OF PYRODINIUM BAHAMENSE VAR COMPRESSUM IN HONDA BAY, PALAWAN**

Avillanosa A, Sumeldan J, Delgado J, Creencia L,

This study visualized the spatial and temporal behaviour of *Pyrodinium bahamense var compressum* in Honda Bay. Using free available GIS software, interpolated images of cell density of this dinoflagellate were created which showed coastal
waters where the dinoflagellate proliferates most (mean=88 cells/L) and months where it proliferates less (mean<1 cell/L). This study only presented the mean density of *Pyrodinium bahamense var compressum* from 2013 to 2018. Further study on its correlation with other environmental factors is highly recommended.

**PHYTOPLANKTON COMPOSITION ON SELECTED SHALLOW MARINE ECOSYSTEM IN VERDE ISLAND, PHILIPPINES**

*Magtibay A, Vacarizas J, Binay J,*

Phytoplankton has a crucial role in maintaining the biodiversity of marine ecosystem. They serve as food for zooplanktons and cetaceans, absorbs majority of CO$_2$ on the planet and an important bio indicator of change in water component. As considered to be the center of the center of marine shore fish biodiversity, assessment of phytoplankton diversity in Verde Island will serve a baseline information of the condition of its marine ecosystem. Four selected sites i.e., coral reef and seaweed-seagrass beds were chosen in determining the phytoplankton diversity. Two replicates in each sites were collected and preserved using Lugol’s iodine. Physicochemical parameters such as temperature, pH, salinity, and dissolved oxygen of selected sites were measured. Thirty-three (33) genera of phytoplankton belong to major group of diatoms, dinoflagellates and cyanobacteria were identified. Genus of *Thalassiosira*, a potential HAB (Harmful Algal Bloom) forming phytoplankton, were found to be abundant in the second selected sites, while genus of *Navicula*, a common genera found in marine environments, almost dominates in all stations.

**BEACH FOREST CHARACTERIZATION IN BARANGAY SAN AGAPITO, VERDE ISLAND, BATANGAS CITY, PHILIPPINES**


Beach forest play important roles in sustaining coastal ecosystems and local communities. It serves as barrier to the increasing effects of climate change such as sea level rise, increased temperatures, and shifts in rainfall patterns. Despite being the greenbelts bestowing protection on coastal communities, beach forests are less studied in the Philippines and access to studies on its disappearing vegetation is limited. The Verde Island Passage merited the distinction of being the center of the world’s marine shore fish biodiversity. Its priority level in terms of conservation was elevated from high to extremely high. This study was conducted to determine the biological characteristics of beach forest in San Agapito, Verde Island. Transect lines measuring from 100 m to 200 m with 10x10m quadrats were established in the site. A total of 37 specimens of 10 different tree species were identified. The three most dominant species include *Morinda citrifolia* L., *Cocos nucifera* L. and *Azadirachtha indica*. *Morinda citrifolia* L. has the highest abundance of 9.0 and relative abundance of 0.24. It also has the highest density of 1.13 and relative density of 24.32%. On the other hand, the value for the highest frequency and relative frequency of species found within the sampled quadrats were 0.63 and 62.50 % which is attributed to *Cocos nucifera* L. It also has the highest species importance value of 81.61. In terms of mean diameter breast height and mean
height, *Terminalia catappa* L. has the highest value of 173.80 cm and 90.98 m. The overall species richness is 2.49 while 0.81 for species evenness. For Shannon-Wiener index, it has value of 2.01 and 0.13 for Simpson index. There is no documented study pertaining to these parameters as vegetation characteristics in Verde Island. This, therefore, can be a baseline data for future studies on beach forest community structure. Furthermore, marine protected area can be established and managed through community-based approach.

**SPATIAL AND TEMPORAL BEHAVIOUR OF PYRODINIUM BAHAMENSE VAR COMPRESSUM IN PUERTO BAY, PALAWAN**  
**Avillanosa A, Sumeldan J, Delgado J, Creencia L,**

In this study, map images showing bloom of Pyrodinium bahamense var compressum along Puerto Bay were generated using free GIS software. The monthly dynamics of dinoflagellate in terms of relative abundance is shown. Continuous and regular monitoring of the Bay is recommended to correlate species abundance and environmental factors for possible prediction of harmful algal bloom.

**PHYTOCHEMICAL SCREENING OF MARINE SPONGES COLLECTED FROM BOHOL AND SAMAR**  
**Faiwas J, Rojo J, Topor V, Campos W, Piloton R,**

Ethyl acetate extracts of 22 marine sponges collected from Bohol and 21 samples from Samar were subjected to phytochemical screening. Secondary metabolites such as alkaloids, terpenes, flavonoids, saponins, glycols, and aromatic compounds were determined using spray reagents and thin layer chromatography (TLC) in hexane:ethyl acetate (8:2) solvent system. On the other hand, glycosides and sterols were determined using Keller Kelliani's and Liebermann-Burchard test, respectively. Among the samples collected from Bohol, all twenty-two (22) samples were tested positive for flavonoids, terpenes, saponins, and glycosides. Sixteen (16) marine sponges were positive for sterols and aromatic compounds, while seventeen (17) were positive for glycols. Twenty-one (21) sponge samples from Samar share the same results with Bohol sponges for flavonoids, terpenes, saponins, glycols and glycols. Sixteen (16) samples were positive for sterols and only fourteen (14) for aromatic compounds. Differences in environment as well as microorganisms associated with sponges can be factors for the different results between same species of sponges. The results will guide the selection of sponge samples for further study that could lead to isolation of lead compounds for medicinal chemistry and drug discovery.

**DIVERSITY AND DISTRIBUTION OF ECHINODERMS IN THE INTERTIDAL AREAS OF SAMAL ISLAND, DAVAO GULF**  
**Fortaleza M, Ang G, Aquino F, Consuegra J, Lanutan J, Nañola, Jr. C,**

Biodiversity assessments involving macro-invertebrates receive little attention despite their ecological importance in marine ecosystems. Here, we present
baseline information on diversity and distribution of echinoderms from opportunist surveys in six intertidal and shallow water areas around Samal Island, Davao del Norte. Live echinoderms encountered along the 50-m belt transect laid in mid to low intertidal zones were recorded and photographed for identification. Characterization of habitat types was also included to discuss factors that affect their distribution. Results of reef walks and surveys accounted for a total of 22 species representing 16 families. The presence and number of echinoderm species found in a particular area is highly dependent on the habitat type. Out of 22 species recorded, 6 are known to have economic importance, either harvested for subsistence or for aesthetic value. The presence of a corallivore Acanthaster planci is also noted on two sites. This study provides a list of echinoderm species in the intertidal areas of Samal Island at present time, which may be valuable for future biodiversity assessments, as well as studies on the taxonomy, biology, and distribution of representative echinoderm species at a larger scale.

FORMATION OF AN ACETES-NEOMYSIS OFFSHORE, HIGH DENSITY PATCH WITH SUBSEQUENT FEEDING OF A WHALESHARK (RHINCODON TYPUS) AGGREGATION
Torres D

This poster documents opportunistic observations on the formation of an Acetes-Neomysis offshore, high density patch in Honda Bay, Puerto Princesa City, Palawan. While snorkelling about 6 km offshore at around 3PM, solitary, pinkish fist-sized aggregations were observed just below the sea surface. Within a span of two hours, the aggregations had continually fused into larger dimensions, eventually spanning >1 ha and >10m depth. The aggregation was later identified as composed of Acetes and Neomysis. Although not present initially, whalesharks (Rhincodon typus) began to be observed at about 4PM, with at least six sharks frenziedly surface feeding on the offshore, high density patch. Darkness at around 6PM occluded any further observations. No fisherfolk were seen in the area throughout the observation period. Despite being a singular event, this documentation hopes to elicit further research necessary for conserving Acetes and Neomysis in offshore settings, while highlighting the ecological and economic importance of these genera.

COMPARISON OF ZOOPLANKTON DIVERSITY AND ABUNDANCE IN “HAB” COASTAL WATERS OF CARIGARA BAY AND “NON-HAB” COASTAL WATERS OF SAN PEDRO BAY, LEYTE, PHILIPPINES.
Marilao G, Yap-Dejeto L,

The relationship between zooplankton diversity and abundance to Harmful Algal Bloom (HAB) phenomenon was investigated. In this study, simultaneous assessments were performed in two bays in Leyte: Carigara (CB) and San Pedro (SPB) bays. Physico-chemical parameters between the two showed no significant difference between the two datasets (t test, Ŝ±=0.05). Qualitative and quantitative samples were collected using a plankton net and a bucket, respectively. Using a Sedgewick-rafter counting chamber, all samples were viewed under an electric compound microscope and all zooplankton individuals were counted in each concentrated sample. Initial results show a total of 57 species present (36 and 54
species in CB and SPB, respectively), amounting to 1,900 individuals (600 and 1,300 individuals in CB and SPB). Most abundant zooplankton in CB was found to be copepod eggs while calanoid and cyclopoid nauplii were the most abundant in SPB. The most abundant zooplankton taxon in CB was found to be Acartiidae while Tintinnidae was most abundant in SPB. Pyrodinium bahamense count amounted to 2,900 cells in CB alone and none in SPB. Statistically, CB showed a significantly lesser zooplankton number (z-test, $\alpha=0.05$) with an average of $2.80 \times 10^3 \pm 600$ individuals per liter, compared in San Pedro bay with an average of $6.43 \times 10^3 \pm 3400$ individuals per liter. Shannon-Weiner Diversity and Pielou’s Evenness index values were lower in CB (2.67±0.26 and 0.46±0.05, respectively) than in SPB (2.99±0.37 and 0.51±0.06) while Menhinick’s Richness Index value showed higher in CB (4.74±1.95) than in SPB (2.91±0.73).

OTOLITH AGE AND BODY SIZE RELATIONSHIP AND MATURITY OF SCARUS NIGER IN DAVAO GULF

Almario K, Nañola, Jr. C,

Dusky Parrotfish, Scarus niger aids in coral reef health by feeding on algal cover however it is being fished for human consumption all over the country including Davao Gulf. This study aims to determine the age and body size relationship and sexual maturity of S. niger in Davao Gulf to provide basic biological information about the fish species to serve as inputs for its management. Monthly fish samples were collected from May 2018 to December 2018 from local wet markets and fish landing sites around Davao Gulf area. Individual standard length (SL cm), total length (TL cm), weight (W gm) were measured. Otolith was extracted for direct age measurement. A total of 228 fish were recorded with SL ranges from 10 to 26cm. Analysis using the FiSAT software, provided the following parameters: infinity length ($L_\infty=26.25$); growth coefficient ($K=0.33$/year); natural mortality ($M=0.9$/year); total mortality ($Z = 1.01$/year); fishing mortality ($F = 0.11$) and exploitation rate ($E = 0.11$). The inferred recruitment pulses were twice a year with gonadosomatic index (GSI) peaks during the months of August and October. Sexual maturity was estimated at 12 cm (SL). For the direct otolith age readings, the computed $K=0.39$. The growth coefficient values generated using different approaches yielded very close results. This suggest good quality of the estimates obtained. Furthermore, it was estimated that full sexual maturity occurred at age 7 at approximately 24 cm SL. This study suggests that for the fishery management of S. niger, not lower that 24 cm SL must be caught and or encourage to have a close fishing seasons during their spawning period sometime between August and October of each year.

INFERENCENCE ON MANGROVE HABITAT UTILIZATION BASED ON TROPHIC STRUCTURE AND LIFE STAGES OF FISH COMMUNITIES CAUGHT ALONG MANGROVE FRINGES IN SOUTHERN GUIMARAS, PHILIPPINES

Malingin M, Campos W,

The function of mangroves in nursery role, providing food and protection to many coastal fish species is well accepted. These fish fauna, utilize mangrove habitat differently, as well as interacting in complex ways in the adjacent habitats. As such, the role of the mangroves can inferred from the characteristics of the fish
communities that move in and out of them. In this study, weekly samples of catches from several fish corrals set close to the mangrove fringe in the vicinity of Taklong Island National Reserve (TINMAR), Southern Guimaras were monitored along from March 2011 - April 2012. Most fish species caught were invertebrate feeders while the abundance of different fish groups across months vary relatively. Most juveniles occur towards end of Northeast Monsoon while many adults were caught in Southwest Monsoon. Further analysis on the temporal variability of trophic structure and life stages are examined. Insights on the apparent patterns are also discussed in relation to the relative importance of the mangrove habitat in the areas of the marine reserve and its proximity.

UPDATED STATUS OF GIANT CLAMS IN THE PHILIPPINES

Giant clam populations have declined because of overharvesting and other disturbances. This has led to their listing in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). In the Philippines, it has been 34 years since the last nationwide survey of giant clams was conducted. To provide an updated status of giant clams in the country, selected sites in Luzon (i.e., Bolinao, Anda, Alaminos, Zambales, Batangas, Calaguas, Apo Reef, and Palawan), Visayas (i.e., Cebu), and Mindanao (i.e., Camiguin and Samal) were surveyed. Giant clam diversity and abundance were assessed along transects at 1-15 m depth in selected coral reef areas at each site. Initial results showed that Tridacna crocea, T. maxima and T. squamosa were common at all sites. Hippopus hippopus and H. porcellanus were recorded in Apo reef and Palawan while T. derasa were only recorded in Apo Reef. T. noae, a species previously confused with T. maxima, was observed in Bolinao, Batangas, Calaguas, Palawan, Camiguin, and Samal. Individuals of the largest species, T. gigas, which was deemed virtually extinct in the country since the 1970s, were not observed at any of the surveyed sites except in Palawan. However, natural recruits from restocked T. gigas were reported in Anda, Alaminos, Batangas, Camiguin, and Samal. Apo Reef had the highest diversity of giant clams with six of eight species present. Calaguas had the highest abundance with a clam density of 0.04 individuals/m² compared to the other sites where density was typically 0.01 individuals/m². Updated information on the local distribution, abundance, and diversity of giant clams is essential for establishing protection and management strategies for this endangered species.

OCCURRENCE OF TRIDACNA NOAE (RÖDING, 1798): FIRST RECORD IN SAMAL ISLAND, PHILIPPINES
Tabalanza T, Edullantes C, Sobradil R, Gumanao G,

The giant clam species, Tridacna noae (Röding, 1798) has been defined and revived from synonymy with T. maxima (Röding, 1798). Rosewater (1965) thought T. noae was only a variant of T. maxima based on its shell structure. This has raised confusion of the two species in the past that may have led to overestimates of their population and significant overlap of geographic distributions as the two species
can be found living in the same locality. We observed the occurrence of two individuals of *T. noae* both in protected and unprotected sites in Samal Island, Philippines. It is distinguished by the shell morphology and highly distinct mantle patterns. The hyaline organs are sparsely distributed in the mantle and numerous brown oval patches bordered by thin white or lightly colored ring-like margins are located along mantle edge. The mantle patterns of *T. maxima* are also featured in this study. The identification of this rare species constitute the first record of *T. noae* in Samal Island.

**POPULATION BIOLOGY OF THE FRINGED FALSE LIMPET, SIPHONARIA LACINIOSA IN THE INTERTIDAL AREAS OF CATAGMAN, SAMAL ISLAND, DAVAO DEL NORTE**

*Palmare T, Nañola, Jr. C,*

*Siphonaria laciniosa*, commonly known as the fringed false limpet, is found in rocky, intertidal shores, serving as a biological and ecological indicator in intertidal communities. Limpets are potentially gleaned for its aesthetic value and its accessibility as a source of food for locals, which can affect its population structure. This study aims to describe the population dynamics and structure of *S. laciniosa*, in Brgy Catagman, Samal Island. A total of 1697 species were measured in a span of 11 months. Analysis have shown that recruitment peaked during May with $K = 1.7$ and $L_{\text{au}}$ of 19.43mm. The study provides baseline information for the population biology of the *Siphonaria* genus.

**MEIOFAUNA ABUNDANCE AND COMMUNITY STRUCTURE AS AN INDICATOR OF ORGANIC ENRICHMENT ASSOCIATED WITH DENSELY POPULATED COASTAL AREA**

*Del Socorro A, Flandez A,*

Meiofaunal samples as well as sediment and water physico-chemical properties were assessed in Palompon Bay, Leyte to determine the relationship between environmental variables and meiofaunal assemblage across areas with varying degree of exposure to possible sources of organic enrichment. Station 1 was established adjacent to the commercial, residential and fish farming areas while station 2 which was about 300 m away from the town was located in the intertidal area of Tabuk Islet Marine Sanctuary. Station 3 was established in a seagrass meadow located on the other side of the islet and is ideally sheltered from various anthropogenic impacts. Results from non-metric multi-dimensional scaling (MDS) showed meiofauna from station 1, which had the highest organic matter content (>1%), plotted closely together and was significantly different among other stations with low organic matter. Since meiofaunal groups are sensitive to the concentration of organic matter present in an area, absence of pollution-sensitive meiofaunal groups such as Amphipoda, Kinorhyncha, Tardigrada, Copepoda and Nauplii could indicate possible organic enrichment in the area. Additionally, dissolved oxygen was significantly low in station 1 (5.7 mg/L) and was negatively correlated with meiofauna abundance and diversity. Trend between nematode to copepod ratio and organic loading was likewise evident as copepod numbers decreased while nematode numbers increased along the gradient of increasing organic levels. These distinct
meiofaunal assemblage could indicate sensitivity to organic enrichment and highlights its usefulness as a bioindicator.

POCILLOPORIDS DOMINATING CORAL RECRUITMENT IN CAPE BOLINAO DURING TWO MONSOONAL SEASONS
Albelda R, Cabaitan P,

Coral community assemblage and structure is a product of natural and human-induced factors that may influence the survival of coral recruits in a certain area. Natural factors include currents, light, and temperature which may differ between monsoonal seasons and depth; human-induced factors, on the other hand, include nutrient enrichment and pollution which may be brought about by the presence of mariculture. This study aims to assess the vertical (shallow and deep) and horizontal spatial (study areas situated near and far from mariculture) and temporal (northeast and southwest monsoon of 2018) variations in coral recruitment in Cape Bolinao, Philippines. In addition, this study aims to investigate the correlation of adult coral and benthic covers to coral recruitment. Results show that pocilloporids dominate coral recruitment in all study areas regardless of depth, monsoon season and proximity to mariculture. Furthermore, the presence of high adult coral cover seemed to positively correspond with high coral recruitment in the study areas. However, the most abundant adult coral family (Poritidae) did not produce the greatest number of coral recruits (Pocilloporidae). This study provides new insights on the different factors which may influence coral recruitment variation.

SCLERACTINIAN CORALS OF CUATRO ISLAS, LEYTE, PHILIPPINES IN EDGE AND IUCN RED LIST OF THREATENED SPECIES
Tuang-tuang J, Cesar S, Montes H,

Cognizant that coral species are among the threatened marine fauna, specific coral species had been added for the first time in the IUCN Red List of Threatened Species in 2007. Cuatro Islas, in Leyte, Philippines is among the NIPAS sites and the coral reefs had been monitored since 1994. The species list IUCN and Evolutionary Distinct and Globally Endangered (EDGE) corals was extracted from data through time using different methods with the latest monitoring adopting the NACRE-SHINE modified photo-transect method on May to October 2018. The surveys were conducted in four (4) randomly identified coral reef areas per island. The transect photographs were scored in Coral Point Count with Excel extensions software using the Taxonomic Agglomeration Units (TAUs) to quantify the biodiversity and percentage covers and know the taxonomic composition. Fimbriaphyllia ancora, Heliofungia actinoformis, Pachyseris rugosa and Physogyra lichtensteini were the IUCN Red List and EDGE coral species. This science-based documentation of their presence should be integrated in the ecological management to balance the developmental undertakings that is leaning to economic activities.
COMMUNITY STRUCTURE OF MANGROVES IN SAN FRANCISCO, CAMOTES ISLAND, CEBU, PHILIPPINES
Mazo A, Rosales R, Montes H, Almine N,

The community structure of the mangroves in San Francisco, Camotes Island, Cebu was studied using transect line-plot method to determine the species composition, abundance and diversity in the area. A total of ten (10) mangrove species belonging to six (6) families were recorded in the area. Among the ten (10) species, Rhizophora stylosa had highest relative density (29.91%), while Sonneratia alba had highest relative dominance (41.78%) and importance value (87.76). Species diversity (H',A') value is 1.44. Saplings of Rhizophora mucronata had highest density (2,500 saplings ha⁻¹) while Avicennia marina had the highest seedling density (22,500 seedlings ha⁻¹).

RESILIENCE OF MANGROVE SPECIES TO HEAVY METAL POLLUTION: THE CASE OF PAGATBAN RIVER, BAYAWAN CITY, NEGROS ORIENTAL
Aparece J, De Leon R,

Pagatban River was polluted with heavy metal tailings from mining industries before, and although operations have already ceased for three decades already, heavy metal levels, especially copper, are still beyond the acceptable levels. This study focused on the resilience of mangrove species to heavy metal pollution at the mouth of Pagatban River by quantifying its diversity and abundance. Bayawan River, which has no history of heavy metal pollution, was used as the control. Both rivers were sampled using the transect-plot method and analyzed using the Wilcoxon Rank Sum Test. The copper content of the sediments in both areas were also determined using the total extractable heavy metal analysis by Flame Atomic Absorption Spectrophotometry. The results found out that there is still a significant amount of copper found in the sediments of Pagatban River, however, this does not have a significant effect on the diversity and abundance of mangrove species, suggesting its resilience to heavy metal pollution and its role as an effective phytoremediator.

ENVIRONMENTAL CHANGE DEDUCED FROM SEDIMENTARY DEPOSITS OF DEAD FOREST IN BORACAY
Rañada M, Elegado A, Bejasa K, Bautista VII A, Mendoza N, Jaraula C,

Boracay Dead Forest is said to be a product of ecological disturbance leaving dead tree trunks emerging from its stagnant waters with only a narrow fringe of live mangrove trees left. Unfortunately, due to unplanned development in the island, the rapid growth of population and irresponsible tourism activities continuously degraded the environment for decades. Recent reclamation of its mangrove areas and the poor solid waste and sewage management of the residential and commercial establishments within and surrounding the wetland decimate the lush forest to the “Dead Forest” it is called now. We analyze core sediments of the Dead Forest to further understand biogeochemical changes in the sediments that evolve alongside the historical changes within the wetland in relation to natural processes and anthropogenic activities that occurred for the past years. Three sediment cores were collected from the mouth of the wetland, a catchment of water from the Dead
Forest, for physical characterization and chemical analysis. Initial findings from color, texture, and material composition in the sediment samples indicate environmental changes during its deposition that are correlated with known historical accounts and impacts to sediment biogeochemistry. Further analysis of organic compounds, metal composition, and bulk carbon and nitrogen isotope analyses of the sediments, as well as age-dating techniques, are currently performed to provide enough evidence on the evolution of the Dead Forest.

SEDIMENT RECORD OF PRECIPITATION AND THE OVERTOPPING OF THE SURIGAO STRAIT BASED ON XRF DERIVED GEOCHEMICAL-proxy

Buen S

Deep marine sediments may provide insights on past climate and oceanographic events. Knowledge of past events can aid in scenario setting of future climate and their oceanographic consequences. For this study, a sediment core retrieved from the western side of Bohol Sea was analyzed using an XRF core scanner at 1cm resolution. Five radiocarbon dates from bulk organic matter provide age control spanning back to the Last Glacial Maximum. Relative abundances of Ti, Al and ratios of Ti/Al, Zr/Al and K/Al are used as sediment input proxies. Sediment input was decreasing from 20-15 ka, followed by a relatively stable trend until ~9ka. After ~9ka sediment input again increased up until the most recent years. This sedimentation trend follows the winter insolation curve at 10°N. This signifies that the sediment input record reflects the general changes in precipitation in the area. A shift in the characteristics of sediment composition (K/Al, Al, Ti) coincides with the expected timing of the overtopping of the Surigao Strait during the overall rise of sea level from the LGM to about 6 ka. The overtopping of the Surigao strait would have changed the circulation of Bohol Sea. Greater westward transport of suspended material from large rivers to the east would then contribute to sedimentation in the western part of Bohol Sea.

MARINE CRYPTO-BIOTA WITHIN THE CORAL REEF AREAS OF MALABUNGOT PROTECTED LANDSCAPE AND SEASCAPE

Dioneda R, Dioneda R, Dioneda R,

Many studies have been done on coral reefs to examine its fishes and diverse group of macroinvertebrates. However, insufficient studies were done to these cryptic organisms as they served specific functions to the reef system. This study assessed the crypto-fauna of Malabungot Protected Landscape and Seascape coral reef. Specifically, it estimated the calcified materials deposited in Autonomous Reef Monitoring Structure (ARMS), microscopically analyzed the samples for benthic diatoms, and evaluated the reef condition. The structure was deployed for 8 months and results showed a biomineralization in the ARMS caused by deposition of tubular calcareous materials secreted by polychaetes or tube worms. Species under phylum Annelida (48%) specifically polychaetes dominated the plates. This was followed by tunicates (22%), cnidarians (18%) and some species of mollusk (10%), crustacean (1%), and macroalgae (1%). Several benthic diatom species such as Asteromphalus sp., Navicula sp., Fragilaria sp., Paralia sp, Cocconeis sp., Coscinodiscus sp. Bacteriastrum sp., Gomphonema sp., Tropidoneis sp, Pleurosigma sp. and
*Nitzschia* sp were identified. Due to heavy siltation in the area, the unit were covered by mud allowing some macroalgae to thrive. Sedimentation adversely affects the coral reef area of MPLS based from the settlement unit preventing recruitment of corals and other sessile and motile organisms as observed within the ARMS. The ARMS allowed early stage of fish larvae to thrive. It is recommended to further expose the structure for longer time duration. Further research must be implemented in the future which include such microbial and genetics studies.

**CORAL REEF ASSESSMENT IN BONGAO, TAWI-TAWI**

Bara A, Halun S,

Tawi-Tawi is located in the Sulu Sulawesi marine ecoregion and is rich in natural resources. Unfortunately, the reefs of Tawi-Tawi are not well studied. This study assessed the hard coral cover and diversity of reefs in Bongao, Tawi-Tawi using the Photo-Transect Method. The images from the survey were processed using Coral Point Count with Excel extensions An average of 33 (± 4.7) genera were identified. The top ten coral taxonomic amalgamation units were *Acropora* branching, *Galaxea*, *Echinopora*, *Porites* branching, *Fungia*, *Pavona*, *Porites* massive, *Goniopora*, *Favites*, and *Isopora*. The average percentage cover of hard coral Bongao is 40% (±9.72) which suggests that the reefs in Bongao are in good condition.

**ECOLOGICAL KNOWLEDGE AND COMMITMENT ON MANGROVE CONSERVATION IN LIAN, BATANGAS: INPUT TO AN INCLUSIVE COMMUNITY-BASED EDUCATION**

Cudiamat M, Limjoco M,

Ecological education is an important aspect of Education for Sustainable Development (ESD) towards marine biodiversity conservation focusing on mangrove systems. Environmental awareness and commitment on mangrove forest ecosystem are two (2) considerations in the successful restoration of mangroves involving the academic community. This study aims to assess the ecological knowledge and commitment of the teachers on mangrove conservation in Lian, Batangas, a Verde Island Passage corridor. The study employed descriptive research and utilized survey questionnaire. Purposive sampling was used in selecting the one hundred twenty-five (125) respondents living nearby the mangroves in the District of Lian. The results of the study showed that teachers’ knowledge on mangrove conservation is sufficiently enough for them to provide capacity building to the community. Teachers showed a very high commitment on mangrove conservation through involvement and participation in the community. The study will serve as a framework in developing an inclusive environmental community-based education on mangroves for disaster preparedness and climate change mitigation for the benefit of the community and school stakeholders.
MAINSTREAMING MARINE BIODIVERSITY IN THE K TO 12 SCIENCE CURRICULUM OF THE DEPARTMENT OF EDUCATION
Cudiamat M, Hernandez C, Panganiban M,

Education plays a significant role in promoting biodiversity conservation especially in the Verde Island Passage (VIP), the world's center of the center of marine shorefish biodiversity. The Province of Batangas is one of the corridors of the VIP that is home to diverse marine organisms. This study aims to integrate marine biodiversity and conservation in the K to 12 elementary and high school science curriculum of the Department of Education. This was done through contextualization of the curriculum and integration of the different concepts of marine biodiversity and conservation practices in the lessons of the teachers across K to 12 science competencies in Grade 6-12 levels.

The topics contextualized from the science competencies include coral reefs, mangroves swamps, seagrass meadows, marine invertebrates and conservation and protection. Mainstreaming activities were done through marine fieldwork in the nearby seashore and mangrove park, interactive pedagogical approaches focusing on marine organisms and science fair and exhibits. The study will serve as an input towards developing an ecological-oriented curriculum for elementary, junior and senior highs school learners to motivate them to care and show love and concern for marine life.

THE BML ADOPT-A-CLAM PROGRAM: HELP SAVE THE LITTLE GIANTS
Esmolo R, Diamante V, Curiano Jr. J, Conaco C,

The giant clam conservation program of the Bolinao Marine Laboratory (BML) of the University of the Philippines Marine Science Institute (UP MSI) began in the 1980s. The success of the program to date may be attributed to the continuing research, training, and education activities spearheaded by researchers and students of UP MSI. However, a major challenge in sustaining these efforts is the lack of widespread community involvement and limited information dissemination. BML launched the Adopt-a-Clam Program in April 2018 in an effort to reach a wider audience. The program aims to raise public awareness and support for giant clam research, culture, and maintenance. Since its inception, the program has been featured at several public exhibits, various media outlets, and on social media. The program has elicited interest from multiple sectors, including students, resort owners, government officials, private companies, and even foreign donors. 34% of the donors were younger than 23 years old, 19% were between 24-42 years old. 42% of the individual donors were students. Most of the donations were in small amounts, with 56% donating P200 and 35% donating up to P500. The largest single donations were provided by NGOs and government agencies. These findings suggest that the crowdsourcing approach is an effective mechanism for disseminating information and for seeking funding support for the giant clam conservation effort. This approach is particularly valuable for reaching a younger demographic. Further improvements on the program will ensure its long-term success. In the future, this citizen science-based platform may also be applied towards obtaining public participation in documenting giant clams on Philippine reefs.
SEAGRASSES CONTRIBUTE TO FOOD SUPPLY OF COASTAL COMMUNITIES IN NUEVA VALENCIA, GUIMARAS

Lopez M, Unsworth R, Cullen-Unsworth L,

Coastal communities relied on coral fisheries as one of the major source for its food supply. But due to effects of climate change on these areas, it had been observed that fishers are now shifting to seagrasses and mangrove areas as their new fishing grounds.

As of now, only a handful of literature had been written about the role of seagrass meadows in providing food security to the coastal communities. This study aims to add to this limited number. The evidences presented here support this idea. Data gathered are from household surveys, fisheries catch and market surveys in Nueva Valencia, Guimaras.

The key results indicate that: a.) that more than 70% of the captured fishes are seagrass-associated; b.) preferred source of protein intake are fishes and other seafoods; c.) 80% of daily intake of household meals are seagrass associated fauna.

Findings from this study provide a good argument for the integration of seagrasses in marine protected areas as well as coastal management plans. Such integration, together with sound policies for sustainable fishing practices, will not only provide the coastal communities with food security but economic opportunities as well.

SOCIAL-ECOLOGICAL ANALYSIS OF SEAGRASS ECOSYSTEMS IN BONGAO, TAWI-TAWI

Sakilan A, Halun S,

Seagrasses provide food, habitat, and nursery areas for numerous animals, maintain water quality and stabilize sediments. Unfortunately, Seagrass ecosystems are declining globally because of anthropogenic threats and studies have shown a lack of appreciation for the value of these systems. This study examined the relationships between seagrass beds and people and the various roles seagrasses play in human wellbeing in Bongao, Tawi-Tawi using structured questionnaires and focal group discussions. We also conducted ecological surveys (seagrass cover and invertebrates) and gleaning landing surveys. Understanding seagrass meadows as a coupled social-ecological system is crucial in determining the priority areas in the planning and management of coastal areas and designing management programs that will promote sustainable use and conservation of seagrass beds.

REPRODUCTIVE CYCLE OF CANARIUM URCŒUS URCEUS LINNAEUS, 1758 (MOLLUSCA: GASTROPODA) IN LIANGA, BAY, EASTERN MINDANAO

Ruaza F

The reproductive cycle of Canarium urceus urceus in Lianga Bay was studied from the months of January 2017 to January 2018. This species is the most economically important gastropod that inhibit the Bay. Result revealed that this species majority were gonochoric. Also, almost all months have gonads with developing and ripe
stages, which indicates that spawning could be year round. The peak of spawning of this species is during the months of February- April and September- November. As for management and sustainability of this resource, closed season for collection will be enforced to allow for the replenishment of the stocks.

CAPACITY-BUILDING ON REEF ASSESSMENT AND CORAL TAXONOMY: A TRAINING MODULE FOR CORAL COVER AND BIODIVERSITY ASSESSMENTS

Coral reef assessments are essential for conservation and management efforts but have been severely hampered by a lack of consistent methodology and site selection criteria, low taxonomic resolution, and a dearth of trained personnel. Capacity-Building on Reef Assessment and Coral Taxonomy (C-BRACT) aims to address these issues by empowering local stakeholders to conduct reef assessments through a robust training program. The C-BRACT program is a set of dynamic training modules designed and implemented by experienced personnel from the Synoptic Investigations of Human Impacts on Nearshore Environments (SHINE) project, the coral-focused arm of the recently completed Nationwide Assessment of Coral Reef Environments (NACRE) program. The training modules cover the assessment process from conception and experimental design through fieldwork and data processing, using the methods employed by NACRE-SHINE. The program also has a unique focus on coral taxonomy, including genus-level identification of known Philippine corals and species-level identification of vulnerable and evolutionarily distinct species. Implementation of the C-BRACT training program for academic, government and non-government personnel is recommended as an initial step to creating a standardized national system of reef assessments and distribution maps of various coral taxa. It also provides the basis for a nationwide reef monitoring program.

THE SEACRET GARDEN: AN ONLINE DISCUSSION PLATFORM FOR CORAL GARDENING ISSUES
Garcia-Castro S, Gutierrez A, Garcia E, Luzon K, Licuanan W,

The recent National Assessment of Coral Reef Environments (NACRE) revealed that we have lost one-third of the coral reefs in the last 40 years and that there are no more excellent reefs in the category. Despite this alarming report, there is a prominent shortage of integrated implementation of effective and adaptive conservation methods for our coral reefs and a surplus of restoration practices that are seemingly geared towards reef restoration. Among these restoration practices is coral gardening, a method that requires the collection of fragments or corals of opportunity (COPs) and replanting them in degraded reefs. Coral gardening has been rolled-out in various coasts in the country but there is disagreement coming from key coral reef experts on the ecological and financial viability of coral gardening. The Seacret Garden is a web and infographic video project that was created with the aim to inform and raise awareness on the current state and decline
of the Philippine coral reefs, while exploring the issues that come with coral gardening. This project was created in order to aid the protection of the Philippine coral reefs by presenting the issues and challenges that come with coral gardening, and by bringing to light concrete actions that can be taken that, in the long term, could further the cause for proper reef conservation.

COASTAL FISH CATCH ANALYSIS FOR STA. CRUZ, DAVAO DEL SUR, SOUTHERN PHILIPPINES

Giray E, Estaña L, Mendez Q, Rizon J, Nañola, Jr. C,

The Philippine waters are known to be rich in natural resources which makes increased fish production possible. Marine protected areas (MPAs) are established all over the country to ensure management and conservation of fish production through legal means, hence establishing more sustainable fishing practices. In fact, the Davao Gulf located in Southern Philippines which comprises four cities and 16 municipalities, have many MPAs and the income of most households living near the coasts of its coastal barangays comes from fishing. However, Philippine fisheries across the years has showed signs of depletion in fish production especially in the municipal level. One of the municipalities in Davao Gulf is Sta. Cruz, Davao del Sur which is considered the study area of this study. Thus, this paper investigated the determinants affecting coastal fish catch across varying catch levels of the fishermen of Sta. Cruz, Davao del Sur, Southern Philippines. The fish catch determinants used are effort in days, capital cost, other cost, boat length and type, and training. Quantile regression approach was utilized to analyze the differences of the determinants affecting fish catch across varying catch quantiles. Catch levels were classified into three quantile distributions with the model coefficients having varying effects across different quantiles. Varied factors were found to be significant determinants of fish catch across different catch levels. This study is part of CHED DARE TO Project which aims to address the sustainability of reef fisheries in Davao Gulf.

ANALYSIS OF COASTAL FISH PRODUCTION DURING NORTHEAST MONSOON: THE CASE FOR SAN ISIDRO, DAVAO ORIENTAL

Mendez Q, Estaña L, Giray E, Rizon J, Nañola, Jr. C,

The Philippines is one of the top fish producing countries in the world and its fisheries sector is one of the main sources of food supply and income for Filipinos living near the coasts. Marine protected areas (MPAs) have been established in the country due to signs of depletion and degradation of different marine resources such as fish biodiversity and coral reefs. Despite the establishments of MPAs, however, a continuing decline in fishery production has been observed in the country. Hence, there is a need to determine which of the coastal fishery inputs have significant effects on coastal fishery production. A survey was conducted in this study to investigate for the said inputs. The study site is San Isidro, Davao Oriental which is one of the several municipalities of Davao Gulf which is located in Southern Philippines. Davao Gulf is rich in coral reefs and hence, there are many MPAs within the site. The Cobb-Douglas and Trans-Log stochastic frontier production functions were used to study the relationship between the inputs and the output. Results show
that some of the inputs such as boat length, fishing effort, fishing gears, and food consumption were significant drivers of fishery production.

‘COPING UP WITH THE HARD WAYS’ – FISHERS’ PREFERENCE FOR MANAGING A SCALLOP FISHERY

Camaya A, Bobiles R, Soliman V,

Contrary to popular notion, the long experience by fishers of poor law enforcement could lead them to prefer hard, contentious measures for fisheries management. Addressing tough management options remains a plausible advocacy among local fishers in sustaining a declining, highly-exploited fishery. To examine this, a community-level coastal vulnerability assessment was conducted in Naro Island, Cawayan, Masbate using a comprehensive pre-tested questionnaire to scallop fishers. Factor analysis revealed that scallop fishers prefer largely a suite of technical measures of which the first three components were composed of coastal zoning, size regulation, and close season, followed by prohibition on gathering of young scallops combined with mangrove reforestation and establishment of new MPA and enhancing management of existing ones. Scallop fishers are economically impoverished and have lower years in-school with less opportunity for formal study. They spent multi-years in fishing and the middle-aged and married fishers were dominant in number. Upon presentation of these findings in the town’s law-making body the Sangguniang Bayan, the local government considered the passage of a close season ordinance that prohibited gathering of scallops in December to March when the animals are reproducing within the Cawayan municipal waters. Challenges remain in enforcing the ordinance, providing livelihood to fishers and evaluating whether the ordinance contributes to stock enhancement and improved yield.

NATURAL DIET OF SARDINES DUSSUMIERIA ACUTA (VALENCIENNES, 1847), HERKLOTSICHTHYS QUADRIMACULATUS (RÜPELL, 1837) AND SARDINELLA GIBBOSA (BLEEKER, 1849) FROM WEST PHILIPPINE SEA.

Iguana L, Palla H,

Understanding the diet of fish is vital in evaluating its place in the trophic level. The diet composition, feeding intensity as well as the feeding variation of sardines, *Dussumieria acuta*, *Herklotsichthys quadriraculatus* and *Sardinella gibbosa* from West Philippine Sea were examined from January to December 2018. Overall, a total of 104 specimens comprising three species with stomach content were investigated. The number of stomach of fish ranged from 5 for *D. acuta*, 32 for *H. quadrimaculatus* and 67 for *S. gibbosa*. The diet of *D. acuta* falls into two main categories: crustaceans and fish while squid is negligible. Acetes sp. dominated the diet of *D. acuta* (%Index of Relative Importance=55.18%), while for *H. quadriraculatus* shrimp was the most important (%IRI=62.17%) similarly shrimp dominated the diet *S. gibbosa* (%IRI=50.36%). There was preponderance of empty stomach in all the months. Feeding intensity of *D. acuta* was low for almost 94% of stomachs collected, while in *H. quadriraculatus* the percentage of empty stomach was 43% and for *S. gibbosa* was 83% empty. The feeding of *D. acuta* varied between squid and shrimp with 60% of their diet, while for *H. quadriraculatus* shrimp was more abundant (36%) and for *S. gibbosa*, Acetes sp. was the most important diet. Overall, the three species studied mainly preyed on crustaceans,
whereas fish was of secondary importance. Five preys items were identified from three species studied.

TIME-SERIES ASSESSMENT OF HIGHLY IMPACTED COASTAL AREAS USING EARTH IMAGING DATA FROM THE ONLINE PLATFORM, PLANET.COM
Custado M, Jacinto G,

Earth imaging data have become much more accessible in recent years and provide information on coastal areas at an unprecedented spatial and temporal resolution. Trends and changes offered by these images can be a valuable complement of on-site monitoring efforts that acquire biological, physical and chemical data often constrained by finite human and financial resources. We explore the data available from Planet.com, a website providing non-commercial access to satellite images to academics. We show the value of remotely acquired images of sites using daily, monthly, and quarterly composites spanning a year or several years to complement our understanding of well-studied sites (e.g., Bolinao, Pangasinan and Manila Bay), and areas that are well known, controversial or even politically sensitive. We discuss how the imaging data provide exciting possibilities to support the work of terrestrial and marine scientists and researchers, coastal managers, law enforcers, planners, fisheries authorities, the military, legislators, and even the public at large.

HARD CORAL COVER AND CORAL DIVERSITY OF ISLA VERDE: RESULT OF FIRST ASSESSMENT AND PLAN FOR ESTABLISHING MONITORING STATIONS
Vacarizas J

Isla Verde or Verde Island of the province of Batangas, Philippines is located in the middle of Verde Island Passage which is known for its very high shore fish biodiversity. Despite of increasing environmental threats (illegal fishing, tourist activities, and climate change) in the island, the status and health of its coral reefs, which provides wide range of benefits to fish and humans, have not been monitored. This information is vital for the purpose of reef protection and possible management strategies. Baseline information on coral diversity of Isla Verde is also still lacking. The marine research center of Batangas State University, the VIP CORALS, presents here the result of initial survey of hard coral cover and diversity of corals in reef flat of Isla Verde using the method of Coral Reef Targeted Research and Capacity Building for Management (CRTR) Program. Locations of monitoring stations were randomly selected based on aerial photographs taken using drone which gives insight on the extent of the reefs in the island. It is planned to monitor the reef areas of Isla Verde every 6 months and information gathered from every sampling will be relayed to local government units for appropriate policies and action plan.
ESTABLISHMENT OF AN OYSTER RECRUITMENT AREA AS AN ALTERNATIVE AND SUSTAINABLE LIVELIHOOD OPTION IN COASTAL COMMUNITIES IN PALAWAN

Avillanosa A, Caipang C,

Coastal communities are mainly dependent upon goods and services of natural ecosystems for food and livelihood. Promotion of alternative sustainable livelihood can serve as control measure for unsustainable wild-harvest fisheries. A coastal community in Palawan was identified and used as a model for the establishment of an oyster recruitment area because an earlier survey showed the abundance of oyster spats at certain times of the year. Initial study on the recruitment of oyster Crassostrea sp. in spat collectors at sites in Roxas, Palawan as basis to ensure continuous availability of seed stocks. Results of this study will provide a valuable information supporting further development of oyster culture in Palawan.

THERMAL TOLERANCE OF FISH-PARASITIC GNATHIID ISOPODS IN THE CENTRAL PHILIPPINES

Shodipo M, Sikkel P,

Extreme warming events that result in coral bleaching are occurring with increasing regularity, and the effects of these events on coral reef biodiversity have received considerable recent attention. However, as with other studies on coral reef ecology, parasite-host interactions are typically ignored. Extreme warming events can have significant effects on host-parasite interactions through their effects on mortality and performance. Gnathiid isopods are common external parasites of coral reef fishes that feed only during the juvenile stage. Like terrestrial mosquitoes and ticks, they are highly mobile blood-feeders that associate only temporarily with hosts, and thus may be considered “micropredators”. The goal of this study was to examine the effects of simulated bleaching conditions on survivorship of gnathiid isopod juveniles. Gnathiids were collected using light traps set on shallow fringing coral reefs (<10m) of Cangmating, Agan-an and Bantayan in Negros Oriental in the central Philippines, and sorted by size into two size classes (< 2mm, and > 2 mm). Individuals were then allowed to feed on host fish (Labridae and Pomacentridae ), and assigned to one of five temperature conditions, ranging from ambient (28°C) to 36°C in the first trial, and 30°C to 35°C in the second. Containers were heated gradually over a 10 hour period to their desired temperature, and inspected daily for mortality until all gnathiids were dead or until 20 days. Rapid mortality for large (>2mm) and small size classes (>2mm), occurred from 35°C, and 34°C respectively. Given that some fishes can tolerate temperatures up to 40°C, these results suggest that bleaching events may have more of an impact on gnathiids then their fish hosts. Further studies are needed to examine sub-lethal effects such as behavior and reproductive performance and at other localities to determine the generality of these findings.
COMPETITION AMONG REEF BENTHIC BIOTA WITH VARYING PROXIMITIES TO MARICULTURE FARMS IN BOLINAO, PANGASINAN

McGlone M, Manaid J, Quimpo T, Sayco S, Cabaitan P,

Competition among sedentary benthic biota for space on the substratum is one of the ecological processes that influences community structure of reef ecosystems. The ability of scleractinian corals to successfully maintain space without being out-competed is dependent on numerous processes, one of which is the local environmental conditions. Nutrient enrichment brought about by nearby mariculture farms may change environmental conditions, and hence alter competitive outcomes. To observe the potential effects of mariculture farms on benthic competition, four sites within the Bolinao-Anda Reef Complex of varying proximities to mariculture farms: near (Lucero and Cangaluyan, 4-5 km away), and far (Balingasay and Magsaysay, 10-12 km away) were surveyed. Photo transects of the benthic community at 5-7 m depth were conducted in each site and were subsequently analyzed for the identification of competitive pairs, i.e. (1) two scleractinian coral colonies or (2) scleractinian colonies versus other benthic biota (i.e. Octocorallia, macroalgae, and turf algae). Competitive encounters were then classified as either win-lose situations or a draw between both organisms. Initial results show that competition between two scleractinian colonies was less frequent in all sites than competition between scleractinians and other biota, with other biota having the competitive advantage in most encounters. Competition between scleractinians and macroalgae/turf algae was found to be particularly heightened in areas near the mariculture farms, specifically in Lucero, and in most of these interactions, algae almost completely overgrew the corals. Results suggest that proximity to sites of mariculture farming likely heightens competition between scleractinians and other benthic biota such as algae in the Bolinao-Anda Reef Complex. Mariculture farms may have altered the environmental conditions allowing other biota to be more competitive than corals, which in turn may lead to detrimental effects on coral community structure and shifts to alternate reef states with the continuation of mariculture activities in the area.

MICROBIAL BIOFILMS FACILITATE ATTACHMENT OF HABS-CAUSING SPECIES ON FLOATING PLASTICS DEBRIS IN VITRO

Tolentino M, Onda D,

Floating marine plastics provide a durable and persistent substrate for the colonization of microorganisms, which is initiated by the formation of bacterial biofilms. These biofilms provide attached microbial assemblages access to organic matter, protection from environmental stress, metabolic cooperation with other microorganisms, enhanced horizontal gene transfer, and enhanced opportunities for dispersal. Eventually, biofilms drive the succession of other micro- and macroscopic organisms, creating highly diverse and complex community assemblages that are taxonomically distinct from the surrounding seawater. Among the communities on floating marine plastics are potentially harmful algal blooms (HABs) -causing species, indicating the potential role of plastics in the increased global occurrences of HABs. In this study, we determined the role of biofilms on the attachment and viability of the toxic dinoflagellate *Alexandrium sp.* on polyethylene (PE) plastic fragments. We compared the rate of attachment of the dinoflagellates on plastic
fragments coated with and without bacterial biofilms. The structural and physiological mechanisms for attachment of the cells on the plastics were characterized by high resolution imaging using confocal laser scanning microscope (CLSM) and scanning electron microscope (SEM). Results showed microbial biofilms could indeed facilitate the faster attachment on plastic fragments and sustain viability of the cells. This study is a significant contribution to the growing knowledge on the ecological implications of floating marine plastic debris as a new environment in marine ecosystems.

GENETIC DIVERSITY AND ASSOCIATION OF AMOEBOPHRYA SPP. (SYNDINIALES) WITH HOST DINOFLAGELLATES IN MARICULTURE-IMPACTED AREAS
De La Cruz M, Onda D,

Recently, Amoebophrya (Syndiniales), a group of marine eukaryotic parasites known to infect dinoflagellates including those of harmful algal species, has been gaining interest for its natural potential to control dinoflagellate blooms. However, our understanding of their diversity and host specificity in terms of infections remains incomplete since many of their hosts are uncultivable. In addition, recent environmental surveys using high throughput sequencing has steadily reported new sequences of the parasite, but with no reports in Southeast Asia including the Philippines. Therefore, we investigated in this study the genetic diversity of Amoebophrya present in mariculture-impacted areas using culture-independent methods complemented with high-resolution microscopy. The frequent HABs occurrences as well as the diversity of the species associated with the blooms in mariculture areas provided an opportunity to address gaps on the diversity of phylotypes of Amoebophrya as well as explore its potential as natural control of HABs. Further, host association of the phylotypes present was explored using high-resolution microscopy. Lastly, phylogenetic affiliations of the generated sequences were determined. Results were able to confirm the presence of Amoebophrya in mariculture areas. This study provides baseline information on the ecology and diversity of Amoebophrya in tropical waters.

GEOMETRIC MORPHOMETRIC ANALYSIS ON THE SHELL OF GREEN MUSSEL (PERNA VIRIDIS) FROM TWO CULTURING SITES IN CAVITE PROVINCE, PHILIPPINES
Velasco D, Gamier D, Dalisay T, Saco J,

In certain regions of the world, aquaculture has been practiced and continuously being developed due to increasing demand for it. In the Philippines, bivalve production has been popular in which green mussels are being cultured. Green mussels (Perna viridis), locally known as “tahong”, has been a valuable source of food and livelihood in the country. However, water pollution is also continually paving its way in posing a threat to the marine environment especially in most culturing sites of green mussel. Thus, the study tries to determined morphological variations on the shell of P. viridis using traditional measurement and geometric morphometric analysis and their relationship to the physicochemical parameters of the waters from two culturing sites in Cavite Province, as possible effects of water quality to the
green mussel. ImageJ was used to process the traditional measurement of the shells. In addition, the geometric morphometric analysis was used to statistically analyze shape variation within and among samples based on their digitized landmarks and procrustes superimposition to remove size difference were used. In addition, the physicochemical parameters of the waters were tested i.e., temperature, salinity, pH, and turbidity. Results showed that the dimension of the shell in terms of length and width are relatively similar from both sites. Also, the physicochemical parameters of the waters from both culturing sites seem to be relatively similar. Moreover, the principal component analysis showed that there was no significant difference in the digitized landmarks on the green mussel shell from both collecting sites in two successive collections. Furthermore, there is no significant relationship between the geometric morphometric of P. viridis and the physicochemical parameters of the waters from the two culturing sites. This implies that the shell morphology of green mussel might have a high tolerance to the different marine environment.

MAPPING OXYGEN DEPLETION IN BOLINAO AND ANDA, PANGASINAN

Sotto L, Rayos Del Sol M, San Diego-McGlone M, Villanoy C, Jaraula C, Jacinto G,

Eutrophic conditions have often characterized the waters of Bolinao and Anda, Pangasinan due to extensive milkfish farming in the area. Increased nutrients and organic matter input from feed wastage have been observed in the channel as well as depleted oxygen levels which often lead to fish kills resulting to millions of losses. The most recent fish kill was in June 2018 resulting to 110 M in losses and recorded occurrences almost annually. Surface, bottom, and water column average dissolved oxygen (DO) values according to the following criteria were compiled for the area: DO < 5.0 mg/l, DO < 2.0 mg/l, and DO <0.5 mg/l representing low, hypoxic, and near anoxic dissolved oxygen conditions, respectively. The frequency of DO levels meeting these criteria per station was then mapped out to show the stations which often have low, hypoxic, or near anoxic dissolved oxygen conditions representing mid to high-risk areas for oxygen depletion, respectively. There are 3 stations along Guiguianen Channel and 1 station along Caquiputan Channel that have low dissolved oxygen most of the time (<50%). The station along Caquiputan Channel also exhibited hypoxic and near anoxic dissolved oxygen levels at least once throughout the different field outings. The areas that are often at risk for oxygen depletion are along channels that have restricted flow and increased organic matter input due to the mariculture activities.

ACIDIFICATION OF WATERS IN BOLINAO-ANDA, PANGASINAN

Tamayo N, Isah R, Magyaya R, San Diego-McGlone M,

There are global and local sources of anthropogenic CO₂ in seawater. In the coastal waters of Bolinao, Pangasinan where mariculture activities have operated for over two decades, the local CO₂ input far outweighs global contribution. Fish farming activities in the area have been linked to eutrophication, algal blooms, and fish kills. Unregulated fishing practices have resulted to wasted feeds that end up in the marine environment thus contributing to high organic load that when decomposed release CO₂ and cause seawater pH to decrease (acidification). This study aims to
assess the spatio-temporal changes in carbonate and other environmental parameters in Bolinao-Anda where mariculture activities could affect adjacent coastal ecosystems (coral reef, seagrass beds).

For both wet and dry seasons, nutrients (e.g., nitrite, phosphate, ammonium), chlorophyll-a, total alkalinity (TA), dissolved inorganic carbon (DIC), and pCO$_2$ were higher in the mariculture area than in coral reef and seagrass areas, while dissolved oxygen (DO), pH, and aragonite saturation were lower in the mariculture area. In addition, nutrients and chlorophyll-a in the mariculture area were twice higher than the ASEAN Marine Water Quality Criteria Value. TA, DIC, and DO were higher during the dry season, while nutrients and pH were higher during the wet season. During the dry season, pH was low at 7.44 and DO at 2.08 mg/L in the mariculture area in Anda, Pangasinan. Organic parameters (e.g., dissolved organic carbon, chromophoric dissolved organic matter, and particulate organic matter) were also determined. TA, DIC, and pCO$_2$ showed strong positive correlation with nutrient parameters - particularly with phosphate, having a Pearson correlation coefficient of 0.885, 0.759, and 0.916, respectively. On the other hand, pH, DO, and aragonite saturation were negatively correlated with nutrient parameters. This shows that nutrient loading in mariculture areas is correlated with increases in organic matter inputs and its attendant CO$_2$ production. The pH levels now seen in Bolinao-Anda are projected values for what will be seen at the end of this century.

SCREENING CORAL SPECIES RESILIENT TO MULTISTRESSOR IMPACTS (ACIDIFICATION, WARMING, EUTROPHICATION)


Corals significantly contribute to global biodiversity and the local economy. However, they are faced with natural and anthropogenic stressors including threats from climate change. This study screened 17 selected coral species from the Bolinao-Anda Reef Complex by examining effects of ocean warming (T), ocean acidification (OA), and increased nutrient (anthropogenic nutrient-coastal acidification stress or ANS-COA) on growth and survivorship. Coral stress tolerances were ranked based on coral’s direct (survival), and other physiological responses (i.e. growth rate, zooxanthellae density, and photosynthetic efficiency). Those ranked “7” had the highest stress tolerance, and “1” was lowest. Nine of the coral species ranked “6” under high ANS-COA (A. digitifera, A. tenuis, H. coerulea, H. rigida, M. scabricula, P. cylindrica, P. decussata, F. colemani, F. halicora). Instead of a direct decline in survival, most of the corals exposed to ANS-COA stress exhibited decline in other physiological responses. For OA, 6 coral species were ranked “7” (A. tenuis, H. coerulea, M. digitata, S. pistillata, P. cylindrica, P. lutea). Upon exposure to T, highest rank was only “5” for 3 species (F. colemani, H. coerulea, M. digitata, P. lutea). When exposed to OAT, the highest rank was “5” for only 2 species (F. colemani, H. coerulea), and “1” for 6 species (A. digitifera, A. millepora, A. tenuis, P. damicornis, S. caliendrum, S. pistillata). Results of the study suggest that corals exhibited lower tolerance to thermal stress (T) compared to ocean acidification (OA). However, majority of the corals tested exhibited a drastic decline in their stress tolerance at exposure to synergy of ocean acidification and thermal stress (OAT).
RECENT TRENDS OF CARBONATE PARAMETERS IN A MARICULTURE AREA OF BOLINAO, PANGASINAN
Lagumen M, Aguilar J, San Diego-McGlone M,

In the last 3 years, monitoring of the carbonate parameters from a fixed station in Bolinao, Pangasinan has been carried out as an addition to the water quality monitoring conducted in waters affected by mariculture activities. Samples were collected daily and analyzed for nutrients namely NO$_3^-$, NO$_2^-$, PO$_4^-$, NH$_4^+$, Si(OH)$_4$; chlorophyll-a; and carbonate parameters namely total alkalinity (TA) and pH. Other carbonate parameters such as pCO$_2$, dissolved inorganic carbon (DIC), aragonite saturation and Revelle Factor were calculated using the CO2Sys program. The 3-year data showed seasonal variability of TA and DIC, supersaturation of CO$_2$ parameters during dry season and undersaturation in wet season relative to the atmosphere. The variability can be attributed to mixing of seawater with riverine water and precipitation during wet season and biological activity in the dry season. The 3-year data showed a decrease in TA by 0.13 unit per year which suggests a decrease in the buffering capacity of Bolinao waters. On the other hand, pH data gave an estimate of -0.0002 pH unit per year or a decrease in the rate of acidification for these waters.

INDIVIDUAL AND INTERACTIVE EFFECTS OF OCEAN ACIDIFICATION AND WARMING ON THE ADULT TROPICAL CORAL, FAVITES COLEMANI (VERON, 2000)
Tanedo M, San Diego-McGlone M, Villanueva R,

The occurrence of ocean acidification acting in synergy with ocean warming emphasizes the need to understand how tropical corals will respond to predicted near future changes in seawater temperature and pH. This study examined individual and synergistic effects of present-day seawater pH (8.0) and temperature (28°C) along with IPCC predicted near-future ocean scenarios of decreased seawater pH (7.7) and increased seawater temperature (32°C) on the adult Favites colemani in Bolinao, Pangasinan. Coral growth rates, Symbiodinium densities and maximum photosynthetic efficiencies were more adversely affected by temperature than ocean acidification, with ocean acidification exhibiting a significant effect only on coral growth. Symbiodinium in Favites colemani were of clade C, and did not change before and after exposure to pH-temperature treatments. This suggests that impending threat of acidification in the area may pose detrimental impact on species growth and distribution. Interestingly, there was no mortality observed with Favites colemani after exposure to lower pH (7.7) for 28 days, while survival was still 66.7% under ocean warming, and co-occurrence of ocean acidification and warming. The observed physiological behavior suggests that F. colemani may still persist amidst projected near-future ocean acidification and warming.
SPATIO-TEMPORAL SHIFTS IN THE COMMUNITY STRUCTURE OF BENTHIC DIATOMS IN THE EUTROPHIC WATERS OF BOLINAO, PANGASINAN

Baure J, San Diego-McGlone M, Junio-Meñez M,

Mariculture in Bolinao, Pangasinan had adversely affected the surrounding waters, increasing nutrient input, and thereby decreasing pH. Such phenomenon may pose threats on marine organisms by affecting their physiology and ecology. Diatoms, as primary producers, serve as food for larval and juvenile species, thus any alteration brought about by environmental factors might affect food quality and feeding. In the present study, the community structure of benthic diatoms near and away from fish cages was investigated. Sites near fish cages were found to have lower levels of pH, chlorophyll-a and dissolved oxygen (DO), but have higher levels of nutrients, such as NO₃⁻, NO₂⁻ and PO₄³⁻. Glass and polycarbonate slides were deployed at four (4) different sites around Santiago Island, Bolinao, and were sampled after 1, 3 and 6 days. Analysis of variance showed significant differences in biomass among sites, with sites near fish cages having higher biomass. A total of twenty (20) diatom genera were identified, with at least 9 genera occurring in all sites, dominated by Nitzschia, Navicula, Cylindrotheca and Amphora. This study shows that under increased nutrient input and lowered pH conditions, benthic diatom communities remain unaffected and even proliferated.

ACIDIFICATION FROM ‘MAX BUBBLES’ VENT IN TINGLOY, BATANGAS


The rising anthropogenic carbon dioxide (CO₂) in the atmosphere is accompanied by increase in oceanic CO₂ (pCO₂) and consequent decline in seawater pH also known as ocean acidification. Although anthropogenic CO₂ emission is the dominant driver of ocean acidification, low pH and elevated pCO₂ conditions can occur naturally. Such is the case in Tingloy, Batangas where natural volcanic vents or CO₂ seeps are present. This study examined one of the vents where huge bubbles or “max bubbles” come out. Carbonate and other water parameters (nutrients, chlorophyll) were determined. Water sampling was done along horizontal and vertical transects from the vent center radiating at a finer-scale distance of 10, 20, 30, 60, and 120 cm from center. Highest temperature recorded was close to center at 41.27°C. The horizontal transects showed a range of pH from 7.96 (10cm) to 8.04 (120cm) with small variability in total alkalinity (TA) and dissolved inorganic carbon (DIC). The pH value directly at the “max bubbles” vent was 6.4, TA and DIC were high at 4278.98 –µmol/kg and 8483.46 –µmol/kg, respectively. These levels will cause very low aragonite saturation state of <2 that will promote dissolution of CaCO₃. Tidal variability of pH was also observed with lower pH value of 5.49 seen during low tide. Overall, the signal of low pH in the “max bubbles” site was only observed within a small distance from the vent center. This may be due to strong water currents in the area that can readily dissipate low pH waters. Implications on
the biology of this area which is part of the Verde Island Passage, a very rich area of marine life and biodiversity in the world, are being examined.

BACTERIAL ASSEMBLAGE AND IMMUNE RESPONSES IN TOURISM-INFLUENCED CORALS
Nuñal S, Posadas N, Santander-de Leon S, Acabado C, Caigoy J,

Corals harbor highly structured microbiome and confer immune response strategies that contribute to their resiliency in perturbed environments. The symbiotic microbial assemblage have major roles in metabolic processes and adaptation to environmental changes. However, under stress, the bacterial complement of coral holobiont may undergo dysbiosis that is usually followed by the recruitment of opportunistic or pathogenic microbes. This activates the melanin synthesis pathway and Phenoloxidase systems of corals that have important roles in tissue integrity and disease resistance. These processes are usually accompanied by oxidative burst that produce cytotoxic intermediates. As a response, corals produce free radical scavenging enzymes to convert toxic ROS to reduce oxidative stress. Since Philippine coral reefs are continually exposed to multiple environmental and anthropogenic stressors, understanding the immune responses of coral holobionts will provide hints on the factors and processes causing their anomalous mortality. To describe responses in corals influenced by tourism-associated stressors, bacterial community composition and biomarker enzyme activities of healthy and bleached Acropora, Seriatopora and Porites samples collected from two identified coral reef sites that are pristine (Unisan, Guimaras) and tourism-influenced (Boracay Is., Aklan) within Panay island, Philippines were evaluated. 16S rRNA gene fingerprinting revealed shifts in the bacterial community composition of holobiont among samples and between sampling sites, suggesting that shifts are linked to coral morphology and genus. Furthermore, biomarker enzymes involved in melanin cascade and radical scavenging were investigated to determine susceptibility of these corals to diseases. Crude enzyme extracts of coral samples from tourism-influenced site generally showed significantly higher activities than those collected from pristine environment. The results also suggest that tourism-related stressors may have induced dysbiosis and pathogen recruitment due to the correlated activities of enzymes associated to melanin synthesis. Findings of this study highlights the negative impacts of tourism on the health and landscape of reef systems.

COMPARISON OF 3M™ PETRIFILM™ COLIFORM COUNT PLATES, IDEXX® QUANTI-TRAY, FIELD INCUBATOR SET-UP, AND MULTIPLE TUBE FERMENTATION TECHNIQUE IN THE QUANTIFICATION OF E. COLI AND TOTAL COLIFORM IN WATER
Artuz E, Jacinto G, Ong J, Manalo M, Jaraula C,

The need for a viable method for the quantification of microbial counts in water especially in distant and inaccessible areas where laboratories are absent limit the application of standard methods of analysis. The advent of rapid count methods for Escherichia coli and total coliform greatly enhance analytical techniques in terms of faster testing time, wider range of applications, and elimination of confirmatory testing, and are thus preferred especially in fieldwork. Comparison of four different
methods, 3M™ PetriFilm™ Coliform Count Plates, IDEXX® Quanti-Tray, Field Incubator Set-up, and Multiple Tube Fermentation Technique, for the determination of E. coli and total coliform was performed using different water samples. 3M™ PetriFilm™ Coliform Count Plates was employed as the method of choice for the enumeration of E. coli and total coliform counts in Boracay.

SURVIVAL OF THE CORALLINE LITHOTHAMNIIUM SP. UNDER LONG-TERM LOW-PH CONDITIONS

Narvarte B, Roleda M,

The increasing atmospheric CO₂ has led to the increased level of dissolved CO₂ in the ocean. The concomitant reduction in pH is known as ocean acidification (OA). This phenomenon also contributes to the increase in HCO₃⁻ concentration and decrease in carbonate saturation state. Such changes in the chemistry of seawater have several impacts on marine life. The physiological response of calcifying algae to this global stressor may have an ecological implication because of their roles as shelters, reef-builders and primary producers. Calcifying algae are vulnerable to OA because their carbonate skeletons are susceptible to dissolution. The calcifying red alga Lithothamnium sp., collected from Bolinao, Pangasinan, was cultured under two pH treatments. The low pH treatment (target pH= 7.65; measured pH = 7.45-7.85) was achieved by bubbling the aquarium with mixed CO₂ while ambient (pH 8.0) was achieved by bubbling air. The growth, inorganic content and calcification rate were measured. Interestingly, Lithothamnium sp. survived long-term exposure to extremely low pH.

CAN LOCAL GOVERNMENT POLICY SAVE OUR CORAL REEFS FROM PLASTIC POLLUTION?

Cabaitan P, Manaíd J, Alcantara C, Tambihasan A, Dagum L, Park E, Sayco S, Gomez R, Quimpo T, Conaco C,

Coral reefs are frequently exposed to both natural and anthropogenic disturbances. In recent years, plastic pollution has emerged as one of the most pressing concerns facing coral reefs worldwide and is associated with increasing occurrence of coral diseases. Reef sites that are frequented by tourists are particularly vulnerable to plastic pollution. Yet, little information is available on the extent of this problem and its impact on Philippine reefs. Here, we surveyed eight reef sites at two National Integrated Protected Areas System (NIPAS) locations, one with an existing local government policy to manage plastic waste and one without, but both experiencing heavy tourist traffic. The prevalence of plastic debris in the water column and on reef substrates, as well as the partial mortality of coral colonies, was quantified using the photoquadrat method. The two NIPAS locations exhibited indications of successful management of fishing pressure, as the two had similar reef fish community structure with the abundance of commercially important herbivore fishes. However, we observed more floating plastic debris in the water column and entangled with the corals at the NIPAS location with no existing local policy on plastic waste management, in comparison to the other location where tourists were given incentives to dispose of garbage properly. There was no correlation between the
prevalence of plastic debris and the frequency of partial mortality of corals at the sites. The prevalence of plastic debris was generally higher on reefs directly in front of resorts. Thus, strategies that encourage tourists and resorts to assist in the proper management of solid waste appear to be successful in minimizing plastic pollution. These results suggest that effective implementation of local policies may be essential in saving our reefs from the emerging plastic problem.

LONG-TERM RECORD OF WATER QUALITY IN GUIGUIWANEN CHANNEL, BOLINAO, PANGASINAN (2002-2018)

Aguilar J, Lagumen M, San Diego-McGlone M,

The rise in fish farming activities in the coastal waters of Bolinao, Pangasinan from the early 1990s climaxed in 2002 with the occurrence of a major fish kill event that coincided with an algal bloom. This was the impetus to monitor water quality in Bolinao waters on a regular basis. Monitoring has been deemed important to provide warnings for impending algal blooms and fish kills linked to eutrophication. It was also meant to check if local regulations on carrying capacity for number of fish pens and cages have become effective. The long-term (16 years) record on water quality of Bolinao waters is based on samples collected daily from a permanent station along Guiguiwanen channel. Samples were collected for nutrient (ammonium, nitrite, nitrate, phosphate, silicate) and chlorophyll determination, and more recently carbonate parameters (pH, total alkalinity, dissolved inorganic carbon). Concentration levels are compared to the ASEAN criteria to determine if they are within allowable limits. The long-term record shows that water quality conditions in Bolinao have remained eutrophic, the biggest manifestation of which are the algal blooms of both toxic and non-toxic species, and fish kills that continue to occur. There is also seasonality, with higher concentrations of chlorophyll-a and nutrients observed during wet seasons for most years with values exceeding the ASEAN criteria. An increasing trend in average phosphate values from 2011 to 2018 is seen. Recent (2016-2018) annual ammonium concentrations are significantly higher compared to earlier years (2002). Mean nitrate values significantly decreased from 2002 to 2018. Changes in N:P ratio seem to be associated with occurrence of various algal blooms and fish kill events. Long term changes and annual trends in water quality conditions are meant to help guide policy makers in efforts to achieve sustainability in fish farming activities.

EFFECTS OF LOW PH ON THE PHYSIOLOGY AND BIOCHEMISTRY OF KAPPAPHYCUS SP.

Mendones S, Roleda M,

Anthropogenic atmospheric emissions of CO₂ are responsible for ocean acidification (OA), which have important impacts on marine fleshy macroalgae and coastal ecosystems. Different eucheumatoid species are farmed in the Philippines for their carrageenan. The effect of high CO₂/low pH on the physiology and biochemistry of wild Kappaphycus sp. collected in Bolinao, Pangasinan was investigated under long-term cultivation in the laboratory. The low pH treatment (target pH= 7.65; measured pH = 7.11-7.82 was achieved by bubbling the aquarium with mixed CO₂. while ambient (pH 8.0) was achieved by bubbling with air. Growth was not
significantly affected by OA and increased availability of dissolved inorganic carbon species. Our results suggest neutral effect of extreme low pH on the growth rate of fleshy macroalgae. However, different biochemical parameters may be affected by OA.

CORAL SETTLEMENT AND POST-SETTLEMENT PROCESSES IN A SUBMARINE GROUNDWATER DISCHARGE (SGD) SITE IN MABINI, BATANGAS, PHILIPPINES

Maningas J, Lim R, Rodriguez M,

Coral settlement and post-settlement processes are important in understanding coral recruitment and population structure of coral communities. These processes are reduced by ocean acidification, an effect of global climate change due to the increased carbon dioxide emissions. Naturally occurring submarine groundwater discharge (SGD) in the Verde Island Passage, has been noted to discharge low pH groundwater (pH 6). This feature exhibits acidic condition, a projected impact on coral reefs in the year 2100. In this study, we aimed to examine coral settlement and other benthos in SGD site. Twenty settlement plates were deployed on the substrate for in 2018. However, after 4 months of deployment, it was observed that no coral recruits settled on the plates retrieved from each site. The tiles retrieved from the low pH side showed only 24% covered by benthic organisms on face up and bottom down side of the plates. The plates were dominated by macroalgae at 28.15%, followed by bryozoans and other living organisms such as polychaetes and mollusks at 18.02%, and coralline algae at 7.92%. Preliminary investigation in this ecosystem suggests an alteration of dominant settlers from calcifying organisms to fleshy algae. Therefore, coral settlement is limited in SGD, a characteristic of future reefs where acidification.

COMPARISON OF ESTIMATED CARBON IN DIFFERENT ABOVE AND GROUND BIOMASS FROM MANGROVE TREES IN AKLAN ECO-PARKS

Cabiguin M, Clemente J, Orizar I, Lagumen M, Munar J, McGlone M,

Mangroves provide essential ecosystem services that can mitigate climate change. One way to do this is by storing carbon from the atmosphere in their biomass. This study estimated the carbon content in different above and ground biomass of mangrove trees collected using litter traps deployed at the KII and Bakhawan Eco-parks in Aklan. The total organic carbon (TOC) content was estimated using loss-on-ignition method. Comparing different above ground sources, leaves had the highest estimated TOC compared to twigs in both sites. Results also showed that overall TOC was higher in the KII Eco-park. This may be attributed to the naturally grown, mature and bigger mangrove trees at the KII Eco-park compared to planted and smaller trees at the Bakhawan Eco-park. Larger leaves have larger surface area and thicker twigs that contribute to higher organic carbon content. Estimating carbon storage in mangrove ecosystems is important in projecting carbon loss when these ecosystems are destroyed.
CONDITIONS AFFECTING CARBON STORAGE IN MANGROVE LEAVES AT KATUNGGAN IT IBAJAY (KII) AND BAKHAWAN ECO-PARKS, KALIBO AKLAN
Clemente J, Orizar I, Munar J, Lagumen M, Cabiguin M, San Diego-McGlone M,

Mangrove forests play a big role in mitigating climate change contributed by carbon emissions by storing carbon above and below-ground. This study aims to estimate carbon content in mangrove leaves of Sonneratia alba, Rhizophora sp., and Avicennia sp. Leaves were collected and then exposed to different conditions (exposed to air and submerged in water) for three months at the Bakhawan and KII Eco-parks. Total organic carbon (TOC) content was determined using Loss on Ignition method. When compared to TOC values of fresh leaves obtained from a previous study, those submerged in water had higher organic carbon content. For both areas, leaves submerged in water showed higher %TOC compared with leaves hung in air. The difference in %TOC between submerged leaves and leaves hung in the air is 0.41% in Bakhawan and 0.26% in KII. Submerged leaves have higher %TOC probably due to resorption from the carbon-enriched water brought by runoff. For leaves in both conditions (exposed to air and submerged in water), Rhizophora had the highest TOC (0.23%), followed by Avicennia sp. (0.22%) and Sonneratia alba (0.17%). Results also showed that the average %TOC of submerged and air-control leaves for the KII Eco-park (0.31%) was higher than Bakhawan Eco-Park (0.17%). This may be due to KII Eco-park being the more mature forest with larger vegetation biomass, and greater net productivity as more plant litter is produced. The overall mean litter (from the litter trap) in KII Eco-park (90.85 g/m) is also an order of magnitude higher than at the Bakhawan Eco-park (1.30 g/m). Results indicate that the ability of mangroves to store Carbon is site- and species-dependent.

CARBON STORAGE AND INVENTORY OF MATURE MANGROVE FOREST IN KATUNGGAN IT IBAJAY ECO PARK
Bejasa K, Dimalanta W, Jaraula C,

The coastal environment is home to species that can provide various ecosystem services. Among these species are mangroves, which sequester and store organic carbon for hundreds and even thousands of years. “Blue carbon” is atmospheric carbon captured by coastal ecosystems through photosynthesis, by which carbon stored in mangrove forests potentially exceed seagrass meadows, coral reefs, and salt marshes, on average, by a factor of five. In the Philippines, Panay Island is one of the places where mangrove trees grow old and big; many forests are developed as tourist areas. The 44.22 hectares Katunggan It Ibajay Eco Park is host to 28 species of mangroves- roughly 80% of the total count in the Philippines. It is one of the well-studied mangrove forests to which this study refines by assessing the labile and recalcitrant carbon across spatial and temporal scales using Loss on Ignition method on sediment samples from two cores collected across the biogeographic zones of the forest. Recalcitrant organic carbon is consistently higher than labile organic carbon for both cores. This supports the notion that mangroves are effective in sequestering carbon and transforming it into organic carbon. Further ongoing
characterization of labile organic carbon is performed by analyzing lipids and other molecular markers to establish the composition of the stored carbon.

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ANNEXES
## Scientific Program at a Glance

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<td><strong>PRE-SYMPOSIUM WORKSHOPS AND MEETING</strong></td>
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<td>Large Marine Vertebrates Research Institute: Workshop on Acoustic Telemetry</td>
<td>Opening Ceremonies</td>
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<td>Opening of posters and exhibit sessions</td>
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<td>Opening of posters and exhibit sessions</td>
<td>Welcome Dinner</td>
<td>ZSL Book Launch</td>
<td>Poster sessions and reception</td>
<td>PAMS Business Meeting</td>
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## PAMS15 2019 Conference Schedule

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<td>NRM</td>
<td>Novel research methods and technologies</td>
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<td>FIA</td>
<td>SMART fisheries and aquaculture</td>
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<tr>
<td>10</td>
<td>SCE</td>
<td>Species, Communities and Ecosystems</td>
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<td>LSI</td>
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<td>MRG</td>
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<td>18</td>
<td>VIS</td>
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### 3 July 2019

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<tr>
<td>8:00-17:00</td>
<td>LAMAVE Training/Workshop</td>
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<td>14:30-17:00</td>
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<tr>
<td>7:00-8:00</td>
<td>On-site Registration</td>
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<td>8:00-9:00</td>
<td>Opening Ceremonies</td>
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| 9:00-9:45  | Keynote Address:  
*The Philippines' Journey to Sustainable Fisheries - from simple to complex Fisheries Management interventions*  
by Dr Nygiel Armada |           |       |                |                |         |
| 9:45-10:00 | Group Photo/Health Break |           |       |                |                |         |
| 10:00-10:15 | SCE-developments in marine geology, evolution, and biodiversity 1  
Chair: Arthur Bos | SCE-coral reef dynamics and community structure  
Chair: Kent Carpenter | FIA-SMART Aquaculture  
Chair: Jon Altamirano | MGM-policies and institutions  
Chair: Romeo Dizon | MGM-fisheries and aquaculture  
Chair: Marge dela Cruz | MGM-Marine protected areas  
Chair: Romel Seronay |
|            | (ID:568) PLIO-PLEISTOCENE MOLLUSCS FROM ILOCOS SUR AND ILOCOS NORTE, NORTHERN PHILIPPINES  
Policarpio D | (ID:409) COASTAL FISH ASSEMBLAGE STRUCTURE FROM SHALLOW TO MESOPHOTIC DEPTHS IN THE CENTRAL PHILIPPINES  
Abesamis R | (ID:689) EFFECTS OF LIGHT ON BEHAVIOR, GROWTH AND SURVIVAL OF *Stichopus cf. horrens*  
Apistar D | (ID:357) KNOWLEDGE, PERCEIVED THREAT, CUES TO ACTION, AND SELF-EFFICACY: IMPLICATIONS FOR SAN JOTAQUIN, ILOILO MARINE |
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<th>Lanai</th>
<th>Agribusiness 1</th>
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<td>(ID:767)</td>
<td>(ID:560)</td>
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<td>RESERVE AND SANCTUARIES’ PROTECTION AND REHABILITATION PROGRAM</td>
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<td>QUANTITATIVE CHARACTERIZATION AND SPECIES-LEVEL IDENTIFICATION OF HOLOCENE CORALS FROM AN UPLIFTED CORAL REEF PLATFORM IN SAN ESTEBAN, ILOCOS SUR CERCADO F</td>
<td>LONG-TERM PATTERN OF TEMPORAL AND SPATIAL VARIABILITY OF CHAETODONTIDAE ASSEMBLAGES IN THE BOLINAO-ANDA REEF COMPLEX, NORTHWESTERN PHILIPPINES MCGLONE M</td>
<td>IN VITRO EGG LIBERATION AND FERTILIZATION OF <em>Sargassum polycystum</em> IN RESPONSE TO DIFFERENT ENVIRONMENTAL CONDITIONS MAGCANTA M</td>
<td>PATING, SAAN KA PARARATING? -- UNDERSTANDING POLICY NEEDS FOR SHARK AND RAY CONSERVATION IN THE PHILIPPINES UTZURRUM J</td>
<td>ASSESSMENT OF FISHING ACTIVITIES IN THE SEAGRASS BEDS OF CONCEPCION, ILOILO BENIGA K</td>
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<td>10:45</td>
<td>SHADOWS OF PAST REFUGIA FROM THE MURKY SEA: GENETIC SIGNATURES OF PLEISTOCENE LOW SEA-LEVEL STANDS IN TWO REEF FISH SPECIES FROM THE FARMER DAMSELFISH POPULATION DYNAMICS IN BOLINAO-ANDA REEF COMPLEX (BARC) ROBLES L</td>
<td>FARMER DAMSELFISH POPULATION DYNAMICS IN BOLINAO-ANDA REEF COMPLEX (BARC) ROBLES L</td>
<td>INDUCTION OF PRECOCIOUS MOLTING IN MANGROVE CRABS SCYLLA SPP. ARTETA A</td>
<td>TOP-DOWN OR BOTTOM-UP? COMPARING DECISION-MAKING APPROACHES WHEN PROVISIONING WHALE SHARKS LEGASPI C</td>
<td>MANAGING A BAY FOR BETTER FISHERIES: THE CASE OF BRGY. SAN ANTONIO NUEVA VALEN CIA,</td>
<td>ESTABLISHING A MUDCRAB SANCTUARY IN GUBAT, SORSOGON: INITIAL PHASE FABURADA A</td>
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<td>11:00-11:15</td>
<td>(ID:785) BUCKETFULS OF BIODIVERSITY: THE CRUSTACEANS AND ECHINODERMS OF TAKLONG ISLAND, GUIMARAS, PHILIPPINES Malay M</td>
<td>(ID:598) COMPARISON OF MACROFAUNAL ASSOCIATES OF THE SPONGE Melophlus sarasinorum FROM TWO REEF AREAS Piloton R</td>
<td>(ID:594) PRELIMINARY EVALUATION ON THE EFFECT OF DIFFERENT SUPPLEMENTAL FEEDS ON THE GROWTH AND SURVIVAL OF JUVENILE</td>
<td>(ID:879) FAO 263: A POLICY THAT CATALYZES SOLUTIONS TO THE SYSTEMIC ISSUES BESETTING FISHERIES MANAGEMENT Ingles J</td>
<td>(ID:719) MONITORING BOAT ACTIVITY OF A SMALL-COMMERCIAL GILL NET BASED IN AJUY, ILOILO Regalado J</td>
<td>(ID:460) COMPETENCE ASSESSMENT OF MANAGERS AND PRACTITIONER TO IMPROVED MANAGEMENT OF SELECTED</td>
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<td>11:45-12:00</td>
<td>(ID:658) SOFT CORALS IN THE PHILIPPINES: WHAT DO WE KNOW ABOUT THEM?</td>
<td>none</td>
<td>(ID:596) EFFECT OF INITIAL SIZE AT STOCKING ON THE GROWTH AND SURVIVAL</td>
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<td>(ID:821) VALUE CHAIN ANALYSIS OF THE SEA CUCUMBER INDUSTRY IN TAWI- TAWI Jumaide N</td>
<td>MANAGEMENT EFFECTIVENESS OF MARINE PROTECTED AREAS IN TAWI-TAWI, PHILIPPINES Irlis R</td>
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<td>Cabasan J</td>
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<td>OF SANDFISH (Holothuria scabra) JUVENILES REARED IN FLOATING HAPAS</td>
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<td>13:00-13:15</td>
<td>SCE-developments in marine geology, evolution, and biodiversity 1</td>
<td>SCE-seagrass assemblages and other invertebrate fauna</td>
<td>FIA-SMART fisheries Chair: Hazel Arceo</td>
<td>MGM-species monitoring Chair: Ronald Maliao</td>
<td>MGM-fisheries and aquaculture; community engagement Chair: Nerissa Salayo</td>
<td>MGM-Marine protected areas 2 Chair: Richard Muallil</td>
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<td>Chair: Maria Celia Malay</td>
<td>Chair: Jayvee Saco</td>
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<td>(ID:534) ASIN'S OYSTER HATCHERY: CULTIVATING</td>
<td>(ID:617) ASSESSMENT OF TRACE METAL LEVELS IN THE</td>
<td>(ID:500) STATUS OF CORAL REEFS</td>
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<td>13:30-</td>
<td>(ID:829) INSIGHTS ON THE MICROBIAL COMMUNITY AND GEOCHEMISTRY OF HIGH TEMPERATURE SEDIMENTS AND MICROBIAL MATS IN A SHALLOW HYDROTHERMAL VENT IN MABINI, BATANGAS Elegado A</td>
<td>(ID:661) SEAGRASS AND MACROINVERTEBRATE DIVERSITY IN OLOTAYAN ISLAND Custodio I</td>
<td>(ID:539) LOCOTOR ACTIVITY AND SURVIVAL OF GLASS EEL <em>Anguilla marmorata</em> (ANGUILLIFORMES: ANGUILLIDAE) EXPOSED TO DIFFERENT SALINTY LEVELS Aquino G</td>
<td>(ID:625) LONG TERM MONITORING OF CORAL REEFS IN DAANTABAYAN MUNICIPALITY Dalongeville A</td>
<td>(ID:872) SHARK CATCH IN PHILIPPINE SMALL-SCALE FISHERY Esoro M</td>
<td>(ID:581) ONSHORE-TO-OFFSHORE GEOLOGIC CONTINUITY AS ADDITIONAL CRITERIA IN THE SELECTION OF POTENTIAL MARINE PROTECTED AREAS Rodolfo R</td>
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<td>(ID:406) METAGENOMIC ANALYSIS OF THE FORAMINIFERA ATTACHED ON</td>
<td>(ID:588) FORAMINIFERA ATTACHED ON</td>
<td>(ID:791) AGE-GROWTH PARAMETERS</td>
<td>(ID:703) TEN YEARS OF PHOTO-</td>
<td>(ID:887) STATUS OF THE SEAWEED</td>
<td>(ID:613) SUSTAINING MPA</td>
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<td>13:45-14:00</td>
<td>ASSOCIATED MICROBIAL COMMUNITY OF THE LOW MICROBIAL ABUNDANCE (LMA) SPONGE, Haliclona amboinensis Conaco C</td>
<td>SEAGRASS BLADES IN TWO SITES IN SOUTHERN GUIMARAS, PHILIPPINES Nunez K</td>
<td>AND MATURITY OF BROWNSTRIPE RED SNAPPER, Lutjanus vitta IN DAVAO GULF, MINDANAO, PHILIPPINES Del Fierro J</td>
<td>IDENTIFICATION REVEAL THE POPULATION DYNAMICS OF WHALE SHARKS AT DONSOL, SORSOGON, PHILIPPINES Miranda J</td>
<td>INDUSTRY OF THE PHILIPPINES Roa-Quiaoit H</td>
<td>MANAGEMENT THROUGH IMPROVED COMPETENCIES OF MPA MANAGEMENT BODIES Bobadilla J</td>
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<td>14:00-14:15</td>
<td>(ID:626) FIRST REPORT OF TAKAYAMA SP. BLOOM DURING A FISH-KILL EVENT IN</td>
<td>(ID:423) COMPOSITION, ABUNDANCE, AND DISTRIBUTION OF MEIOFAUNAL</td>
<td>(ID:569) ANALYSIS OF THE MORPHOMETRIC AND</td>
<td>(ID:768) CURRENT STATUS OF GIANT CLAMS: AN IMPLICATION FOR CONSERVATION</td>
<td>(ID:369) ASSESSING CITIZEN ENGAGEMENT IN ENHANCING</td>
<td>(ID:714) TROPHIC STRUCTURES OF REEF FISH ASSEMBLAGES</td>
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<td>14:15-14:30</td>
<td>OBANDO, BULACAN, PHILIPPINES Gernato E</td>
<td>ASSEMBLAGE IN BANATE BAY, ILOILO, PHILIPPINES Taborda S</td>
<td>BIOMETRIC CHARACTERS OF DISTANT SCALLOP <em>(Bractechlamys vexillum, REEVE 1853)</em> FROM ASID GULF, MASBATE Buban I</td>
<td>MANAGEMENT IN THE ISLAND GARDEN CITY OF SAMAL Sobradil R</td>
<td>COMMUNITY WELL-BEING IN THE COASTAL COMMUNITIES OF CONCEPCION, ILOILO, PHILIPPINES Belanio J</td>
<td>– A COMPARISON OF TWO MARINE PROTECTED AREAS IN THE PHILIPPINES Felix Jr. L</td>
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<td>(ID:584) DIVERSITY AND SPECIES COMPOSITION OF ANCHIALINE MACROBENTHIC INFAUNA</td>
<td>(ID:587) COMPARATIVE ANALYSIS ON SEX RATIO, MATURITY, GONADOSOMA</td>
<td>(ID:871) THE PHILIPPINE RISE AND WHAT’S DOWN UNDER: ASSESSMENT OF REEF FISH</td>
<td>(ID:456) THE MEN AND WOMEN AS THE KEY DRIVERS IN SUSTAINABLE</td>
<td>(ID:867) EFFECTS OF PROTECTION ON THE AGE AND GROWTH OF</td>
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<td>14:45-15:00</td>
<td>BATANGAS BAY Afalla E</td>
<td>COLLECTED FROM TINGUIBAN ISLET, GUIMARAS, PHILIPPINES Pepino M</td>
<td>TIC INDEX AND MORPHOMETRY OF SPLENDID PONYFISH (Leiognathus splendens CUVIER) CAUGHT IN SAN PEDRO AND CARIGARA BAYS, EASTERN VISAYAS</td>
<td>ASSEMBLAGE IN THE DEEP REEFS OF THE BENHAM BANK REGION Garcia J</td>
<td>MANGROVE CONSERVATION IN MANGROVE CONSERVATION PARK IN CALATAGAN, BATANGAS, PHILIPPINES Creencia G</td>
<td>COMMERCIALlY TARGETED FISH SPECIES IN THE FRENCH MEDITERRANEAN</td>
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<td>(ID:779) DIVERSITY AND ABUNDANCE OF CONE SNAILS IN VERDE ISLAND, BATANGAS CITY, PHILIPPINES Infante R</td>
<td>(ID:773) COMMUNITY STRUCTURE OF GASTROPODS FOUND IN THE INTERTIDAL ZONE OF ISLAND GARDEN CITY OF SAMAL, DAVAO DEL NORTE Aquino F</td>
<td>(ID:740) BLUE SWIMMING CRAB REFERENCE POINTS: A PARADIGM TO SCIENCE-BASED FISHERY MANAGEMENT Mesa S</td>
<td>(ID:697) TEMPORAL VARIATIONS IN POPULATION OF BROWN-SPOTTED SEA CUCUMBER (Bohadschia marmorata) WITH NOTES ON RECRUITMENT SEASON Jontila J</td>
<td>(ID:495) COMMUNITY-BASED ECOTOURISM AS A SUSTAINABLE DEVELOPMENT OPTION FOR TAWI-TAWI, SOUTHERN PHILIPPINES Guinto-Sali M</td>
<td>(ID:883) STATUS OF MANGROVE COMMUNITIES IN MALABUNGOT PROTECTED LANDSCAPE AND SEASCAPE Nieves J</td>
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<td>(ID:775) COMMUNITY STRUCTURE OF BIVALVES ALONG</td>
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<td>(ID:827) AWARENESS OF STUDENTS FROM</td>
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<td>15:30-16:00</td>
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<td>16:00-18:00</td>
<td>Plenary Session 1: Hinunanon</td>
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<td>18:00-21:00</td>
<td>WELCOME DINNER</td>
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### Day 2 - 5 July 2019

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<td>08:00-08:15</td>
<td>Opening preliminaries</td>
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<td>08:15-09:00</td>
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<td>Importance of Economic Valuation in Fisheries Management</td>
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<td>by Dr Alice Ferrer</td>
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<td>09:15-09:30</td>
<td>SCE: herbivory and predator-prey interactions Chair: Victor S. Ticzon (ID:880)</td>
<td><strong>ESTIMATING DUGONG HERBIVORY HIGHLIGHTS THE IMPORTANCE OF CONSERVING SUBTIDAL SEAGRASS MEADOWS</strong> Corcino R</td>
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<td>SCE: reproductive biology and growth of invertebrates Chair: Cleto Nañola Jr. (ID:559)</td>
<td><strong>TISSUE REGENERATION IN MARINE Sponges</strong> Diamante V</td>
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<td>ECN: ecosystem connectivity Chair: Rene Abesamis (ID:381)</td>
<td><strong>MODELLING CORAL LARVAL CONNECTIVITY OFF EASTERN LUZON AND THE POTENTIAL ROLE OF THE BENHAM BANK</strong> De Maligaya J</td>
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<td>NR: novel research methods and technologies Chair: Wilfredo Licuanan (ID:407)</td>
<td><strong>THE CURIOUS CASE OF THE MISSING RNA BAND: EVIDENCE OF A GAP DELETION IN GIANT CLAM 28S RRNA AND ITS IMPLICATIONS IN STUDYING NON-MODEL</strong> Abrina T</td>
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<td>LSI: land-sea interactions Chair: Olive Cabrera (ID:374)</td>
<td><strong>STATUS OF WATER QUALITY OF THE COASTAL ENVIRONMENT SURROUNDING MALABUNGOT PROTECTED LANDSCAPE AND SEASCAPE</strong> Atole M</td>
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<td>MGM: restoration ecology and management interventions Chair: Vanessa Baria (ID:373)</td>
<td><strong>NON-USE VALUES OF CORAL REEF RESTORATION IN THE PHILIPPINES</strong> Abrina T</td>
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<td>09:30-09:45</td>
<td>(ID:683) GRAZING OF THE BLACK LONG SPINED SEA URCHIN (<em>Diadema setosum</em>) ON FLAT AND COMPLEX CORALLINE SUBSTRATE TYPE</td>
<td>(ID:469) OCCURRENCE, FECUNDITY AND UTILIZATION OF NON-INDIGENOUS INVASIVE CHARRU MUSSEL, <em>Mytella charruana</em>, IN THE PHILIPPINES</td>
<td>(ID:475) NEAR-BED FLOW CHARACTERISTICS OVER DIFFERENT BOTTOM TYPES</td>
<td>(ID:521) HILL’S NUMBERS AS AN EMERGING TOOL IN TEMPORAL ANALYSES OF SPECIES DIVERSITY IN CORAL REEF COMMUNITIES</td>
<td>(ID:533) MODELING THE INTERCONNECTIVITY OF COASTAL CURRENT CIRCULATION AND LANDSCAPE HYDROLOGY ALONG VERDE ISLAND PASSAGE MARINE BIODIVERSITY CORRIDOR (VIPMBC)</td>
<td>(ID:446) ASSISTED MASS SETTLEMENT OF <em>Acropora cf loripes</em> CORAL LARVAE IS AN EFFECTIVE CORAL RESTORATION APPROACH</td>
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<td>Aguirre A</td>
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<td>(ID:385) SEDIMENT YIELD SIMULATION USING SWAT IN DAVAO GULF, PHILIPPINES</td>
<td>dela Cruz D</td>
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<td>09:45-10:00</td>
<td>(ID:452) SEA URCHINS ARE MAJOR MACROALGAL BROWSERS IN A REEF FLAT IN CALATAGAN, BATANGAS</td>
<td>(ID:571) REPRODUCTIVE RHYTHM OF SENATORIAL SCALLOP (<em>Chlamys senatoria</em>, GMELIN 1791) IN RELATION TO LUNAR PHASE</td>
<td>(ID:518) LARVAL CONNECTIVITY AND ITS IMPLICATIONS FOR MARINE RESERVE NETWORKS IN THE PHILIPPINES</td>
<td>(ID:722) RECONSTRUCTING HISTORICAL IMPACTS AND TRANSPORT PATHWAYS OF ANTHROPOGENIC RADIONUCLIDES IN THE WESTERN EQUATORIAL</td>
<td>(ID:385) SEDIMENT YIELD SIMULATION USING SWAT IN DAVAO GULF, PHILIPPINES</td>
<td>(ID:840) ENHANCING DEGRADED REEFS THROUGH INTRODUCTION OF HATCHERY REARED <em>Acropora millepora</em> LARVAE</td>
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<td>10:00-10:15</td>
<td>(ID:394) BIOEROSSION OF CORALLINE SUBSTRATE BY BLACK LONG-SPINED SEA URCHIN (<em>Diadema setosum</em> LESKE, 1778) IN CALATAGAN, BATANGAS Salva C</td>
<td>(ID:665) STATUS AND SEXUAL SYSTEM OF ANCHIALINE SHRIMP <em>Parhippolyte uveae</em> Borradaile, 1900 IN TINGUIBAN ISLET, GUIMARAS, PHILIPPINES Ebreo K</td>
<td>(ID:734) EXAMINING CONNECTIVITY OF <em>Scylla olivacea</em> POPULATIONS IN THE SULU SEA BASIN: LARVAL DISPERSAL MODELLING AND GENOMIC APPROACHES Mendiola M</td>
<td>(ID:590) CLONAL PRODUCTION OF <em>Kappaphycus alvarezii</em> (DOTY) DOTY IN-VITRO Luhan M</td>
<td>(ID:592) SEDIMENT PLUME BEHAVIOUR AND COASTAL CURRENT CIRCULATION PATTERNS IN THE COASTAL MARINE ENVIRONMENTS OF THE CAGAYAN DE ORO RIVER CATCHMENT Tan M</td>
<td>(ID:825) APPLYING CORAL LARVAL ENHANCEMENT TECHNIQUE TO RESTORE DEGRADED AREAS IN HUNDRED ISLANDS NATIONAL PARK, NORTHWESTERN PHILIPPINES Ligson C</td>
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<td>10:15-10:30</td>
<td>(ID:477) BEHAVIOR OF JEWEL DAMSELFISH (<em>Plectroglyphidodon lacrymatus</em>) IN AREAS OF VARYING PREDATOR</td>
<td>(ID:651) BEHAVIOR, SEXUAL SYSTEM, AND COLOR POLYMORPHISM OF THE SEMI-TERRESTRIAL</td>
<td>(ID:566) VARIATIONS OF EDDY FORMATION AND PROPAGATION AROUND THE</td>
<td>(ID:461) NEW BENCHMARKS AND SCALES FOR EVALUATING HARD CORAL COVER AND DIVERSITY DATA</td>
<td>(ID:652) WEIGHING IN ON THE INFLUENCE OF LAND-SEA BREEZES ON THE OBSERVED NORTHWEST LUZON COASTAL</td>
<td>(ID:772) EFFECTS OF RESTORED REEF USING CORAL LARVAL ENHANCEMENT ON FISH COMMUNITY STRUCTURE IN</td>
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<td>BIOMASS. Maala G</td>
<td>SHRIMP <em>Merguiia oligodon</em> (DE MAN, 1888) FROM TAKLONG ISLAND, GUIMARAS, PHILIPPINES Malay M</td>
<td>PHILIPPINES del Rosario A</td>
<td>FROM PHILIPPINE REEFS. Licuanan W</td>
<td>CURRENT IN AUGUST 2017 Solera L</td>
<td>THE NORTHWESTERN PHILIPPINES Gomez R</td>
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<tr>
<td>10:30-10:45</td>
<td>(ID:354) EFFECT OF PREDATOR SIZE ON THE BEHAVIOR OF THE JEWEL DAMSELFISH (<em>Plectroglyphidodon lacrymatus</em>) Aurellado M</td>
<td>(ID:797) EGG SIZE OF BALI SARDINELLA <em>Sardinella lemuru</em> (BLEEKER, 1853) OFF BULAN, SORSOGON Kwon J</td>
<td>(ID:882) OCEAN CIRCULATION AND CONNECTIVITY IN WESTERN PHILIPPINES Villanoy C</td>
<td>(ID:616) UTILIZING FACEBOOK FOR ESTABLISHING MARINE WILDLIFE BASELINE INFORMATION IN THE PHILIPPINES Yaptinchay A</td>
<td>(ID:875) SEA-LEVEL CHANGES IN THE PHILIPPINES Sta Maria M</td>
<td>(ID:780) LONG-TERM CHANGES IN FISH ASSEMBLAGE COMPOSITION ON RESTORED DEGRADED REEF PATCH BY CORAL TRANSPLANTATION AND GIANT CLAM RESTOCKING TREATMENTS Gomez R</td>
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<td>11:30-11:45</td>
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<td>(ID:869) AGE DETERMINATION AND GROWTH OF <em>Siganus guttatus</em> IN CEBU, PHILIPPINES</td>
<td>Ualat S</td>
<td>none</td>
<td>(ID:532) ESTIMATES OF MIXING IN THE MINDORO-PANAY-TABLAS STRAIT JUNCTION USING CTD DATA Maloles P</td>
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<td>(ID:818) IDENTIFICATION AND QUANTIFICATION OF MICROPLASTICS IN THE GUTS OF RABBITFISHES (SIGANIDAE), BIVALVES, AND SEDIMENTS FROM SELECTED COASTAL AREAS OF NEGROS ORIENTAL, PHILIPPINES Romano E</td>
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<td>(ID:901)</td>
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<td>PNAP SELECTED SITES, MALITA, DAVAO OCCIDENTAL Elemino M</td>
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<td>INTEGRATING GENOMICS WITH IMAGE ANALYSIS, GIS AND MOBILE COMPUTING FOR IMPROVED REARING OF MANGROVE CRABS Lagman M</td>
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<td>12:00-13:00</td>
<td>LUNCH</td>
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<td>13:00-13:45</td>
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<td>Plenary Talk: Making science work for fisheries management areas by Dr Wilfredo Campos</td>
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<td>13:45-14:00</td>
<td>SCE-movement patterns, behavior and habitat use of marine animals Chair: Patrick Cabaitan</td>
<td>SCE-Status reports on coral reef fish communities Chair: Jerome Cabansag</td>
<td>GOS-ocean warming and acidification Chair: Celia Conaco</td>
<td>NRM-novel research methods and technologies (cont'd) Chair: Wilfredo Licuanan</td>
<td>PAN-legacy of Maricar Samson (ID:908) PEOPLE AND NATURE CITIZEN SCIENCE AND YOUTH</td>
<td>Special Session: Visayan Seas Chair: James Kho (ID:424) GROWTH, RECRUITMENT,</td>
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<td>14:00-14:15</td>
<td>(ID:352) TIDAL MOVEMENT OF THE INDO-PACIFIC HORNED SEA STAR (<em>Protoreaster nodosus</em> LINNAEUS, 1758) IN A SEAGRASS MEADOW IN CALATAGAN, BATANGAS Manaligod H</td>
<td>(ID:878) THE STATUS OF GROUPERS IN THE PHILIPPINES Casauay R</td>
<td>(ID:497) EFFECT OF ELEVATED TEMPERATURE ON THE CORAL IMMUNE RESPONSE Da-anoy J</td>
<td>(ID:704) COASTAL SEA RESPONSE TO ATMOSPHERIC FORCING IN PANAY STRAIT, PHILIPPINES Repollo C</td>
<td>(ID:909) THE COASTAL SCOUTS AUXILIARY: YOUTH-BASED OUTREACH AND CITIZEN SCIENCE Cancio E</td>
<td>(ID:839) POPULATION BIOLOGY OF SWORDTIP SQUID <em>Photololigo edulis</em> (HOYLE, 1885) FROM THE VISAYAN SEA IN CONCEPCION, ILOILO, PHILIPPINES Sanchez K</td>
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<td>14:15-14:30</td>
<td>(ID:482) MOVEMENT PATTERNS OF SHRIMP-ASSOCIATED</td>
<td>(ID:576) TAWI-TAWI: THE HEART OF THE CORAL TRIANGLE FOR</td>
<td>(ID:618) STILL HOLDING ON TO THAT NUGGET OF HOPE: A CASE FOR SCE - biochemistry and pathogens Chair: Nathaniel Ascano</td>
<td></td>
<td>(ID:843) BUILDING HIGH SCHOOL TEACHERS’ CAPABILITY ON MARINE</td>
<td>(ID:755) SPATIAL DYNAMICS OF VARIOUS SARDINE SPECIES IN THE</td>
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<td>GOBIES DEPEND ON GOBY CLADE AND PREDATOR DENSITY</td>
<td>COMMERCIALY IMPORTANT CORAL REEF FISHES</td>
<td>ADAPTIVE BLEACHING IN PHILIPPINE CORALS</td>
<td>(ID:468) ANTIMICROBIAL SENSITIVITY OF CRUDE SEA URCHIN TOxin EXTRACT (Diadema setosum) AGAINST Staphylococcus aureus AND Pseudomonas aeruginosa.</td>
<td>BIODIVERSITY RESEARCH: A BATANGAS STATE UNIVERSITY INITIATIVE</td>
<td>VISAYAN SEA: INSIGHTS ON POTENTIAL CRITICAL HABITATS</td>
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<td>Stiefel K</td>
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<td>14:30-14:45</td>
<td>(ID:463) HABITAT UTILIZATION OF HARPACTICOID COPEPODS IN TAKLONG ISLAND GUIMARAS, WEST CENTRAL PHILIPPINES</td>
<td>(ID:483) STATUS OF CORAL REEF FISHES IN TAWI-TAWI</td>
<td>(ID:439) EFFECTS OF FOUR VARYING TEMPERATURES ON THE PLANULAR SETTLEMENT AND ASEXUAL REPRODUCTION OF THE TROPICAL UPSIDE-DOWN JELLYFISH, Cassiopea andromeda</td>
<td>(ID:765) ANTIBACTERIAL ACTIVITY OF MARINE SPONGE EXTRACTS AND BACTERIAL ISOLATES</td>
<td>(ID:660) STIMULATING INTEREST OF HIGH SCHOOL STUDENTS IN MARINE ECOSYSTEMS THROUGH SCIENTIFIC INVESTIGATION IN ZAMBOANGUITA, NEGROS ORIENTAL, PHILIPPINES</td>
<td>Andringa A</td>
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<td>Lapara S</td>
<td>Injani A</td>
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<td>15:00-15:15</td>
<td>(ID:633) VIDEO-BASED SURVEYS AND IMAGE ANALYSIS OF DAMSELFISH SHOALING BEHAVIOR Manogan D</td>
<td>(ID:552) COMMUNITY ASSEMBLAGES OF FAMILY CHAETODONTIDAE IN TAWI-TAWI, PHILIPPINES Habibuddin A</td>
<td>(ID:732) EFFECT OF SALINITY AND TEMPERATURE ON THE SURVIVAL AND GROWTH OF <em>Heliopora coerulea</em> Esmolo R</td>
<td>(ID:433) ALGICIDAL POTENTIAL OF CULTIVABLE BACTERIA FROM PELAGIC WATERS AGAINST TOXIC DINOFLAGELLATES <em>Pyrodinium bahamense</em></td>
<td>(ID:453) RECREATIONAL ACTIVITIES OF MANGROVE FORESTS IN CAMOTES ISLANDS, CEBU, PHILIPPINES Andriano B</td>
<td>(ID:904) ASSESSING GOVERNABILITY OF VISAYAN SEA, PHILIPPINES Ferrer A</td>
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<td>Health Break</td>
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<td>16:00-17:00</td>
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<td>17:00-18:30</td>
<td>PAMS Business Meeting</td>
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Day 3 – 6 July 2019

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<td>08:00-08:15</td>
<td>Opening preliminaries</td>
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<td>08:15-09:00</td>
<td>Plenary Talk:</td>
<td>Science-based Mangrove Rehabilitation and Conservation in the Philippines by Dr. Jurgenne Primavera</td>
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<td>09:15-09:30</td>
<td>SCE-coral reproduction and recruitment Chair: Dexter dela Cruz</td>
<td>SCE-biological oceanography and plankton Chair: Ephraime Metillo</td>
<td>GOS-pollutants and other local stressors Chair: Malou San Diego-McGlone</td>
<td>SCE - population biology of invertebrates and giant clams Chair: Nadia Abesamis</td>
<td>PAN-people and nature Chair: Arnel Yaptinchay</td>
<td>Special Session: Blue Carbon Chair: Ariel Blanco</td>
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<td>(ID:743) LOCAL ECOLOGICAL</td>
<td>(ID:465) ABOVE-GROUND</td>
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<td>CAGAYANCILLO PALAWAN, PHILIPPINES Alarcon R</td>
<td>BANK SEAMOUNT Bantay K</td>
<td>FEEDING POTENTIAL OF A MARINE HERBIVORE IN SEAGRASS BEDS Bangi H</td>
<td>NORTHERN MINDANAO Labaja J</td>
<td>ORGANIC MATTER IN A MANGROVE ECOPARK IN KATUNGGAN IT IBAJAY (KII)</td>
<td>AND FIELD-BASED METHOD Cruz C</td>
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<td>09:30-09:45</td>
<td>(ID:536) PATTERNS OF CORAL RECRUITMENT IN BONGAO, TAWI-TAWI Mohammad K</td>
<td>(ID:387) NUTRIENT AND PRIMARY PRODUCTION OF THE COASTAL WATERS IN THE</td>
<td>(ID:654) SCREENING FOR RADIONUCLIDE CONTAMINATION FROM THE FUKUSHIMA</td>
<td>(ID:807) RIDGE TO REEF PARTICIPATORY NATURAL RESOURCE ASSESSMENT IN TBM</td>
<td>(ID:600) BULK CARBON AND NITROGEN ISOTOPIC COMPOSITIONS OF SEDIMENTARY</td>
<td>AND ITS IMPLICATIONS Bejasa K</td>
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<td>VICINITY OF THE COAL POWER PLANT, CULAMAN, MALITA, DAVAO OCCIDENTAL</td>
<td>ACCIDENT BY IODINE-129 MEASUREMENT IN CORALS FROM THE PHILIPPINES</td>
<td>ANCESTRAL DOMAIN, CORON, PALAWAN Baobao J</td>
<td>ORGANIC MATTER IN A MANGROVE ECOPARK IN KATUNGGAN IT IBAJAY (KII)</td>
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<td>(ID:760) POPULATION BIOLOGY OF A LIMPET (Patelloida saccharina) IN THE</td>
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<td>INTERTIDAL ZONE OF PUNTA DEL SOL, SAMAL ISLAND, DAVAO GULF</td>
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<td>(ID:807) RIDGE TO REEF PARTICIPATORY NATURAL RESOURCE ASSESSMENT IN TBM</td>
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<td>09:45-10:00</td>
<td>(ID:694) REPRODUCTIVE PATTERN AND FECUNDITY VARIABILITY OF <em>Acropora tenuis</em>colonies in Northwestern Philippines</td>
<td>(ID:664) PHYTOPLANKTON COMPOSITION AND WATER NUTRIENT LEVELS IN GREEN MUSSEL FARM AT INNER MALAMPAYA SOUND, TAYTAY, PALAWAN, PHILIPPINES</td>
<td>(ID:416) PROKARYOTIC MICROBES IN THE CTENIDIA OF JUVENILE <em>Tridacna gigas</em></td>
<td>(ID:753) POPULATION BIOLOGY OF A GASTROPOD, (<em>Nerita undata</em>) AT THE ROCKY INTERTIDAL ZONE IN PUNTA DEL SOL, SAMAL ISLAND, DAVAO GULF</td>
<td>(ID:393) FISHERIES TREND IN BATAN ESTUARY, AKLAN</td>
<td>(ID:717) CARBON STOCK ASSESSMENT IN MANGROVE AREAS IN TAWI-TAWI, PHILIPPINES</td>
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<td>Gomez E</td>
<td>Baldevieso A</td>
<td>Tejada A</td>
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<td>(ID:489) SIZE AT THE ONSET OF SEXUAL MATURITY AND FECUNDITY OF <em>Favites abdita</em></td>
<td>(ID:553) SPATIAL AND TEMPORAL DISTRIBUTION OF PHYTOPLANKTON IN SAN PEDRO, LEYTE, PHILIPPINES</td>
<td>(ID:451) LEVELS OF HEAVY METALS, TRACE ELEMENTS AND SEDIMENTATION RATE IN THE MARINE PROTECTED AREAS IN LANUZA BAY, SURIGAO DEL SUR</td>
<td>(ID:736) ABUNDANCE, DISTRIBUTION AND RECRUITMENT OF NERITA PLICATA (<em>Linnaeus, 1758</em>) ALONG THE DISTURBED INTERTIDAL SHORES OF SAMAL ISLAND, DAVAO GULF</td>
<td>(ID:507) LET’S TALK FISHING: A CONVERSATION STARTER TO PROMPT COMMUNITIES TO TALK AND DO GOOD FOR PHILIPPINE FISHERIES</td>
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<td>Bonilla K</td>
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<td>(ID:498) SIZE AT THE ONSET OF SEXUAL MATURITY AND FECUNDITY OF <em>Favites abdita</em></td>
<td>(ID:553) SPATIAL AND TEMPORAL DISTRIBUTION OF PHYTOPLANKTON IN SAN PEDRO, LEYTE, PHILIPPINES</td>
<td>(ID:451) LEVELS OF HEAVY METALS, TRACE ELEMENTS AND SEDIMENTATION RATE IN THE MARINE PROTECTED AREAS IN LANUZA BAY, SURIGAO DEL SUR</td>
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<td>10:30</td>
<td>Pocilipora acuta IN THE BOLINAO-ANDA REEF SYSTEM Torres A</td>
<td>EASTERN SULU SEA COASTAL UPWELLINGS IN 2012 AND 2013 Metillo E</td>
<td>CAPIZ. Baranda L</td>
<td>ISLAND NATIONAL MARINE RESERVE (TINMR), NUEVA VALENCIA, GUIMARAS, PHILIPPINES</td>
<td>PROTECTION AND CONSERVATION IN MABINI, BATANGAS, PHILIPPINES</td>
<td>MANGROVES IN TANDOG ISLAND, TAKLONG ISLAND NATIONAL MARINE RESERVE,</td>
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<td>Medina B</td>
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<td>10:30-</td>
<td>(ID:789) EFFECTS OF PHOTOPERIOD ON PLANULAR SETTLEMENT AND SURVIVAL</td>
<td>(ID:710) SPATIO-TEMPORAL VARIABILITY AND ASSOCIATION OF DINOFLAGELLATE-</td>
<td>(ID:586) SUBLETHAL EFFECTS OF PETROLEUM HYDROCARBONS IN THE MARINE RED</td>
<td>(ID:836) THE DNA BARCODING PROJECT OF DOST ON MARINE FISHES Nañola Jr. C</td>
<td>(ID:812) CARBON STOCK IN SEAGRASS MEADOWS OF TAWI-TAWI</td>
<td>de los Santos K</td>
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<td>10:45</td>
<td>OF THE BIRDNEST CORAL, Seriatopora guttata (VERON, Beringuela R)</td>
<td>DIATOM ASSEMBLAGES ON SELECTED RED SEAWEEDS (RHODOPHYTA)</td>
<td>SEAWEEDS (RHODOPHYTA) KAPPAPHYCUS SP. Merro S</td>
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<td>Burias D</td>
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<td>11:15-11:30</td>
<td>(ID:591) REPRODUCTIVE TIMING OF SOFT CORAL LOBOPHYTUM SP. (OCTOCORALLIA : ACLYONACEA) IN BOLINAO-ANDA REEF COMPLEX, PANGASINAN Baran C</td>
<td>(ID:804) ZOOPLANKTON COMMUNITY DURING WHALE SHARK (<em>Rhincodon typus</em>) SEASON IN PINTUYAN, SOGOD BAY, SOUTHERN LEYTE, PHILIPPINES Granada J</td>
<td>(ID:466) MARINE BIOFILM DEVELOPMENT UNDER DIFFERENT REEF CONDITIONS AND EFFECTS ON CORAL LARVAL SETTLEMENT Padayhag B</td>
<td>(ID:762) GIANT CLAM RECRUITMENT AT DIFFERENT SITES IN NORTHWESTERN PHILIPPINES Requilme J</td>
<td>(ID:902) CATCH OF <em>Otolithes ruber</em> (BLOCH &amp; SCHNEIDER, 1801) (SCIAENIDAE) AND FISHING PRACTICES OF SMALL-SCALE FISHERFOLKS IN SAN MIGUEL BAY, PHILIPPINES Bergonio E</td>
<td>S Blanco A</td>
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<td>11:30-11:45</td>
<td>(ID:677) REMNANT UPSTREAM PATCHES OF <em>Sonneratia caseolaris</em> CONFIRM PAST EXTENSIVE MANGROVE COVER IN THE COASTAL</td>
<td>(ID:646) SPECIES COMPOSITEON, ABUNDANCE AND DISTRIBUTION OF CHAETOGRAPHS IN SOUTHERN ZAMBOANGA PENINSULA Ranises D</td>
<td>(ID:634) OCCURRENCE OF ANTIBIOTICS IN THE COASTAL WATERS OF MABINI, BATANGAS Mariano S</td>
<td>none</td>
<td>(ID:673) THE MARINE RESOURCES IN PAGASA ISLAND, WEST PHILIPPINE SEA, PHILIPPINES (AFTER TEN YEARS) AND THEIR IMPLICATIONS Nadaoka K</td>
<td>(ID:896) THE BCNET: A BRIDGE OVER TROUBLED WATERS IN CLIMATE CHANGE MITIGATION Fortes M</td>
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<td>11:45-12:00</td>
<td>(ID:787) Sonneratia alba: THE ONLY MANGROVE SPECIES THRIVING IN BARANGAY SAN AGAPITO, VERDE ISLAND, BATANGAS CITY, PHILIPPINES Infante R</td>
<td>none</td>
<td>(ID:377) EVALUATING THE EFFECTS OF MARINE PROTECTED AREAS (MPAS) AND FISHING PRESSURE ON FISH PARASITIC GNATHIID ISOPods IN THE CENTRAL PHILIPPINES Shodipo M</td>
<td>none</td>
<td>(ID:662) DIVERSITY AND TRADITIONAL USES OF SEAGRASSES IN SIBUTU AND TANDUBAS, TAWI-TAWI, PHILIPPINES Abduraup Y</td>
<td>(ID:897) A WORKING 3-TIER FRAMEWORK FOR MANAGEMENT INTERVENTION OPTIONS FOR PHILIPPINE COASTAL HABITATS Rollon R</td>
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<td>12:00-13:00</td>
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<td>13:00-13:15</td>
<td>SCE-mangroves and associated fauna Chair: Zayda Halun</td>
<td>SCE-biological oceanography and plankton Chair: Mary Mar Noblezada-Payne</td>
<td>GOS-pollutants and other local stressors Chair: Cesar Villanoy</td>
<td>none</td>
<td>PAN-people and nature Chair: Hilly Roa-Quiaoit</td>
<td>Special Session: Blue Carbon Chair: Ariel Blanco</td>
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<td>(ID:708) DO PRESENCE OF MANGROVES</td>
<td>(ID:438) Rhincalanus nasutus GIESBRECHT 1888</td>
<td>(ID:721) ABUNDANCE OF CORALLIVORE</td>
<td></td>
<td>(ID:688) CITIZEN SCIENCE SHEDS LIGHT ON THE DISTRIBUTION,</td>
<td>(ID:898) HYDROLOGIC-HYDRODYNAMIC IMPACT</td>
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<td>13:45-14:00</td>
<td>(ID:408) SMALL-SCALE SPATIAL PATTERN OF COMMUNITY STRUCTURE OF MANGAL-ASSOCIATED MALACOFUNA IN REFORESTED MANGROVE FOREST OF ISLA KAPISPISAN, NEW WASHINGTON, AKLANTAK, ALCEDO J</td>
<td>(ID:556) ABUNDANCE AND COMPOSITION OF FISH LARVAE CAUGHT BY LIGHT TRAP AND PLANKTON NET ALONG THE BONGAO CHANNEL, BONGAO, TAWI-TAWI, JULKANAIN A</td>
<td>(ID:372) MODELING AND RETURN PERIOD ANALYSIS OF WAVES GENERATED IN THE PHILIPPINES BY CYCLONES FROM 1980-2013, RODRIGO S</td>
<td>none</td>
<td>(ID:542) AN INTEGRATED APPROACH TO COMMUNITY-DRIVEN MARINE CONSERVATION IN MALAPASCUA ISLAND, NORTHERN CEBU, PHILIPPINES, GENISAN A</td>
<td>none</td>
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<td>14:00-14:15</td>
<td>(ID:848) RECOLONIZATION OF MANGROVES</td>
<td>(ID:386) ABUNDANCE AND DISTRIBUTION OF ICHTHYOPLANKTO</td>
<td>(ID:447) MAPPING &amp; MODELING COASTAL WASTE WATER</td>
<td>none</td>
<td>(ID:622) THE DEVELOPMENT OF KATUNGGAN IT IBAJAY ECO-</td>
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<td>(ID:358) FISH COMPOSITION AND BIOMASS STRUCTURE IN RELATION TO PHYTOPLANKTON</td>
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<td>14:30</td>
<td>none</td>
<td>AND ZOOPLANKTON ASSEMBLAGES IN MANILA BAY, PHILIPPINES</td>
<td>Bendano A</td>
<td>(ID:684)</td>
<td>UNDERSTANDING A COMPLEX RELATIONSHIP: AN ASSESSMENT OF MARINE WILDLIFE TOURISM WITH ENDANGERED MARINE TURTLES AT APO ISLAND PROTECTED LANDSCAPE AND SEASCAPE Dollano J</td>
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<td>17:00-</td>
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In line with this year’s theme, the logo symbolizes the strategic cooperation between the scientific community and the different facets of the local institutions and the government to achieve wholesome and sustainable seas. The lower half signifies the ocean while the upper half shows the diversity of marine life and its interconnectivity with food security and environmental resilience. The halves meet at the center forming a handshake embodying the common understanding of the local communities, government, academe, private sector, NGOs, and especially the Filipino masses on the protection, management, and holistic conservation of the oceans. Lastly, the hues used also represent the colors of the sea at the break of dawn, signifying a new chapter for a more hopeful, science-based, and community-oriented future of the Philippine seas.

Best logo design for PAMS15
Mr. John Michael Lastimoso
PHOTO GALLERY
Dr. Yasmin Primavera-Tirol, President 2017-2019, declared the PAMS15 open and shared the rationale of the theme Fostering Synergy of Science, Community and Governance for Healthy Seas.
Honorable Larry Maming delivered his welcome address on behalf the Municipal Mayor of Banga, Hon. Erlinda Maming.
Hon. Carlito S. Marquez, Congressman of the 1st District of Aklan welcomed distinguished guests and participants of the Symposium.
Dr. Danilo E. Abayon, President, Aklan State University delivered his welcome remarks and noted the importance of science and technology in solving the most pressing problems and challenges in marine resources management.
Dr. Nygiel Armada, Chief of Party USAID Fish Right Project, as the Keynote Address highlighted the ultimate challenge of confronting excessive fishing effort and overcapacity by optimizing harvest from marine ecosystems through the re-allocation and right-sizing of fishing effort among the users.
The Delegates of the 15th National Symposium of Marine Science.
Dr. Wilfredo Campos, University of the Philippines Visayas emphasized that the overfished condition of most of the country’s coastal waters is a principal concern exacerbated by unclear policies, weak enforcement and lack of capacity and will power to manage local.
Dr. Ferrer emphasized that economic valuation needs to be visible, in order to show how economic principles and economic valuation can help decision making in fisheries management.
Dr. Hilly Roa-Quiaoit facilitating the *Hinun-anon nahanungod sa Kadagatan* was the first for PAMS to hold a multi-faceted discussion with the stakeholders of the coastal and marine environment.
Dr. Jurgenne Primavera emphasized that mangrove rehabilitation and conservation should be science-based and not quota- or budget-driven.
Dr. Lourdes J. Cruz presented the FUTURE EARTH program that seeks to address biocapacity loss due to threats such as deforestation, mangrove destruction and destruction of coral reefs and other marine habitats; and large ecological footprint brought about by generating non-renewable and non-recyclable wastes.
PAMS15 Session Chairs
The Mobile Marine And Naval Centrum made its way to Kalibo!
Experience Tubbataha Reefs Natural Park through a Virtual Reality Box.
Partners from the Southeast Asian Fisheries Development Center/Aquaculture Department promoting initiatives on research and developing technologies for food security, livelihood, equity, and sustainable development.
DA NFRDI promoting the Philippine Journal of Fisheries submission platform.
Oceana Philippines highlighting the importance of law enforcement and the establishment of Fisheries Management Areas of the DA BFAR.
DENR SMARTSeas PH Project highlighting CleanSeas Pilipinas and encouraging delegates to ban the use of single-use plastic.
Two best student oral presentors for 2019 were awarded with cash prizes from the Philippine Association of Marine Science and a trip to the Tubbataha Reefs Natural Park from the Tubbataha Management Office.

Mr. Andrew Torres won the Best Oral (Graduate) and Best Paper Presentation.
Ms. Mary Yshabelle Flores won the Best Oral (Undergraduate) Paper Presentation.