Participatory Resource and Socioeconomic Assessment of Ragay Gulf (Bicol Side), Philippines

Bicol University Center for Policy Studies and Development

10/30/2019

EXECUTIVE SUMMARY

INTRODUCTION

Ragay Gulf is a major source of fish in the Philippines. Ragay Gulf, together with Burias Pass, make up a basin located in the Bicol Region southeast of Luzon, Philippines and lies between latitudes 13° 00' N and 14° 00' N and longitudes 122° 25' E and 123° 20' E Jamir (1990). Ragay Gulf has a maximum width of about 25 nautical miles and longitudinal length of about 75 nautical miles with the main axis oriented along the northwest –southeast axis. It covers an area of 3,225 hectares which makes it the third largest gulf in the country next to Moro Gulf (12,900 has) and Davao Gulf (4,024 has) (PSA, 2019). The gulf is surrounded by three provinces: it is bounded on the north and east by the province of Camarines Sur, Quezon province on the west and southwest portion, and Masbate province (Ticao Island) on the southeast portion. Lying at the South western section are water bodies that connect the gulf to Sibuyan Sea and to Burias Pass. This elongated inland sea receives enormous discharges from rivers of Camarines and from Bondoc Peninsula of Quezon Province.

Post Resource and Social Assessment (PRSA) of Ragay Gulf by Campos et al (2006) reported that based on the Philippine Statistical Yearbook the population density in Camarines Sur rose from 201 persons / km^2 in 1980 to 283 persons / km^2 in 2000. Population density further increased to 354 persons / km^2 with reference to the 2015 census of population (PSA, 2016). This figure is above the regional average population density of 320 persons / km^2 as well as the national average population density of 337 persons / km^2 in 2015. The increase population density puts pressure on the natural resources to provide food for the growing number of people. This can be observed in the increasing fisheries production in Camarines Sur from 52,467.30 metric tons in 2002 to 86,956.90 metric tons in 2015 (PSA, 2018). More recent data from PSA shows that fisheries production continues to decline from 71,031.68 metric tons in 2016 to 69,371.29 metric tons in 2017, and 63,780.08 metric tons in 2018.

The Fisheries, Coastal Resources and Livelihood Project (FishCORAL) is a joint endeavour of the Government of the Philippines and the International Fund for Agricultural Development (IFAD). The overall goal of the Project is to contribute to the reduction of poverty incidence in the coastal communities of the 11 target bays in the Philippines, including Ragay Gulf. Specifically, the project aims achieve the following: (1) decrease poverty incidence by 5% from baseline of 42% (mean poverty incidence), (2) increase ownership of household assets by 20% of baseline, (3) decrease child malnutrition (ages 0-5 years) by 4% from baseline of 24.4%, (4) increase annual income of participating fishing community by 10% of baseline, and (5) increase in the employment of women engaged in income generating activities to 40% from baseline of 20%. In support to the FishCORAL project, this present baseline research aims to generate the following information:

1. Status socio-economic, livelihood, and coastal resources management initiatives;
2. Status of the aquatic ecology and habitats, namely corals and coral reef fishes, mangroves, and seagrass and seaweeds;
3. Status of the basic water quality;
4. Status of the catch and fishing efforts; and,
5. Establish Management Information System for the PRSA data.

METHODOLOGY

Primary and secondary data were utilized in this research. Existing reports and publications particularly the terminal report of the Post Resource and Social Assessment (PRSA) of Ragay Gulf prepared by the University of the Philippines in Los Baños Foundation Incorporated (UPLBFI) in 2006 and the findings from the Resource and Ecological Assessment in 1996 were referred utilized. Gulf-wide occurrence of coastal habitats specifically coral reefs, mangrove forests, and seagrass meadows were worked out from landsat data and rendered in mapping software. Coordination to LGUs and community partners were done both in writing and personal interactions.

Socio-economic, livelihood, and coastal resources management. Based on the 2019 FishR data of the Bureau of Fisheries and Aquatic Resources Region V there are 6,755 registered fishers involved in capture fisheries in the municipalities of Balatan, Bato, Bula, Del Gallego, Lupi, Minalabac, Pasacao, Ragay, San Fernando, and Sipocot. They are distributed in 44 coastal barangays. The estimated sample size was 220 households based on 95% confidence level (Z=1.96), margin of error of 0.065 and sample proportion of 0.5. For each barangay there was a target of 5 households. The research instrument used in this study was patterned after the Participatory Coastal Resource Assessment Training Guide developed by Deguit et al (2004). It divided into six parts: (1) Socio-demographic profile, (2) Household members, (3) Property ownership, (4) Economic characteristics, (5) Coastal resources management, and (6) Community involvement. The questionnaire was pre-tested in Sto. Domingo, Albay on March 2 – 3, 2019 before it was refined through the assistance of FishCORAL Technical Committee members. Training of the Field Interviewers immediately followed. To facilitate the data collection, coordination with the municipal and barangay officials were done prior to the activity. After coordination was done, simultaneous data collection was conducted by the team. The data were analyzed using descriptive statistics. Socio-demographic characteristics, frequency and percentage distribution were illustrated using figures and tables. Income and expenditure data, on the other hand, were reported using mean and range as numerical measures.

Status of corals and coral reef fishes. All diving activities used SCUBA equipment and with the knowledge and/or participation of barangay officials, designated bantay dagat members or with some community representatives. Coral reef assessment used Line Intercept Transect (LIT) method (English et al 1987) which employed video documentation to enable off-water life form identification and intercept reading. This was undertaken in all MPAs situated inside the gulf including non-MPA reef system for comparison purpose. Location coordinates were obtained for these sampling stations using Garmin GPS76CSx and all transects were 50 meters long. Coral reef status was evaluated based on criteria set by Gomez (1982). Ecological indices such as Simpson and Shanon-Weiner index of Diversity, Dominance index and Equitability/evenness were computed.

Fish Visual Census (FVC) was employed to assess the diversity of fish assemblage and estimate their approximate biomass. Within this observation area, reef fishes encountered were identified, counted and their lengths estimated. These length estimates were converted into weights using established length-weight relationships from published and unpublished local works and from FishBase. Macro invertebrates were observed and noted for their occurrence and abundance. Comparison of the reef health/statuses and the reef fish diversity and biomass were done per MPA using available baselines. Lastly, observable perturbations were documented together with macro algal colonization, and presence of macro invertebrates.

Status of mangroves. The mangrove habitat condition was evaluated using the Habitat Criteria Rating Chart for Mangroves by Participatory Coastal Resource Assessment (PCRA). Line Plot Method (English et al. 1997) was employed to assess the mangrove communities and determine their frequency, density, and species diversity. A 100-meter maximum transect line

was laid perpendicular to the shoreline, segmented every 5 meters with established sample plots with 5 m x 5 m area. A 1 m x 1 m sub-plot was established inside each plot for the identification and counting of sapling and seedling required for the regenerative capacity characterization. Stations were established per municipality where line plots covered the seaward margin, middle and land ward portions of the mangrove forest laid.

Each mangrove species along each transect was identified, counted, and the diameter of each tree was measured. Ecological Diversity Indices such as Shannon-Weiner Diversity Index (H), Simpson's Index (D), and Evenness (E) were measured. Additional parameters that were estimated include frequency, relative frequency, density, relative density, relative basal area, importance value, and relative dominance. Disturbances were observed based on the ocular inspection and reconnaissance. Rehabilitation efforts were based on the actual interviews of local officials and residents in the area.

Status of seagrass and seaweeds communities. Seagrass and seaweeds habitat assessment was conducted along the Camarines Sur municipalities of Ragay Gulf (Bato, Balatan, Minalabac, Lupi, Ragay and del Gallego) and one in Burias, Masbate (San Pascual). The study was carried out in one to three representative sites around each municipality. Line Transect-Quadrat Method (LQM as described by English et al. 1994) was used. A 100 meter transect lines was laid along the subtidal zone perpendicular to the shoreline while quadrats were laid at 10m interval with dimension of 50 cm x 50 cm and composed of 25, 10 cm x 10 cm sub-quadrats. Locations of each sampling site were recorded using global positioning system (GPS). The frequency of seagrass and seaweeds were also estimated by counting the occurrence of each species inside the quadrat. The cover of each species was also estimated using the standard technique developed by Saito and Atobe (1970).

Seagrasses and associated seaweeds that occurred inside the quadrat were taxonomically identified based on a field guide to the common mangroves, seagrasses and algae of the Philippines (Calumpong and Meñez, 1983). The taxonomic description of the specimen and its anatomical characteristics were referred from the field guide and atlas of the seaweed resources of the Philippines developed by Trono (1997), monographs, and reference herbaria. The community structure of seagrass and seaweeds was determined using the conventional functional ecological indices such as diversity (Shannon H') and dominance (Simpsons D).

Water quality assessment. Twenty-five **s**ampling stations were established in the municipal waters of Del Gallego, Ragay, Balatan, Bula, and Libmanan. Samples were collected following the recommended sampling protocols and were immediately conditioned in sterile polyethylene bottles as part of the proper sample handling prior to laboratory analyses.

In-situ measurements and laboratory analysis were employed in the assessment of primary water quality parameters. In-situ measurements include physical parameters such as temperature, dissolved oxygen and pH were obtained using Hanna multi-parameter water quality meter (HI 91894) with the capacity to read simultaneous recordings of at least 7 parameters with instrument probe deployable to up 5 meters maximum depth. Laboratory analyses for color, nutrients (phosphate ad nitrate), fecal coliform and TSS were undertaken at Regional Center for Food Safety and Quality Assurance laboratory of the Office of the Vice President for Research Development and Extension of Bicol University. Fecal Coliform was determined using Multiple Tube Fermentation Technique (MTFT), Nitrate as NO3-N (mg/L) was estimated using Brucine colorimetric method using UV-Vis Spectrophotometer, and total suspended solids (mg/L). was measured using conventional filtration and drying method. All measured primary parameters were compared to standards and minimum range limits set under the DAO 2016-08 for SB classification and usage. GIS maps to depict selected water quality conditions within each gulf were also made.

Catch and effort statistics. Gear inventory was conducted though Key Informant (KI) interviews to gather vital information pertaining to the number of fishing gear unit, fishing frequency and seasonality of fishing operation of various fishing gears in 57 coastal barangays of Ragay Gulf constituting 11 municipalities surrounding the gulf.

Catch and effort analysis was conducted by determining fish catch, fishing operations, and seasonality of various fishing gear types per category through recall interview with fishers with fishing experience of at least five years. Fishing efforts was estimated by multiplying the average annual fishing trips and count of gear unit. Information gathered were analyzed to determine realistic estimates of catch per fishing efforts exerted by different types of fishing gears to the resource as valid indicators of its status. Incidental catch and landing survey in some coastal villages during the KI interview were also sources of data. Furthermore, secondary data from government agencies (e.g. NSAP of DA- BFAR) were also utilized to estimate the fishery contribution of major finfishes to the total fishery production of the gulf. Total fishery production of the gulf was estimated using validated and monitored catch rate, fishing operation frequency and number of fishing gear units per gear type and per municipality.

Management information system. Rational Unified Process (RUP) was used to build the essential output requirements of the system. There were four phases in the development of the management information system. During the inception phase the researchers analyzed the existing studies and literatures, identify the opportunities, and project objectives. Guided by the objectives and deliverables stipulated in the project proposal, the researchers made an analysis on the survey instrument used and design the database schema. Some application programming language (API) for script and map rendering were analyzed and considered in the development process. Storyboarding was considered to pre-visualize the location of various objects such as text, pictures and other interactive media. In elaboration phase, context flow diagram, data flow diagram, and use case diagram were used to analyze the system needs and its architectural components. The web architecture was considered including its features and sub-modules. The software/hardware specification was considered to make sure that the system accommodates the required system operation. During the construction phase the functionality of the finalized features and sub-modules were tested. The products of this phase include web interface modules, user management module, report generation, and maintenance module. Lastly, in the transition phase, the system was implemented by the stakeholder to make it available to the community. The presentation of the system during the stakeholder's meeting helped to fine tune the system for Alpha/Beta testing.

RESULTS

Socio-economic, livelihood, and coastal resources management. Results of the socio-economic survey reveals that the fishers in Ragay Gulf were getting older. 7 of every 10 fishers were 40 years old and older with mean age of 47 years old. In terms of sex, 90% of the interviewed respondents were males. Household size of 50.68% of the respondents was 6 to 10 members while 44.29% have household size of below 5 members. The predominant cause of morbidity among coastal households was viral infection (27.36%) such as influenza, common cold, chicken pox, mumps, and measles, hypertension (17.92%), and disease symptoms such as headache, fever, back pain, and stomachache (14.15%).

In terms of house ownership, more than half (55.71%) of the households own their house and lot, 28.31% of the households who own their house that was built on another person's lot, and 6.4% of the households stay in houses that they do not own for free. More than one-third (38.81%) have concrete houses, 36.07% have houses made of nipa / cogon, and 24.66% have houses made of wood or bamboo with galvanized iron roof.

Deep well / artesian well was the primary source of drinking water as reported by 47.49% of the respondents, 27.40% obtain their drinking water from their own faucet through community water system or NAWASA, 10.50% bought bottled water from water refilling stations. Since almost all households have access to electricity, it becomes inevitable for them to own appliances such as television (77.17%), electric fan (71.23%), cellphone (49.77%), and radio (41.10%). Aside from appliances, they also own transportation assets or vehicles such as boat (63.90%) and motorcycle (18.26%).

Bottom-set gill net is the most common fishing gear used by the fishers in Ragay Gulf as reported by 111 respondents. In terms of ownership, 87.39% of the respondents owned their bottom-set gill net while 14.41% share the fishing gear with other fishers. Simple handline / hook & line is also a common fishing gear as reported by 83 respondents. Almost all (92.77%) of the fishers owned their simple handline / hook and line while the remaining 6 respondents either use shared or leased fishing gear. Fish/crab/squid pots, scoop net with light, and bottom-set long line were also used by the respondents.

Fishing industry in Ragay Gulf is market driven. Fishers moved away from the traditional subsistence fishing in which they catch fish to sustain the need for food of their families. Eighty-four percent of the respondents catch fish that are intended to be sold for cash. Selling of fish was performed by 60% of the husbands while 19% reported that it is the wife of the fisher that sells fish.

Fishing, being the primary livelihood activity in the coastal municipalities of Ragay Gulf, provides an average household income of Php16,811.67 per month as reported by 210 respondents. Fifty households responded that aside from fishing they earned income from regular employment which amounts to Php7,750.72 per month on the average. Fish marketing was also a supplemental source of income of households. Instead of selling the fish caught to the traders 28 respondents revealed that they sell their fish to their neighbors which provided them an average income of Php4,329.29 per month. In cases when there were surplus fish 11 households process the fish through drying which provided them supplemental income of Php5,455,00 per month. Chicken and hog raising were common agriculture-based livelihood of the fishers which provided supplemental income to 16 households amounting to Php7,696.25 per month.

The other sources of household income were wage income from labor, rice production, business, remittance of OFWs, siblings and children, preparation of gears, root crop production, and vegetable production. It was also revealed by 77 respondents that the transfer payments from 4Ps, pension, and unconditional cash transfer provided supplemental income for the household.

The sampling performed was intended to provide a picture of the poverty situation in coastal communities in Ragay Gulf and not for each municipality surrounding the gulf. Php2,315.00 was the per capita poverty threshold per month based on the Family Income and Expenditure Survey (FIES) for a household with five members. Using this threshold, 52% of the households in Ragay Gulf can be classified as poor. This is high compared to the average poverty incidence in Camarines Sur which reduced from 31.3% in 2015 to 19.2% in 2018. In terms of distribution, the income of households from fishing and from all sources is skewed. Even if the mean annual income per capita is Php67,089, the median income is only Php27,000.00 per capita per year. Median annual per capita income provides better estimate of average income of households in Ragay Gulf because of the presence of few respondents with very high income compared to most of the households. Among the municipalities covered, respondents from Bato have the highest median annual per capita income of Php78,420.00 followed by Del Gallego (Php54,000.00), Ragay (Php27,000.00), and Balatan (Php26,100.00). Median income from fishing was also highest in these municipalities. The baseline poverty threshold was even higher compared to the 42% baseline of the FishCORAL project.

Nonetheless, this figure could be used for monitoring activities as the project progresses to be able to establish trend and potentially provide estimate of the project's impact.

Coastal resources management study reveals that two-thirds or 148 of the 219 respondents perceived that the fish they caught years ago were large only 27 or 12.33% perceives that the size of fish that they caught is better at present. Almost two-thirds of the respondents (143 of 219) also perceive that fish is more abundant years ago while only 38 respondents perceive that fish is more abundant at present. The perceived declining volume and size of fish caught were attributed to anthropogenic factors particularly overfishing and catching of fish even before they reach the size when they are sexually mature to reproduce, illegal use of destructive fishing practices (28.73%), intrusion of commercial fishing vessels in municipal waters, damaged fishing gears, and lack of fishing gears. Natural factors such as typhoon was also cited as cause for the declining volume of fish caught because, in the short run, it reduces the frequency of trips of the fishers to the sea.

Among the illegal fishing methods used in Ragay Gulf as reported by 79 respondents include Danish seine (36.71%), cyanide fishing (29.11%), dynamite fishing (27.85%), and trawl (3.80%).The use of purse/Danish seine and dynamite fishing were observed by at least one-third or 33% of the fishers in Del Gallego and Ragay. Purse/Danish seine was also observed in the neighboring municipalities of Lupi, Sipocot, and Pasacao, as revealed by the respondents. Cyanide fishing was prevalent in the eastern side of Ragay Gulf, particularly in the municipalities of San Fernando, Minalabac, Balatan, and Bato.

There was limited level of awareness on CRM activities. Only 35 or 15.98% of the respondents were aware of the projects or activities related to fishing in Ragay Gulf. Livelihood projects, resource conservation initiatives, and enforcement of fishery laws were the projects/activities of which the respondents were familiar. There were seven respondents who rated the livelihood projects very effective and the same number of respondents rated the projects effective. These livelihood projects included provision of fishing nets by fishers' organizations, ice-making training provided by the Department of Labor and Employment (DOLE), and provision of boats by the Bureau of Fisheries and Aquatic Resources (BFAR). These livelihood projects were identified only by the fishers in the municipalities of Balatan, Pasacao, and Ragay.

The enforcement of fishery laws by the *bantay dagat* was identified by the fishers in the municipalities of Balatan, Lupi, Minalabac, Pasacao, Ragay, and San Fernando. Five of the respondents rated the activity moderately effective while four rated it very effective and three rated the activity as effective. *Bantay dagat* is an initiative of the municipal local government unit, barangay LGU, and, in some, cases by the fishers' organization. This CRM activity was moderately effective because the presence of *bantay dagat* in municipal waters, particularly in areas with Marine Sanctuary and Fisheries Reserve (MSFR), is not constant.

Among the identified CRM projects/activities, resource conservation was rated very effective by more than half of the respondents who were familiar of this initiative. Eight respondents rated it very effective, while two rated it effective, and the same number rated it moderately effective. It was also noted that there were more fish in municipalities with established sanctuaries in Balatan, Bula, Pasacao, and San Fernando. Another resource conservation initiative was mangrove planting which was reported by fishers in Lupi, Pasacao, and Ragay. Despite the existence of illegal fishing in the municipal waters, 48% of the respondents believed that their municipal ordinances are effective. The extent of illegal fishing activities could be higher if there were no ordinances in place.

Status of corals and coral reef fishes. The Bicol side of Ragay Gulf constitute 76% of the entire area. San Pascual dominate the area of municipal waters (1,429 km^2), followed by

Pasacao, Ragay and Libmanan. As noted in Post RSA report (2005), reef areas of the gulf provide narrow fringe forms in the shallow coastal areas.

There were only six Marine Protected Areas in Ragay Gulf from 1993 to 2005 according to the Post RSA report in 2006. The oldest MPA is in Caranan (Dalupaon) which was established in 1993. Recently, there were already twelve MPAs in Ragay Gulf with combined area of 2664.34 hectares. This protection coverage represents 0.88% of the total municipal water of 2,993.53 km^2 for the Bicol side of the gulf which is below the mandated protection of coastal waters outlined in the Fisheries Code. San Pascual MPA is the largest MPA in Ragay Gulf with 1,139 hectares which represents 43% of the total MPA area in the Bicol side of the gulf. This is followed by the 526 hectares MPA in Del Gallego and the remaining MPAs have smaller sizes ranging from 30 hectares to 165 hectares. The smallest MPA is in Caorasan in Bula, Camarines Sur with an area of 30 hectares.

Payak MPA in Bato, Camarines Sur has an area of 51 hectares which harbours a reef system that is in fair condition, with live coral cover ranging from 42-43%. Growth of macroalgae was also very extensive here, yielding 35-39% cover. Dead corals appeared to be minimal (6.7-11.6%), but the big proportion of seaweed bed dominated by brown algal species are previously dead corals that are now colonized by the macroalgae. Coral condition inside this MPA was maintained based from the 2006 baseline which was 41.5% inside. A reference outside reef was found to be in good condition with a live coral cover (LCC) of 65%. This highlights opportunity for Bato to reconsider expansion of its Payak MPA to provide protection as well to the non-MPA reef systems. This was necessary as its three MPAs only provided an aggregate protection of 1.01% of its municipal water.

Balatan has a 106-hectare Pararao MPA with narrow and silted reef system. Another site fronting Barangay Coguit is being proposed as additional MPA. Both reef systems are shallow with expansive intertidal area for daily gleaning, crown of thorns are present as well as left-out nets and parts of fishing paraphernalia. The occurrence of new coral formations and numbers of coral recruits in Pararao MPA manifest some good management couple of years back. Dead corals reduced to 19% from 27.22% in the 2005 assessment. These are now covered by macroalgal assemblage. The proposed MPA in Coguit showed some good condition on its reef system, especially those at the deeper part. This has good coral cover ranging from 50.6%-52.3%. Algae was considerable (21% cover) with large area of barren hard substrate (8%-17%). The proposed additional MPA in Coguit is an opportunity to improve municipal water protection of Balatan which was only 1.56%.

MPA in front of Caorasan, Bula is the smallest MPA with an area of 30 hectares which represents only 0.33% of the entire municipal water of Bula. This was established in 2005 and harbors a reef system that was in poor to fair condition (11-26% coral cover). Based on the latest assessment, there was a tremendous improvement in the condition of its coral reefs to good condition with live cover of 57.9%. Dead corals were also significantly reduced from 24-33% to 21% in the recent assessment. Algae was also significantly reduced from 21-27% in 2005 to just 8.42%. Abiotic components were very high in 2005 (13-22%) while it was just 7.74% in the present assessment. All indicators in the present life forms indicate good development in the reef systems, unlike its neighboring reefs, which can be attributed to good MPA management in the area.

San Fernando has two MPAs: the youngest Gnaran with an area of 26.8 hectares and a nearly two decades old Cotmo MPA with an area of 115 hectares. Only Gnaran was assessed in the present study and was found out to be on fair condition with live coral cover of 34.7%. Bulk of this were hard corals but non-Acropora types. It was

noteworthy to mention the large coverage of macroalgae, covering 44.9% of the transects. Algae in the nearby Cotmo MPA was only 14% while abiotic constitutes 24.5%. In 2005, Cotmo reef was found to be in fair condition (28.98% LCC) with dead corals (27.2%) and abiotic factors (24.5%).

Pasacao has two MPAs. MPA in Dalupaon in Barangay Caranan/Sarimao was the oldest MPA in the Bicol side of Ragay Gulf which was established in 1993 with an area of 112 hectares. The new MPA was established in Tinalmod with a total area of 144 hectares. The aggregate 266 hectares coastal protection area of the two MPAs only represented 0.30% of its municipal water. There seemed to be a drastic improvement in the coral cover of the MPA in Caranan-Sarimao MPA in the latest assessment compared to the Post RSA in 2006 and REA in 1995. Live coral cover is in good health status of 54.10%. The reef system of the other MPA (Tinalmod) is in fair condition (38.3% LCC). Overall, the detected improvement of the coral cover could be attributed to the protection afforded by the LGU to the reef systems. However, it was observed that there was increasing seaweed beds thriving on top of dead corals and abiotic substrates with 54.9% coverage compared to 47% in 2005. The microalgal bed was dominated by Padina and Sargasum species.

MPA in Minalabac, Camarines Sur has a total area 126.2 hectares which is composed of a 23.8-hectare sanctuary and 102.4-hectare reserve. The present assessment revealed that the coral condition inside the sanctuary is in good condition with two transects yielding almost identical live coral cover of 50%-50.4%. Compared to the Post RSA report in 2006, the reefs of the MPA in Salingogon was reported to be in poor condition, both inside (22.8% LCC) and outside (18.4% LCC). Coral mortality remains unchanged but the shift to macroalgal growth is evident from 39% in 2006 to 42% coral cover in 2019.

MPA in front of Barangay Bangon in Lupi, Camarines Sur is the second smallest MPA with an area of 54 hectares. It provides 2.58% protection to the small municipal water of the municipality. The recent assessment showed improvement in coral condition (54%-56.7% LCC) in the MPA. Based on the previous two assessments, reef condition was near to being in good state (49.9% LCC) in 1995 (REA, 1995) but it deteriorated to 31.4% in 2005 (Ticson et al, 2006). The deterioration in 2005 status can be attributed to huge cover of dead corals (21%) and abiotic factors (38%).

Ogtok MPA in the municipality of Ragay was established in 1997 and it covers an area of 98.55 hectares. It constitutes 0.32% protection of the municipal water with core area occupying two thirds (2/3) of the MPA while the remaining served as the buffer or reserve. Historical coral condition record of this MPA showed poor coral cover (15.8%) in 1995 and it improved to fair condition (25.6%) in 2005 (Ticson et al, 2006). Outside transects yielded better coral condition (31% LCC).

MPA in Del Gallego can be found in front of Barangay Sabang which covers 526 hectares. The corals condition is fair with live coral cover of 32.9% that appear in patches with high cover of substrate component (56.9%). The health condition of the corals declined compared to the 2005 assessment which revealed that it was in good condition (52.6% LCC). Inside the MPA, the reefs were in poor state (15.84), with huge component covered by algae (27.8%) and substrate (40%). There is a need for Del Gallego to do revalidation study of the location and extent of coverage of Sabang sanctuary.

San Pascual in Ticao Island, Masbate has the biggest MPA among the municipalities of the Bicol Region bordering Ragay Gulf. The MPA Busing was established in 2012 which encompass a total area of 2,139 hectares with a very small core area (65 hectares) while the rest are reserve/buffer zone. The MPA only covers 0.80% of its municipal water due to the huge municipal water of San Pascual. The present assessment was focused on Busing Marine

Reserve and Sanctuary and a non-MPA shallow reef system located near Tinalisayan Island. The coral cover here in MPA is only fair (25-35.4% LCC) as compared to the 49.8-54% coral cover of the non-MPA site in Tinalisayan. The relatively low live coral cover inside the MPA can be attributed to the growth of seaweed beds (24%-26%) and the patchy occurrence of the coral formations, resulting to large cover (34%-36.7%) of abiotic/substrate component.

Reef fishes of Ragay, Bula, Pasacao (Sarimao) and Balatan registered the highest diversity indices because these areas harbor the greatest number of species and fishes encountered. Reef fishes in these municipalities were fairly distributed as well, with evenness indices ranging from 0.73 to 0.87. The reef systems with low diversity indices include Busing (0.01), Gnaran (0.06), and Tinalmod (0.07). These areas have either less species and fish abundance and/or a species or several species dominate in terms of fish abundance. Generally, reef fish species assemblage was less diverse in the present survey than in the 1995 (REA) and Post RSA of 2006.

Associated macro invertebrates such as crown of thorns were ubiquitous and were seen in almost all stations. These are prevalent in Busing, Coguit and Bangon reef in Balatan and Lupi. Ropes and abandoned fishing gears such as entangled fishing nets and bottom set long lines were seen in all reef systems. Minimal bleaching was observed in Ragay Gulf. But shallow reefs of Tinalmod and Sarimao of Pasacao were seen to have events of bleaching but they were recovering. The highlighted overgrowth of macroalgae was also everywhere.

Status of mangroves. Five stations were established in Ragay Gulf for mangrove assessment. These are located in Halabang Baybay and Pinamasingan in San Pascual, San Juan and Sabang in Del Gallego, and San Rafael in Ragay.

Mangrove areas under good condition include Halabang Baybay, Pinamasingan, San Juan, and San Rafael, while Sabang in Del Gallego falls under fair to poor condition due to massive fish pond conversion of mangrove areas. The mangrove areas converted were approximately one hundred hectares. Large fish ponds line the road sides from the town proper to the Sabang port. The back portions of the already converted fish ponds were converted into even smaller fishponds, which lead to their poor condition. Other mangrove areas covered as sampling sites have recover due to mangrove rehabilitation projects. However, these projects do not guarantee mangrove survival. Many mangrove areas in the coastlines of Ragay Gulf were already under poor conditions, such as the entire Balatan/Bato mangrove area, including San Cirilo, Sta. Rosa, Mainit, Balogo, and San Vicente mostly within the municipality of Pasacao. Most of the mangroves are in peril and in the brink of destruction. Other disturbances that contributed to the decline in mangrove area and survival include land reclamations and conversions. Some examples of these would be the construction of road networks, construction of residential areas, the presence of an oil depot near mangrove areas, and the presence of solid wastes that impede the growth of mangrove seedlings and saplings. Other threats to mangrove survival are rapid urbanization and population.

Some mangrove areas already caused siltation to the sea and affected the sea grass beds covering approximately 150 meters with mud soil and a depth of one meter. A typical example was observed in the Sabang area in the municipality of Del Gallego and in Pinamasingan in San Pascual. This happens due to a lack of frontline mangroves with filtering ability. Mangrove species with filtering ability include *Avicennia marina* (Bungalon) and *Sonneratia alba* (Pagatpat) because of their root structure with pen-like and cone-shape breathing roots.

Status of seagrass and seaweeds communities.

Water quality assessment.

Catch and effort statistics.

Management information system.

ACKNOWLEDGEMENTS

TABLE OF CONTENTS

SOCIO-DEMOGRAPHIC AND ECONOMIC ASSESSMENT OF COASTAL COMMUNITIES IN RAGAY GULF

Erwin E. Torres
Ronnel R. Dioneda, Sr.
Aliana Joy G. Carrillo
Richelle Bañadera
Bicol University
Legazpi City

Torres, E.E., R. R. Dioneda, A.J.G. Carrillo, and R. B. Banadera. 2019. Socio-demographic and economic assessment of coastal communities in Ragay Gulf. Pp 50-81. In Dioneda R.R., E.E. Torres and G. Naz. (Eds). 2019. Participatory Resource and Socio-Economic Assessment of Ragay Gulf-Bicol Side. Terminal Report Submitted for the Fisheries, Coastal Resources and Livelihood Project, Department of Agriculture-Bureau of Fisheries and Aquatic Resources, Quezon City. Bicol University, Center for Policy Studies and Development, Legazpi City. 200 pp.

ABSTRACT

This paper primarily intends to provide baseline information about the sociodemographic and economic characteristics of the coastal communities in Ragay Gulf. Lessons were drawn from 219 samples from 49 barangays in 11 municipalities in Camarines Sur though sample survey. Results reveal that the fisheries sector confronts multitude of problems that suppress its growth. Among these are declining volume of fish caught, ageing fishers, unsecured property rights, limited access to proper water and sanitation facilities, and over-all above dismal poverty situation.

Despite these impediments there were improvements in access to public health services, availability of vehicle for information dissemination, and alternative sources of livelihood which can potentially be utilized to boost the fisheries sector through provision of alternative sources of income through value addition to lessen the pressure of overexploitation of coastal resources to support the growing population

Keywords: sociodemographic, economic, assessment, FishCORAL, Ragay Gulf

INTRODUCTION

Figure 1. Map of Ragay Gulf showing municipal waters.

Ragay Gulf is a major source of fish in the Philippines. It covers an area of 3,225 hectares which makes it the third largest gulf in the country next to Moro Gulf (12,900 has) and Davao Gulf (4,024 has) (PSA, 2019). The gulf is surrounded by three provinces: it is bounded on the north and east by the province of Camarines Sur, Quezon province on the west and southwest portion, and Masbate province (Ticao Island) on the southeast portion. Campos et al (2006) reported that based on the Philippine Statistical Yearbook the population density in Camarines Sur rose from 201 persons / km^2 in 1980 to 283 persons / km^2 in 2000. Population density further increased to 354 persons / km^2 with reference to the 2015 census of population (PSA, 2016). This figure is above the regional average population density of 320 persons / km^2 as well as the national average population density of 337 persons / km^2 in 2015. The increase population density puts pressure on the natural resources to provide food for the growing number of people. This can be observed in the increasing fisheries production in Camarines Sur from 52,467.30 metric tons in 2002 to 86,956.90 metric tons in 2015 (PSA, 2018). More recent data from PSA shows that fisheries production continues to decline from 71,031.68 metric tons in 2016 to 69,371.29 metric tons in 2017, and 63,780.08 metric tons in 2018.

Population that are dependent on farming and fishing are among the vulnerable groups. Although they serve as the country's lifeline in assuring food security are the top sectors with alarming poverty incidence of 38.3 and 39.2%, respectively (PSA 2012). Existing documents attribute to big family size and low educational level as the primary culprits of high poverty incidence among farmers and fishers (Reyes et al., 2012). Depletion of fish stocks and the continuing deterioration of the state of coastal habitats have also been demonstrated to be the cause of dismal trend of economic status of fishing families. To address the alarming poverty incidence in fishing communities and provide protection and conservation of coastal resources, the Department of Agriculture's Bureau of Fisheries and Aquatic Resources (DA-BFAR) launched the Fisheries, Coastal Resources and Livelihood (FishCORAL) Project. This United Nations Fund for Agricultural Development (UN-IFAD)-funded project prioritizes 11 target fishing grounds for a development goal of enabling coastal communities sustainably manage their fishery and coastal resources and generating livelihood benefits for fishing households. At the end of the project it is expected that poverty incidence in the coastal communities will be reduced by 5% from the baseline of 42%, child malnutrition will be reduced by 4% from the baseline of 24.4%, and employment of women to 40% from the baseline of 20%. The project also intends to increase annual income of fishing households by 10% and asset ownership by 20% based on the baseline to be identified at the local level.

This study intends to provide localized baseline of socioeconomic indicators for the FishCORAL Project and intends to fill-in the gap in the trend in the socioeconomic characteristics of coastal communities as described by previous studies under the Socioeconomic Investment Opportunities studies under the Fisheries Sector Program (FSP) in 1991 and Post Resource and Socioeconomic assessment in 2005. Specifically, the paper aims to:

1. describe the socio-demographic and economic profile of coastal communities;
2. analyze the sociodemographic characteristics of the fishers; and
3. evaluate the economic situation of the households engaged in the fishing sector.

METHODOLOGY

This research employed descriptive research method through the conduct of sample survey in identified project sites of FishCORAL. This section presents population where the samples were identified, method of data collection, and method of data analysis.

Population and sample. Based on the 2019 FishR data of the Bureau of Fisheries and Aquatic Resources Region V there are 6,755 registered fishers involved in capture fisheries in the municipalities of Balatan, Bato, Bula, Del Gallego, Lupi, Minalabac, Pasacao, Ragay, San Fernando, and Sipocot. They are distributed in 44 coastal barangays. The estimated sample size was 220 households based on 95% confidence level (Z=1.96), margin of error of 0.065 and sample proportion of 0.5. For each barangay there was a target of 5 households. The summary of the number of respondents per municipality was presented in Table 1.

Table 1. Coastal barangays covered along Ragay Gulf: 2019.

Municipality	Coastal Barangays	No. of respondents
Balatan	Camangahan, Pararao, Luluasan, Siramag, Duran, and Coguit	30
Bato	Pagatpatan, Payak, and Palo	15
Bula	Caorasan and Itangon	10
Del Gallego	Magais I, Pasay, Sabang, Salvacion, San Juan, Penafrancia (Sinawagaswasan), and Sinuknipan II	34
Lupi	Bangon	5
Minalabac	Bagolatao, Hamoraon, Salingogon, and San Antonio	20
Pasacao	Balogo, Caranan, Dalupaon, San Cirilo, andSanta Rosa Del Sur, and Tinalmud	30
Ragay	Apad, Binahan Prop., Buenasuerte, Cabugao, Catabangan Proper, F. Simeon, Lohong, Lower Omon, San Rafael, &Tagbac	50
San Fernando	Bical, Cotmon, Gnaran, and Pinamasagan	20
Sipocot	Binahian	5
	Total Respondents	**219**

Method of data collection. The research instrument used in this study was patterned after the Participatory Coastal Resource Assessment Training Guide developed by Deguit, et al (2004). The questionnaire was pre-tested in Sto. Domingo, Albay on March 2 – 3, 2019 before it was refined through the assistance of FishCORAL Technical Committee members. Training of the Field Interviewers immediately followed. To facilitate the data collection, coordination with the municipal and barangay officials were done prior to the activity. After coordination was done, simultaneous data collection was conducted by the team. The questionnaire utilized in the study was divided into six parts: (1) Socio-demographic profile, (2) Household members, (3) Property ownership, (4) Economic characteristics, (5) Coastal resources management, and (6) Community involvement.

Each field interviewer was assigned to do a face-to-face interview with the respondent which could extend for 25 to 30 minutes. In each barangay, the Purok with the greatest number of fishers was selected as the sampling unit of the coastal barangay. With the assistance of the assigned barangay official, households were randomly selected with an interval of one household after each qualified household. Replacements were done in cases of outright refusal or when there was no member engaged in fishing. In cases when the member of the household primarily engaged in fishing activities was not available during the day of the visit, other members “directly or personally and physically engaged in taking and/or culturing

and processing fishery and/or aquatic resources" (R.A. 8550) served as the respondent. Data collection was conducted in May to July 2019.

Figure 2. Data collection in the coastal communities in Ragay Gulf.

Method of data analysis. The data were analyzed using descriptive statistics. Socio-demographic characteristics, frequency and percentage distribution were illustrated using figures and tables. Income and expenditure data, on the other hand, were reported using mean and range as numerical measures.

RESULTS AND DISCUSSION

This section is divided into four parts: socio-demographic characteristics of the respondents, household and health profile, housing profile, and their economic profile.

Socio-demographic characteristics of respondents. The fishers in Ragay Gulf were getting older. 7 of every 10 fishers were 40 years old and older with mean age of 47 years old (Table 2). This was higher compared to the 42 years old mean age of fishers in 1991 based on SEIOS and 41 years old based on Post-RSA in 2005. This could also imply the declining interest of the younger generation to engage in fishing activities. In terms of sex, 90% of the interviewed respondents were males. Fishing is pre-dominantly an activity of men. The only time that the researchers were able to interviews their spouse was when the fishers were not around during the conduct of interview. 86% of the respondents were married while 10% remained single as of the date when the interview was conducted.

At least half (52%) of the respondents were at most elementary graduates, 21% were able to earn secondary education, 20% were able to complete secondary education, and 7% were able to enter tertiary education. It is common in coastal communities for families to send their children in primary school to learn to read and write afterwards they joined their father in fishing activities to earn for a living. Another explanation is the limited secondary schools in coastal areas in the past which prohibits the families to send their children to pursue further studies beyond primary level. Lastly, the religious affiliation of the respondents is reflective of the Philippines' being a predominantly catholic country. Almost all (95%) of the respondents are Roman Catholics while the remaining 5% belong to Iglesia ni Cristo or Philippine Independent Church (Aglipayan).

Table 2. Distribution of respondents by socio-demographic profile, Ragay Gulf: 2019.

Socio-demographic profile	Frequency	Percent
Age		
Below 20	1	1
21-30	22	10
31-40	43	20
41-50	68	31
51-60	49	22
61 and above	36	16
Sex		
Male	197	90
Female	22	10
Civil Status		
Single	22	10
Married	189	86
Others	5	2
No Response	2	1
Highest Educational Attainment		
Elementary Level	43	20
Elementary Graduate	71	32
Highschool Level	47	21
Highschool Graduate	44	20
College Level	10	5
College Graduate	4	2
Religion		
Roman Catholic	209	95
Iglesia ni Cristo	4	2
Others	2	1
No Response	4	2

Household and health profile. More than half (50.68%) of the households have household size of 6 to 10 members while 44.29% have household size of below 5 members (Table 3). Households in coastal communities resemble an extended family because even if the children get married they tend to stay in their parent's house. A typical coastal community household is composed of a couple, their children (including the dependents), and their children's children. This is supported by the evidence that 31% of the household members are below 20 years old.

Table 3. Distribution of respondents by household profile, Ragay Gulf: 2019.

Household size	Frequency	Percent
below 5	97	44.29
6 to 10	111	50.68
10 and above	8	3.65
No Response	3	1.37
TOTAL	**219**	**100**

There were varied causes of illness of household members as revealed in Table 4. The predominant cause of morbidity among coastal households was viral infection (27.36%) such as influenza, common cold, chicken pox, mumps, and measles (Table 4). This was followed by hypertension (17.92%), and disease symptoms such as headache, fever, back pain, and stomachache (14.15%).

Table 4. Distribution of respondents by illness experienced in the past 12 months and to whom they consulted, Ragay Gulf: 2019.

Illnesses	Consulted with						Percent
	Local Hilot	BHW	RHU	Private Physician	None	**Total**	
Viral Infection	7	9	6	2	5	**29**	**27.36**
Hypertension	0	11	7	1	0	**19**	**17.92**
Disease Symptoms	2	10	1	2	0	**15**	**14.15**
Inflammatory Illnesses	0	4	3	3	0	**10**	**9.43**
Asthma/Respiratory Diseases	0	3	2	1	2	**8**	**7.55**
Heart Disease and other organ complications / disorders	0	1	2	4	0	**7**	**6.60**
Bacterial Infection	0	0	1	4	0	**5**	**4.72**
Blood Infection	0	0	3	0	0	**3**	**2.83**
Diabetic	0	0	1	2	0	**3**	**2.83**
Others	0	1	2	2	2	**7**	**6.60**
TOTAL	**9**	**39**	**28**	**21**	**9**	**106**	**100**

It can be observed in the table that the household members consult barangay health workers and rural health units more than traditional *hilot.* This is a good indicator that health care services of the government can now reach the marginalized groups in geographically isolated areas. Viral infection, hypertension, disease symptoms, and inflammatory illnesses are among the causes of morbidity consulted with the BHW and RHU. More complicated illnesses such as heart disease and other organ complications / disorders, bacterial infection, and diabetes were referred to private physicians.

Housing profile. It is a notable observation in Ragay Gulf that more than half (55.71%) of the households own their house and lot (Table 5). House ownership is a good barometer of standard of living. There were also 28.31% of the households who own their house that was built on another person's lot. Most

of these households stay in the lot of their relatives. Lastly, 6.4% of the households stay in houses that they do not own for free. This is, however, a minimal number compared to those who already own the property.

Table 5. Distribution of respondents by housing profile, Ragay Gulf: 2019.

Housing profile	Frequency	Percent
Ownership of House		
Owner, owner-like possession of house and lot	122	55.71
Own house, rent-free lot with owner's consent	62	28.31
Own house, rent-free lot without owner's consent	21	9.59
Rent-free house, including lot	6	2.74
Rent-free house and lot with owner's consent	7	3.20
Rent-free house and lot without owner's consent	1	0.46
Type of dwelling		
Concrete (Cement)	85	38.81
Nipa/Cogon Hut	79	36.07
Wood/Bamboo with GI Roof	54	24.66
Mixed	1	0.46

The type of dwelling varies among households. More than one-third (38.81%) have concrete houses, 36.07% have houses made of nipa / cogon, and 24.66% have houses made of wood or bamboo with galvanized iron roof. The type of dwelling was dependent on the ability of the households to purchase durable materials that can withstand the typhoons and monsoon winds that usually hit their place.

Almost all households (95.89%) have access to electricity. Only seven households reported that they used kerosene as primary fuel for lighting (Table 6). Although they have access to electricity, not all of them have their own electricity connection. There were 78.54% households with their own electricity connection and 15.53% have shared connection with their neighbors. The 34 households that share electricity connection with their neighbor only pay minimum amount per electric bulb for their lighting needs especially at night. Two respondents reported that their household have their own generator set to produce electricity and another two respondents revealed that their household used batteries as source of power for their electric devices.

Table 6. Distribution of respondents by utility and health facilities, Ragay Gulf: 2019.

Utility and health facilities	Frequency	Percent
Lighting Facility		
Electricity	210	95.89
Kerosene Lamp	7	3.20
No response	2	0.91
Source of Electricity		
Electricity own connection	172	78.54
Electricity shared connection	34	15.53
Generator	2	0.91
Battery	2	0.91
None	5	2.28
No Response	4	1.83
Source of drinking water		
Deep well / Artesian well	104	47.49
Own water faucet	60	27.40
Bottled water	23	10.50
River, stream, lake, and other bodies of water	16	7.31
Others	13	5.94
No Response	3	1.37

Utility and health facilities	Frequency	Percent
Toilet Facility		
Water-sealed	164	74.89
Drop/overhang	23	10.50
Flush type	12	5.48
Open Field	8	3.65
Pit toilet/ latrine	4	1.83
Others	3	1.37
No Response	5	2.28

Deep well / artesian well was the primary source of drinking water as reported by 47.49% of the respondents. More than a quarter (27.40%) obtain their drinking water from their own faucet through community water system or NAWASA. The rest of the respondents bought bottled water from water refilling stations (10.50%) or bodies of water (7.31%). Clean source of water is necessary to ensure good health of household members. It can be remembered in Table 4 that five respondents reported that bacterial infection is among the causes of morbidity in their household.

Similar to the necessity of having safe source of drinking water is the need to have hygienic toilet facility. Close to three-fourths (74.89%) of the respondents reported that they have water-sealed toilets in their households. In a coastal community it is relatively expensive to have their own septic tank to contain human excreta. And this is further constrained by lot ownership. As reported in Table 5, only 55.71% of the respondents own their lot. Drop/overhang (10.50%), open field (3.65%), pit toilet / latrine (1.83%) are among the toilet facilities that can potentially expose the members of the households to different diseases.

Since almost all households have access to electricity, it becomes inevitable for them to own appliances. Television (77.17%), electric fan (71.23%), cellphone (49.77%), and radio (41.10%) are the most common appliances owned by the households (Table 7). These appliances are important source of information and comfort for the household members. The television, cellphone, and radio can be a vehicle for knowledge transfer and information dissemination to the residents of the coastal communities. Other appliances owned by the respondents include refrigerator (16.35%), gas stove (15.23%),s and computer / laptop (1.83%). Some respondents also reported that they own bed (29.22%) and *sala* set (12.33%).

Table 7. Distribution of respondents by furniture and appliances owned, Ragay Gulf: 2019.

Furniture/appliance owned	Frequency	Percent
Television	169	77.17
Electric fan	156	71.23
Cellphone	109	49.77
Radio	90	41.10
Bed	64	29.22
Refrigerator	38	17.35
Gas Stove	34	15.53
Sala Set	27	12.33
Computer/laptop	4	1.83

Aside from appliances, the respondents were also asked if they own transportation assets or vehicles. Boat was the most common vehicle owned by the households (63.90%) because it is primarily used in their fishing activities to earn for a living (Table 8). Those who did not own boat join other fishers and share from the sales proceeds of the fish they caught. Motorcycle is also a common transportation asset of the household as reported by 18.26% of the respondents. In the absence of well-paved roads in coastal barangays motorcycles provides more utility in transferring people from one place to another. It was also used by the households as alternative source of income as *habal-habal* drivers in cases when the weather

posts danger for them to catch fish in the gulf. Some (5.81%) own tricycle, car (1.24%), and bicycle (1.24%).

Table 8. Distribution of respondents by transportation asset owned, Ragay Gulf: 2019.

Transportation asset owned	Frequency	Percent
Boat	154	63.90
Motorcycle	44	18.26
Tricycle	14	5.81
Car	3	1.24
Bicycle	3	1.24
Others	1	0.41
None	22	9.13
TOTAL	**241**	**100**

Economic profile. The primary economic activity of the respondents is fishing because this is the natural endowment in their locality. On the average the households earned Php16,811.67 from fishing activities per month as reported by 210 respondents who revealed details for their income from fishing activities (Table 9). Fifty households responded that aside from fishing they earned income from regular employment which amounts to Php7,750.72 per month on the average. Fish marketing was also a supplemental source of income of households. Instead of selling the fish caught to the traders 28 respondents revealed that their household sell fish to their neighbors which provided them an average income of Php4,329.29 per month. In cases when there were surplus fish 11 households process the fish through drying which provided them supplemental income of Php5,455,00 per month. Chicken and hog raising were common agriculture-based livelihood of the fishers which provided supplemental income to 16 households amounting to Php7,696.25 per month.

Table 9. Distribution of respondents by source of income and average household income, Ragay Gulf: 2019.

Source	No. of HH Reporting	Total Income	Average HH Income
Fishing	210	3,530,450.00	16,811.67
Regular Employment	50	387,536.00	7,750.72
Fish Marketing/Selling	28	121,220.00	4,329.29
Animal Husbandry	16	123,140.00	7,696.25
Fish Processing	11	60,005.00	5,455.00
Laborer	9	65,000.00	7,222.22
Rice Production	7	217,300.00	31,042.86
Business	8	29,000.00	3,625.00
Remittance of OFW, sibling, children, etc.	5	112,500.00	22,500.00
Preparation of gears	3	23,000.00	7,666.67
Root Crop Production	3	4,530.00	1,510.00
Vegetable Production	2	2,250.00	1,125.00
4Ps Benefits	77	238,150.00	3,092.86
Pension	4	4,000.00	1,000.00
UCT Benefits	2	5,800.00	2,900.00
Others	3	16,400.00	5,466.67

The other sources of income of households were wage income from labor, rice production, business, remittance of OFWs, siblings and children, preparation of gears, root crop production, and vegetable production. It was also revealed by 77 respondents that the transfer payments from 4Ps, pension, and unconditional cash transfer provided supplemental income for the household.

Considering the differences in the sources of income and household size of the respondents in the study, the mean and median per capita income was estimated and presented in Table 10. This result, however, should not be used to characterize the entire coastal barangay because of limited sample size. The sampling performed was intended to provide a picture of the poverty situation in coastal communities in Ragay Gulf and not for each municipality surrounding the gulf. Php2,315.00 was the per capita poverty threshold per month based on the Family Income and Expenditure Survey (FIES) for a household with five members. Using this threshold, 52% of the households in Ragay Gulf could be classified as poor. This is high compared to the average poverty incidence in Camarines Sur which reduced from 31.3% in 2015 to 19.2% in 2018. The baseline poverty threshold was even higher compared to the 42% baseline of the FishCORAL project. Nonetheless, this figure could be used for monitoring activities as the project progresses to be able to establish trend and potentially provide estimate of the project's impact.

Table 10. Average annual per capita income and poverty incidence per covered municipality, Ragay Gulf: 2019.

Municipality	Sample size	Mean annual per capita income		Median annual per capita income		Poverty incidence
		All sources	Fishing only	All sources	Fishing only	
Del Gallego	34	80,142	70,657	54,000	46,800	33%
Ragay	50	138,925	136,150	27,000	24,000	55%
Lupi	5	14,312	14,613	14,400	14,400	100%
Sipocot	5	14,759	13,559	12,000	11,250	80%
Pasacao	30	39,707	16,515	23,800	9,840	57%
San Fernando	20	32,608	23,624	25,590	15,307	55%
Minalabac	20	20,345	17,652	14,880	13,200	70%
Bula	10	32,365	18,701	30,060	16,800	50%
Balatan	30	38,886	30,402	26,100	21,000	62%
Bato	15	81,366	61,408	78,420	52,000	27%
All	**219**	**67,089**	**56,821**	**27,000**	**20,000**	**52%**

CONCLUSIONS

The growth of the fisheries sector in Ragay Gulf was constrained by several problems. Official statistics showed declining volume of fish caught coupled with ageing fishers, unsecured property rights, limited access to proper water and sanitation facilities, and over-all above dismal poverty situation compared to provincial statistics. Despite these impediments there were improvements in access to public health services, availability of vehicle for information dissemination, and alternative sources of livelihood which can potentially be utilized to boost the fisheries sector through provision of alternative sources of income through value addition to lessen the pressure of overexploitation of coastal resources to support the growing population.

REFERENCES

Campos, M.A., J.B. Williams, V.V. Hilomen, H.C. Jalotjot, P.A. Tusi, & O.P.A. Alparce. 2006. Post Resource and Socioeconomic Assessment Monitoring of Ragay Gulf. Terminal Report.

Dequit, E.T., R.P. Smith, W.P. Jatulan, A.T. White. 2004. Participatory Coastal Resource Assessment Training Guide. Coastal resource management project of the Department of Environment and Natural Resources Management, Cebu City, Philippines. 134 p.

Philippine Statistics Authority (PSA). 2016. Population of Region V - Bicol (Based on the 2015 Census of Population). https://psa.gov.ph/content/population-region-v-bicol-based-2015-q census-population

Philippine Statistics Authority (PSA). 2019. Fisheries Statistics of the Philippines 2016-2018. Volume 27. https://psa.gov.ph/sites/default/files/ Fisheries%20Statistics%20of%20the%20Philippines%2C%202016-2018.pdf

Philippine Statistics Authority (PSA). 2019. OpenSTAT database for Agriculture, Forestry and Fisheries. http://openstat.psa.gov.ph/PXWeb/pxweb/en/DB/ DB__2E__FS/ 0112E4GVFP0.px/table/tableViewLayout1/?rxid=bdf9d8da-96f1-4100-ae09-18cb3eaeb313

Reyes, C. et al. 2012. Poverty and Agriculture in the Philippines: Trends in Income Poverty and Distribution. PIDS Discussion Paper Series No. 2012-09. https://dirp4.pids.gov.ph/ris/dps/pidsdps1209.pdf

LIVELIHOOD PROFILE OF COASTAL COMMUNITIES IN RAGAY GULF

Erwin E. Torres
Ronnel R. Dioneda, Sr.
Aliana Joy G. Carrillo
Richelle Bañadera
Bicol University
Legazpi City

Torres, E.E., R.R. Dioneda A.J.G. Carrillo and R.B. Banadera. 2019. Livelihood Profile of Coastal Communities in Ragay Gulf. Pp 50-81. In Dioneda R.R., E.E. Torres and G. Naz. (Eds). 2019. Participatory Resource and Socio-Economic Assessment of Ragay Gulf-Bicol Side. Terminal Report Submitted for the Fisheries, Coastal Resources and Livelihood Project, Department of Agriculture-Bureau of Fisheries and Aquatic Resources, Quezon City. Bicol University, Center for Policy Studies and Development, Legazpi City. 200 pp.

ABSTRACT

This paper aimed to provide baseline information about the livelihood profile of communities in Ragay Gulf. Lessons were drawn from 219 samples from 49 barangays in 11 municipalities in Camarines Sur though sample survey. Results revealed that the fishing and farming activities are primarily performed by male members of the households. Women are involved in fish processing and preparation of fishing gears. Bottom-set gill net, simple handline/ hook & line, fish/crab/squid pots, scoop net with light, and bottom-set long line are the common fishing gears used by fishers in Ragay Gulf. Fishers spend for fuel, food, consumables, and repair of fishing gears for every trip.

Fishers moved away from the traditional subsistence fishing in which they catch fish to sustain the need for food of their families. They became more market-oriented by selling fish to their neighbors, assemblers, and in local markets. Fishing, as the source of household income is insufficient for the household to move out of poverty. Additional livelihood opportunities through training and provision of complementary inputs are necessary to address the income gap of the households in Ragay Gulf.

Keywords: livelihood profile, FishCORAL, Ragay Gulf

INTRODUCTION

Figure 1. Map of Ragay Gulf showing municipal waters.

Ragay Gulf is a major source of fish in the Philippines. It covers an area of 3,225 hectares which makes it the third largest gulf in the country next to Moro Gulf (12,900 has) and Davao Gulf (4,024 has) (PSA, 2019). The gulf is surrounded by three provinces: it is bounded on the north and east by the province of Camarines Sur, Quezon province on the west and southwest portion, and Masbate province (Ticao Island) on the southeast portion. Campos et al (2006) reported that based on the Philippine Statistical Yearbook the population density in Camarines Sur rose from 201 persons / km^2 in 1980 to 283 persons / km^2 in 2000. Population density further increased to 354 persons / km^2 with reference to the 2015 census of population (PSA, 2016). This figure is above the regional average population density of 320 persons / km^2 as well as the national average population density of 337 persons / km^2 in 2015. The increase population density puts pressure on the natural resources to provide food for the growing number of people. This can be observed in the increasing fisheries production in Camarines Sur from 52,467.30 metric tons in 2002 to 86,956.90 metric tons in 2015 (PSA, 2018). More recent data from PSA shows that fisheries production continues to decline from 71,031.68 metric tons in 2016 to 69,371.29 metric tons in 2017, and 63,780.08 metric tons in 2018.

Population that are dependent on farming and fishing are among the vulnerable groups. Although they serve as the country's lifeline in assuring food security are the top sectors with alarming poverty incidence of 38.3 and 39.2%, respectively (PSA 2012). Existing documents attribute to big family size and low educational level as the primary culprits of high poverty incidence among farmers and fishers (Reyes et al., 2012). Depletion of fish stocks and the continuing deterioration of the state of coastal habitats have also been demonstrated to be the cause of dismal trend of economic status of fishing families. To address the alarming poverty incidence in fishing communities and provide protection and conservation of coastal resources, the Department of Agriculture's Bureau of Fisheries and Aquatic Resources (DA-BFAR) launched the Fisheries, Coastal Resources and Livelihood (FishCORAL) Project. This United Nations Fund for Agricultural Development (UN-IFAD)-funded project prioritizes 11 target fishing grounds for a development goal of enabling coastal communities sustainably manage their fishery and coastal resources and generating livelihood benefits for fishing households. At the end of the project it is expected that poverty incidence in the coastal communities will be reduced by 5% from the baseline of 42%, child malnutrition will be reduced by 4% from the baseline of 24.4%, and employment of women to 40% from the baseline of 20%. The project also intends to increase annual income of fishing households by 10% and asset ownership by 20% based on the baseline to be identified at the local level.

This study intends to describe the livelihood profile of coastal communities in Ragay Gulf. Specifically, the paper aims to:

1. describe the participation of male and female household members in economic activities;
2. identify fishing inputs particularly the fishing gears used and cost of inputs per trip;
3. document marketing practices of fishery products; and
4. estimate household income from fishing and other sources.

METHODOLOGY

This research employed descriptive research method through the conduct of sample survey in identified project sites of FishCORAL. This section presents population where the samples were identified, method of data collection, and method of data analysis.

Population and sample. Based on the 2019 FishR data of the Bureau of Fisheries and Aquatic Resources Region V there are 6,755 registered fishers involved in capture fisheries in the municipalities of Balatan, Bato, Bula, Del Gallego, Lupi, Minalabac, Pasacao, Ragay, San Fernando, and Sipocot. They are distributed in 44 coastal barangays. The estimated sample size was 220 households based on 95% confidence level (Z=1.96), margin of error of 0.065 and sample proportion of 0.5. For each barangay there was a target of 5 households. The summary of the number of respondents per municipality was presented in Table 1.

Table 1. Coastal barangays covered along Ragay Gulf: 2019.

Municipality	Coastal Barangays	No. of respondents
Balatan	Camangahan, Pararao, Luluasan, Siramag, Duran, and Coguit	30
Bato	Pagatpatan, Payak, and Palo	15
Bula	Caorasan and Itangon	10
Del Gallego	Magais I, Pasay, Sabang, Salvacion, San Juan, Penafrancia (Sinawagaswasan), and Sinuknipan II	34
Lupi	Bangon	5
Minalabac	Bagolatao, Hamoraon, Salingogon, and San Antonio	20
Pasacao	Balogo, Caranan, Dalupaon, San Cirilo, andSanta Rosa Del Sur, and Tinalmud	30
Ragay	Apad, Binahan Prop., Buenasuerte, Cabugao, Catabangan Proper, F. Simeon, Lohong, Lower Omon, San Rafael, &Tagbac	50
San Fernando	Bical, Cotmon, Gnaran, and Pinamasagan	20
Sipocot	Binahian	5
	Total Respondents	**219**

Method of data collection. The research instrument used in this study was patterned after the Participatory Coastal Resource Assessment Training Guide developed by Deguit, et al (2004). The questionnaire was pre-tested in Sto. Domingo, Albay on March 2 – 3, 2019 before it was refined through the assistance of FishCORAL Technical Committee members. Training of the Field Interviewers immediately followed. To facilitate the data collection, coordination with the municipal and barangay officials were done prior to the activity. After coordination was done, simultaneous data collection was conducted by the team. The questionnaire utilized in the study is divided into six parts: (1) Socio-demographic profile, (2) Household members, (3) Property ownership, (4) Economic characteristics, (5) Coastal resources management, and (6) Community involvement.

Each field interviewer was assigned to do a face-to-face interview with the respondent which could extend for 25 to 30 minutes. In each barangay, the Purok with the greatest number of fishers was selected as the sampling unit of the coastal barangay. With the assistance of the assigned barangay official, households were randomly selected with an interval of one household after each qualified household. Replacements were done in cases of outright refusal or when there is no member engaged in fishing. In cases when the member of the household primarily engaged in fishing activities was not available during the day of the visit, other members "directly or personally and physically engaged in taking and/or culturing

and processing fishery and/or aquatic resources" (R.A. 8550) served as the respondent. Data collection was conducted in May to July 2019.

Figure 2. Data collection in coastal communities in Ragay Gulf.

Method of data analysis. The data were analyzed using descriptive statistics. Socio-demographic characteristics, frequency and percentage distribution were illustrated using figures and tables. Income and expenditure data, on the other hand, were reported using mean and range as numerical measures.

RESULTS AND DISCUSSION

This section is divided into five parts: participation of male and female in household economic activities, fishing inputs, marketing of products, household income, and trainings attended by household members.

Participation of male and female. In household economic activities, fishing, being the primary livelihood activity in coastal communities, is a male-dominated activity. As presented in Table 2, 100% of the household members engaged in fishing were males. 79% of the fishers have at least ten years of experience in fishing. They have been engaged in fishing since they reach the age of ten. Mending nets and preparation of fishing gears were also primarily performed my male household members. There were only two respondents who reported that female members of their household also performed these activities. Animal and crop production were also supplemental livelihood activities of the households. There are 27 households that were involved in backyard raising of chickens and pigs. 82 respondents reported that they raised an average of 7 chickens and 39 respondents raised an average of 2 pigs. Crop production such as rice / corn farming, vegetable production, and root crop production were minor supplemental livelihood activities of the households as reported by 13 respondents. Similar to fishing, these activities were also male dominated. Lastly, only four respondents reported to have engaged in small scale business.

Table 2. Distribution of respondents by nature of activities performed by male and female household members, Ragay Gulf: 2019.

Nature of Activities	Male		Female	
	Freq.	Percent	Freq.	Percent
Fishing				
Fish Capture	203	100.00	0	0.00
Mending of nets and other gears	100	98.04	2	1.96
Preparing gears for fishing	108	99.08	1	0.92
Gleaning	18	100.00	0	0.00
Processing/Drying of Fish	11	57.89	8	42.11
Farming (Animal production)				
Backyard raising	27	100.00	0	0.00
Feedlot Fattening	11	78.57	3	21.43
Ranching	2	100.00	0	0.00
Farming (Crop production)				
Rice / corn farming	6	100.00	0	0.00
Vegetable production	6	85.71	1	14.29
Root crops production	1	100.00	0	0.00
Other Income-generating activities				
Small scale business	3	75.00	1	25.00

Fishing inputs. Bottom-set gill net is the most common fishing gear used by the fishers in Ragay Gulf as reported by 111 respondents (Table 3). In terms of ownership, 87.39% of the respondents owned their bottom-set gill net while 14.41% share the fishing gear with other fishers. Simple handline / hook & line is also a common fishing gear as reported by 83 respondents. Almost all (92.77%) of the fishers owned the fishing gear while the remaining 6 respondents either use shared or leased fishing gear. Fish/crab/squid pots, scoop net with light, and bottom-set long line are also used by the respondents.

Fuel was the most common expenditure incurred by the fishers. This amounted to Php189.07 per trip for at least 3 liters of fuel per trip (Table 4). Fishers also spent for food (Php145.73 per trip) and consumables such as cigarettes (PhP55.98 per trip) every time they go fishing. Repair of fishing gears and boats usually costs PhP3,000.00 per repair.

Table 3. Distribution of respondents by type and ownership of fishing gear, Ragay Gulf: 2019.

Fishing Gear	No. of HH Reporting	Ownership					
		Owned		Shared		Leased	
		Freq	%	Freq	%	Freq	%
Bottom-set gill net	111	97	87.39	16	14.41	2	1.80
Simple handline/ Hook & Line	83	77	92.77	4	4.82	1	1.20
Fish/crab/squid pots	12	11	91.67	1	8.33	0	0.00
Scoop net with light	12	10	83.33	1	8.33	0	0.00
Bottom-set long line	10	10	100.00	0	0.00	0	0.00
Drift gill net	9	6	66.67	3	33.33	0	0.00
Others	38	32	84.21	5	13.16	1	2.63

Table 4. Distribution of respondents by average expenditure per trip, Ragay Gulf: 2019.

Expenditure per trip	No. of HH Reporting	Total Expenditure	Average Expenditure
Fuel	174	32,899.00	189.07
Food	84	12,241.50	145.73
Consumable (e.g. Cigarettes)	81	4,534.50	55.98
Repair	75	225,005.00	3,000.07
Fishing gear rental	6	6,350.00	1,058.33
Boat Rental	4	910.00	227.50

Marketing of products. Fishing industry in Ragay Gulf is market driven. Fishers moved away from the traditional subsistence fishing in which they catch fish to sustain the need for food of their families. Eighty-four percent of the respondents catch fish that are intended to be sold for cash (Table 5). The proceeds are then used to buy other food such as rice, meat, and vegetables, pay for utilities, and repair of fishing gears.

Table 5. Distribution of respondents by utilization of fish caught, Ragay Gulf: 2019.

Marketing of fish catch	Frequency	Percent
Sold	185	84.47
Household Consumption	9	4.11
Both	1	0.46
No Response	24	10.96
TOTAL	**219**	**100**

Selling of fish was performed by 60% of the husbands while 19% reported that it is the wife of the fisher that sells fish (Table 6). Fish catch were sold to neighbors immediately after the boat touched the shore. Upon arrival of the boat the neighbors lineup to see the kind of fish caught by the fishers. Assembler-wholesalers or *bagsakan* is also a common market outlet of fishers. Almost a quarter (24.20%) of the respondents reported that they sold their fish to these marketing agents who in turn sold the fish to wet markets in the neighboring municipalities, The remaining 16.89% of the respondents directly sold the fish in local market as retailers while 12.79% sell their catch to another middleman.

Table 6. Distribution of respondents by immediate market of fish caught, Ragay Gulf: 2019.

To whom the catch is sold	Frequency	Percent
Neighbors	86	39.27
Bagsakan	53	24.20
Local Market	37	16.89
Middleman	28	12.79
No Response	15	6.85
TOTAL	**219**	**100**

Household income. Considering the differences in the sources of income and household size of the respondents in the study, the mean and median per capita income was estimated and presented in table 7. This result, however, should not be used to characterize the entire coastal barangay because of limited sample size. The sampling that was performed is intended to provide a picture of the annual income of coastal communities in Ragay Gulf and not for each municipality surrounding the gulf. The income of households from fishing and from all sources is skewed. Even if the mean annual income per capita is Php67,089, the median income is only Php27,000.00 per capita per year. Median annual per capita income provides better estimate of average income of households in Ragay Gulf because of the presence of few respondents with very high income compared to most of the households. Among the municipalities covered, respondents from Bato have the highest median annual per capita income of Php78,420.00 followed by Del Gallego (Php54,000.00), Ragay (Php27,000.00), and Balatan (Php26,100.00). Median income from fishing was also highest in these municipalities.

Table 7. Average annual per capita income per covered municipality, Ragay Gulf: 2019.

Municipality	Sample size	Mean annual per capita income		Median annual per capita income	
		All sources	Fishing only	All sources	Fishing only
Del Gallego	34	80,142	70,657	54,000	46,800
Ragay	50	138,925	136,150	27,000	24,000
Lupi	5	14,312	14,613	14,400	14,400
Sipocot	5	14,759	13,559	12,000	11,250
Pasacao	30	39,707	16,515	23,800	9,840
San Fernando	20	32,608	23,624	25,590	15,307
Minalabac	20	20,345	17,652	14,880	13,200
Bula	10	32,365	18,701	30,060	16,800
Balatan	30	38,886	30,402	26,100	21,000
Bato	15	81,366	61,408	78,420	52,000
All	**219**	**67,089**	**56,821**	**27,000**	**20,000**

Training attended by households. While fishing is the primary source of livelihood in Ragay Gulf which puts there were initiatives to capacitate the people to explore alternative sources of livelihood to lessen pressure on the ability of the natural resources to sustainably provide for the food and economic needs of the people (Table 8). The trainings provided to the household members were fish processing (13%), planting of mangroves and corals (13%), seaweed production (11%), and mudcrab culture (3%).

These trainings provided additional knowledge for the members of the fishing households to potentially engage in alternative livelihood activities not only to supplement their income but also to reduce dependence on abundance of the gulf while it recuperates from damages caused by natural calamities and anthropogenic activities.

Table 8. Distribution of respondents by trainings attended, Ragay Gulf: 2019.

Trainings Attended	Frequency	Percent
Fish Processing	29	13
Planting of mangroves and corals	29	13
Seaweed production	25	11
Culturing of mudcrabs	6	3
Others	17	8

CONCLUSIONS AND RECOMMENDATIONS

Among the municipalities surrounding Ragay Gulf only the respondents in Bato and Del Gallego have per capita income from fishing that was higher than the poverty threshold of Php2,315.00 per capita per month or Php27,780.00 per capita per year. This necessitates supplemental income from other sources. But considering other sources of income there were still municipalities whose annual per capita income that were below the provincial average. The trainings related to value addition and very low level of participation of women in livelihood activities could be considered as opportunity to engage them in fish processing, seaweed processing, and even in mudcrab culture. This should be complemented by providing equipment and necessary inputs for the people to start their businesses. Agriculture should also be promoted through provision of raising farm animals such as chicken and pigs to provide additional income for the households.

REFERENCES

Campos, M.A., J.B. Williams, V.V. Hilomen, H.C. Jalotjot, P.A. Tusi, & O.P.A. Alparce. 2006. Post Resource and Socioeconomic Assessment Monitoring of Ragay Gulf. Terminal Report.

Dequit, E.T., R.P. Smith, W.P. Jatulan, A.T. White. 2004. Participatory Coastal Resource Assessment Training Guide. Coastal resource management project of the Department of Environment and Natural Resources Management, Cebu City, Philippines. 134 p.

Philippine Statistics Authority (PSA). 2016. Population of Region V - Bicol (Based on the 2015 Census of Population). https://psa.gov.ph/content/population-region-v-bicol based-2015-census-population

Philippine Statistics Authority (PSA). 2019. Fisheries Statistics of the Philippines 2016-2018. Volume 27. https://psa.gov.ph/sites/default/files/ Fisheries%20Statistics%20of%20the%20Philippines%2C%202016-2018.pdf

Philippine Statistics Authority (PSA). 2019. OpenSTAT database for Agriculture, Forestry and Fisheries. http://openstat.psa.gov.ph/PXWeb/pxweb/en/DB/ DB__2E__FS/ 0112E4GVFP0.px/table/tableViewLayout1/?rxid=bdf9d8da-96f1-4100-ae09-18cb3eaeb313

Reyes, C. et al. 2012. Poverty and Agriculture in the Philippines: Trends in Income Poverty and Distribution. PIDS Discussion Paper Series No. 2012-09. https://dirp4.pids.gov.ph/ris/dps/pidsdps1209.pdf

COASTAL RESOURCES MANAGEMENT IN RAGAY GULF

Erwin E. Torres
Ronnel R. Dioneda Sr.
Aliana Joy G. Carrillo
Richelle Bañadera
Bicol University
Legazpi City

Torres, E.E., R.R. Dioneda A.J.G. Carrillo and R.B. Banadera. 2019. Coastal Resources Management in Ragay Gulf. Pp 50-81. In Dioneda R.R., E.E. Torres and G. Naz. (Eds). 2019. Participatory Resource and Socio-Economic Assessment of Ragay Gulf-Bicol Side. Terminal Report Submitted for the Fisheries, Coastal Resources and Livelihood Project, Department of Agriculture-Bureau of Fisheries and Aquatic Resources, Quezon City. Bicol University, Center for Policy Studies and Development, Legazpi City. 200 pp.

ABSTRACT

This paper intends to provide baseline information about the coastal resource management (CRM) activities and to assess the implementation of activities/projects, as well as policies on CRM in Ragay Gulf. There were 219 respondents from 49 barangays in 11 municipalities in Camarines Sur who participated in the survey. Results revealed that the size and abundance of fish in Ragay Gulf were perceived by the fishers to be better years ago because of natural and anthropogenic factors. Although still present, illegal fishing activities were reported to have declined in the past decade.

Resource conservation activities/projects, particularly the establishment of Marine Sanctuary and Fisheries Reserve (MSFR), was perceived to be effective by the fishers. Enforcement of fishery ordinances was also perceived to be effective because of the presence of *bantay dagat* in municipal waters. Fishery-related ordinances in the municipalities surrounding Ragay Gulf includes prohibition of destructive fishing practices, regulation of of active fishing gear, proper waste disposal, and protection of rare species.

The gains from these CRM initiatives can be sustained by empowering the local community to manage their own resources through their fishers' organizations. Government agencies and non-government agencies will only provide technical assistance, while the local government units continue to support the *bantay dagat* in the implementation of ordinances.

Keywords: coastal resources management, FishCORAL, Ragay Gulf

INTRODUCTION

Figure 1. Map of Ragay Gulf showing municipal waters.

Ragay Gulf is a major source of fish in the Philippines. It covers an area of 3,225 hectares, which makes it the third largest gulf in the country next to Moro Gulf (12,900 has) and Davao Gulf (4,024 has) (PSA, 2019). The gulf is surrounded by three provinces: it is bounded on the north and east by the province of Camarines Sur, Quezon province on the west and southwest portion, and Masbate province (Ticao Island) on the southeast portion. Campos et al. (2006) reported that based on the Philippine Statistical Yearbook, the population density in Camarines Sur rose from 201 persons/km^2 in 1980 to 283 persons/km^2 in 2000. Population density further increased to 354 persons/km^2 in the 2015 census of population (PSA, 2016). This figure is above the regional average population density of 320 persons/km^2 as well as the national average population density of 337 persons/km^2 in 2015. The increase in population density puts pressure on the natural resources to provide food for the growing number of people. This can be observed in the increasing fisheries production in Camarines Sur from 52,467.30 metric tons in 2002 to 86,956.90 metric tons in 2015 (PSA, 2018). More recent data from the PSA show that fisheries production continues to decline from 71,031.68 metric tons in 2016 to 69,371.29 metric tons in 2017, and 63,780.08 metric tons in 2018.

Populations that are dependent on farming and fishing are among the vulnerable groups. Although they serve as the country's lifeline in ensuring food security, they are the top sectors with alarming poverty incidence of 38.3% and 39.2%, respectively (PSA, 2012). Existing documents say that big family size and low educational level are the primary culprits of high poverty incidence among farmers and fishers (Reyes et al., 2012). Depletion of fish stocks and the continuing deterioration of the state of coastal habitats have also been demonstrated to be the cause of the dismal trend of the economic status of fishing families.

Coastal Resources Management Projects (CRMP) have been in the Philippines since the 1980s to address the severe and increasing threat to the coastal communities brought by decades of uncontrolled and haphazard shoreline development, rapid population growth, overfishing, destructive fishing, and government programs that encourage increased fisheries production despite having a depleted resource base (CRMP, 2004). Coastal resources management is anchored on the following principles: people first, integrated approach, participation and validation, sustainable implementation, and management (Vergara, 2001). CRM activities are initiated by organizations outside the local communities. Although the degradation of coastal resources can be attributed to anthropogenic causes, interventions should be made to address these effects and, in the long run, promote responsible stewardship of coastal areas. CRM considers the collective ideas and commitments of the stakeholders to encourage their sense of ownership and ensure the success of identified interventions. During the implementation phase, continuous participation of stakeholders and validation of decisions are necessary to ensure equitable access to and control of benefits derived from resource management. This further strengthens the responsibility, accountability, and personal motivation of the stakeholders. Development interventions in coastal communities are usually timebound due to limitations in financial resources, but these interventions are expected to sustainably uplift the coastal environment. This can be achieved by crafting an exit plan that will reduce the dependence of local communities from external organizations and make them capable of managing their coastal areas. Lastly, CRM should be viewed as a science with a structure that is necessary to link the context and the goals of specific CRM initiatives or activities. Specific guidelines can be developed to describe the link between decisions, implementation, and impacts. Recognizing a common property approach to resource

management provides a semblance of ownership and provides a sense of power, acts as an incentive to promote sustainable resource use, and foster concern for coastal resources conservation (Vergara, 2001).

This paper sought to assess the Coastal Resources Management initiatives in Ragay Gulf. Specifically, it intended:

1. provide coastal resource management (CRM) baseline data along Ragay Gulf; and
2. assess the extent of implementation of existing projects and policies related to coastal resource conservation and protection in the coastal barangays covered.

METHODOLOGY

This research employed a descriptive research method through the conduct of sample surveys in identified sites of Fisheries, Coastal Resources and Livelihood (FishCORAL) Project. This section presents the population where the respondents were identified, the method of data collection, and the method of data analysis.

Population and sample. According to the 2019 FishR data of the Bureau of Fisheries and Aquatic Resources Region V there were 6,755 registered fishers that were involved in capture fisheries in the municipalities of Balatan, Bato, Bula, Del Gallego, Lupi, Minalabac, Pasacao, Ragay, San Fernando, and Sipocot. They were distributed in 44 coastal barangays. The estimated sample size was 220 households based on the 95% confidence level (Z=1.96), margin of error of 0.065, and sample proportion of 0.5. For each barangay, there was a target of 5 households. The summary of the number of respondents per municipality is presented in Table 1.

Table 1. Coastal barangays covered along Ragay Gulf: 2019

Municipality	Coastal Barangays	No. of respondents
Balatan	Camangahan, Pararao, Luluasan, Siramag, Duran, and Coguit	30
Bato	Pagatpatan, Payak, and Palo	15
Bula	Caorasan and Itangon	10
Del Gallego	Magais I, Pasay, Sabang, Salvacion, San Juan, Penafrancia (Sinawagaswasan), and Sinuknipan II	34
Lupi	Bangon	5
Minalabac	Bagolatao, Hamoraon, Salingogon, and San Antonio	20
Pasacao	Balogo, Caranan, Dalupaon, San Cirilo, Santa Rosa Del Sur, and Tinalmud	30
Ragay	Apad, Binahan Prop., Buenasuerte, Cabugao, Catabangan Proper, F. Simeon, Lohong, Lower Omon, San Rafael, and Tagbac	50
San Fernando	Bical, Cotmon, Gnaran, and Pinamasagan	20
Sipocot	Binahian	5
	Total Respondents	**219**

Method of data collection. The research instrument used in this study was patterned after the Participatory Coastal Resource Assessment Training Guide developed by Deguit et al (2004). The questionnaire was pre-tested in Sto. Domingo, Albay on March 2–3, 2019 before it was refined through the assistance of FishCORAL Technical Committee members. Training of the field interviewers immediately followed. To facilitate the data collection, coordination with the municipal and barangay officials were done prior to the activity. After the coordination, simultaneous data collection was conducted by the team. The questionnaire utilized in the study was divided into six parts: (1) socio-demographic profile, (2) household members, (3) property ownership, (4) economic characteristics, (5) coastal resources management, and (6) community involvement.

Each field interviewer was assigned to do a face-to-face interview with the respondent which lasted for 25 to 30 minutes. In each barangay, the purok with the greatest number of fishers was selected as the sampling unit. With the assistance of the assigned barangay official, households were randomly selected with an interval of one household after each qualified household. Replacements were done in cases of outright refusal or when there was no member engaged in fishing. In cases when the member of the household primarily engaged in fishing activities was not available during the day of the visit, other

members “directly or personally and physically engaged in taking and/or culturing and processing fishery and/or aquatic resources” (R.A. 8550) served as the respondent. Data collection was conducted from May to July 2019.

Figure 2. Photo documentation during data collection in Ragay Gulf

Method of data analysis. The data were summarized using frequency and percentages in tables. The effectiveness of projects/activities related to fishing and level of enforcement of ordinances related to fishing were presented in table containing the number of the respondents who rated the level of effectiveness, as well as level of enforcement.

RESULTS AND DISCUSSION

This section is divided into four parts: perceived changes in fish size and abundance, perceived level of effectiveness of projects/activities related to fishing, perceived level of enforcement of existing laws/ordinances related to coastal resource conservation, and trainings attended by fishers.

Perceived changes in fish size and abundance.

Two-thirds or 148 of the 219 respondents perceived that the fish they caught years ago were large (Table 2). Only 27 or 12.33% perceives that the size of fish that they caught is better at present. Almost two-thirds of the respondents (143 of 219) also perceive that fish is more abundant years ago while only 38 respondents perceive that fish is more abundant at present.

Table 2. Distribution of respondents by perceived changes in fish size and fish abundance, Ragay Gulf: 2019

Changes in	Better now	Better years ago	No change	No response	Total
Fish size	27	148	40	4	219
Fish abundance	38	143	31	7	219

The perceived declining volume and size of fish caught were attributed to anthropogenic and natural causes. Anthropogenic causes include overfishing and catching of fish even before they reach the size when they are sexually mature to reproduce. The same number of respondents revealed that their biggest problem encountered in fishing is the illegal use of destructive fishing practices (28.73%) and natural disasters (28.77%) (Table 3). Intrusion of commercial fishing vessels in municipal waters was also identified as the biggest problem in fishing by 26 respondents. The other reasons cited by the respondents were damaged fishing gears (6.63%) and a lack of fishing gears (3.31%).

Table 3. Distribution of respondents by biggest problem encountered in fishing, Ragay Gulf: 2019

Biggest problems in fishing	Frequency	Percent
Illegal use of destructive fishing practices	52	28.73
Natural disaster	52	28.73
Intrusion of commercial fishing vessels	26	14.36
Damaged fishing gears	17	9.39
Few catch	12	6.63
Lack of fishing gears	6	3.31
Weather condition	6	3.31
Closed fishing season	4	2.21
Others	6	3.31

Seventy-nine or 36% of the respondents revealed that there existed illegal fishing activities in Ragay Gulf. This is lower compared to the 227 out of 303 respondents (75%) in the Bicol Side of Ragay Gulf who reported in 2005 that there existed illegal fishing activities in their area (Campos et al, 2005). According to the Fisheries code of 1998, active fishing gears, use of destructive methods or substances, and commercial fishing vessels within 15 km from shore are illegal. Respondents identified Danish seine (36.71%), cyanide fishing (29.11%), dynamite fishing (27.85%), and trawl (3.80%) as the most common illegal destructive fishing methods that they have observed. The use of purse/Danish seine and dynamite fishing were observed by at least one-third or 33% of the fishers in Del Gallego and Ragay. Purse/Danish seine was also observed in the neighboring municipalities of Lupi, Sipocot, and Pasacao, as revealed by the

respondents. Cyanide fishing was prevalent in the eastern side of Ragay Gulf, particularly in the municipalities of San Fernando (75%), Minalabac (67%), Balatan (63%), and Bato (75%).

Table 3. Distribution of respondents by observed destructive fishing methods, Ragay Gulf: 2019.

	n	Purse/Danish seine	Cyanide fishing	Dynamite fishing	Trawl	Others
Del Gallego	12	33%	8%	42%	8%	8%
Ragay	27	37%	7%	52%		4%
Lupi	5	80%	20%			
Sipocot	1	100%				
Pasacao	10	40%	30%	10%	20%	
San Fernando	4	25%	75%			
Minalabac	3	33%	67%			
Bula	1			100%		
Balatan	8	25%	63%	13%		
Bato	8	25%	75%			
Total	**79**	**36.71%**	**29.11%**	**27.85%**	**3.80%**	**2.53%**

In 2005, the use of explosives was observed by 60.3% of the respondents, Danish seine by 57.4%, trawl by 34.9%, and the use of poisonous substances by 21.8% (Campos et al, 2005). In the past 14 years, there was a decline in use of explosives (60.3% to 27.85%), trawl (34.9% to 3.80%), and Danish seine (57.4% to 36.71%). However, it was observed that there was an increasing percentage of respondents who reported the use of poisonous substances from 21.8% in 2005 to 29.11% in 2019.

Level of effectiveness of existing projects/activities for the protection, conservation, and rehabilitation of resources

There was limited level of awareness on CRM activities. Only 35 or 15.98% of the respondents were aware of the projects or activities related to fishing in Ragay Gulf (Table 4). This is lower compared to the PRSA report in 2005 when, 77 out of the 261 respondents (29.5%) were aware of the presence of CRM in their locality (Campos, et al, 2005). This implies that the information about CRM projects/activities are not widely disseminated to the respondents. Livelihood projects, resource conservation initiatives, and enforcement of fishery laws were the projects/activities of which the respondents were familiar. There were seven respondents who rated the livelihood projects very effective and the same number of respondents rated the projects effective (Table 4). These livelihood projects included provision of fishing nets by fishers' organizations, ice-making training provided by the Department of Labor and Employment (DOLE), and provision of boats by the Bureau of Fisheries and Aquatic Resources (BFAR). These livelihood projects were identified only by the fishers in the municipalities of Balatan, Pasacao, and Ragay.

The enforcement of fishery laws by the *bantay dagat* was identified by the fishers in the municipalities of Balatan, Lupi, Minalabac, Pasacao, Ragay, and San Fernando. Five of the respondents rated the activity moderately effective while four rated it very effective and three rated the activity as effective. *Bantay dagat* is an initiative of the municipal local government unit, barangay LGU, and, in some, cases by the fishers' organization. This CRM activity was moderately effective because the presence of *bantay dagat* in municipal waters, particularly in areas with Marine Sanctuary and Fisheries Reserve (MSFR), is not constant.

Table 4. Distribution of respondents by perceived level of effectiveness of projects/activities related to fishing, Ragay Gulf: 2019

Projects/ Activities	Freq.	Level of Effectiveness					
		Very effective	Effective	Moderately effective	Ineffective	Very ineffective	Ave.
Livelihood	15	7	7	3	1	2	3.80
Law enforcement	14	4	3	5	1	1	3.86
Resource conservation	13	8	2	2	0	1	4.23

Among the identified CRM projects/activities, resource conservation was rated very effective by more than half of the respondents who were familiar of this initiative. Eight respondents rated it very effective, while two rated it effective, and the same number rated it moderately effective. The fish sanctuaries in Ragay Gulf can be directly observed by the fishers, thus, they appreciate its presence. It was also noted that there were more fish in municipalities with established sanctuaries in Balatan, Bula, Pasacao, and San Fernando. Another resource conservation initiative was mangrove planting which was reported by fishers in Lupi, Pasacao, and Ragay.

Level of enforcement of existing ordinances related to coastal resource conservation

Despite the existence of illegal fishing in the municipal waters, 48% of the respondents believed that their municipal ordinances are effective. The extent of illegal fishing activities could be higher if there were no ordinances in place. The respondents were asked whether they were familiar of the following laws/ordinances in their municipalities: ordinances related to illegal use of destructive fishing practices (n=173), proper waste disposal (n=173), protection of rare species (n=159), and illegal use of active fishing gear (n=147). Most of the respondents who were aware of these laws/ordinances reported that there was a very strong enforcement of proper waste disposal (73 out of 173), protection of rare species (78 out of 159), illegal use of active fishing gear (59 out of 147), and closed season fishing in municipal waters (34 out of 74). In terms of ordinances related to the use of destructive fishing practices, out of the 173 respondents who are aware of this ordinance, 71 rated its enforcement as strong and 68 rated its enforcement as very strong.

Table 5. Distribution of respondents by perceived level of enforcement of fishery ordinances, Ragay Gulf: 2019

Ordinances	Freq.	Enforcement Level					
		Very strong	Strong	Good	Weak	None	Ave.
Illegal use of destructive fishing practices	173	68	71	21	11	2	4.11
Proper waste disposal	173	73	61	25	10	4	4.09
Protection of rare species	159	78	58	16	5	2	4.29
Illegal use of active fishing gear	147	59	55	20	9	4	4.06

There was a substantial increase in the number of fishers who perceived that the municipal ordinances on fishing were strongly enforced. The 2005 PRSA study revealed that 54% of the respondents perceived that the municipal ordinances against illegal fishing were effective or very effective (Campos et al, 2005). In the present study, 79% of the respondents perceived that the ordinances on the illegal use of destructive fishing practices as well as the illegal use of active fishing gears, had strong and very strong enforcement. Among the reasons cited for the weak enforcement is the inconsistent presence of the *bantay*

dagat in the gulf and the alleged collusion between the illegal fishers and local officials. Over-all, the respondents perceived that the implementation of fishing-related ordinances was effective and only 16% of them reported that its implementation was weak.

Trainings attended by households

While fishing is the primary source of livelihood in Ragay Gulf, there were initiatives to capacitate the people to explore alternative sources of livelihood. Table 5 shows the trainings provided to the household members in the past five years include fish processing (13.24%), planting of mangroves and corals (13.24%), seaweed production (11.42%), and mudcrab culture (2.74%). These trainings provided additional knowledge to the members of the fishing households to potentially engage in alternative livelihood activities not only to supplement their income but also to reduce the dependence on the gulf while it recuperates from damage caused by natural calamities and anthropogenic activities.

Table 6. Distribution of respondents by trainings attended, Ragay Gulf: 2019

Trainings Attended	Frequency	Percent
Fish rocessing	29	13.24
Planting of mangroves and corals	29	13.24
Seaweed production	25	11.42
Culturing of mudcrabs	6	2.74
Others	17	7.76
None	113	51.60
Total	**219**	**100.00**

In addition to the trainings attended by the fishers, the respondents have identified other training needs, such as non-fishing related livelihood (29%), fishing-related (18.6%), and hog/livestock raising (17.1%).

CONCLUSIONS AND RECOMMENDATIONS

The size and abundance of fish in Ragay Gulf were perceived by the fishers to be better years ago because of a multitude of natural and anthropogenic factors. Natural factors, particularly typhoons, were identified as major natural hindrances for the fishers to catch fish. Anthropogenic causes included overfishing and use of illegal fishing gears. The intrusion of commercial fishing vessels in municipal waters was also identified by the fishers as a culprit in the declining volume of fish catch. Purse/Danish seine fishing, cyanide fishing, dynamite fishing, and trawl fishing were identified as the illegal fishing activities in Ragay Gulf. However, the prevalence of these activities was observed to be declining in the past 14 years, which can be attributed to effective conservation projects and enforcement of fishery ordinances.

Coastal resources management activities in Ragay Gulf were perceived to be effective by the fishers, particularly resource conservation initiatives such as the establishment of the Marine Sanctuary and Fisheries Reserve (MSFR). The enforcement of fisheries laws was linked by the fishers to the presence of *bantay dagat*, who patrol municipal waters and apprehend the violators of ordinances on fisheries. Ordinances related to fisheries were perceived by the fishers to be enforced strongly. These ordinances include the banning of destructive fishing practices, prohibition of active fishing gear, proper waste disposal, and protection of rare species.

Building on the gains of past initiatives on CRM in Ragay Gulf would necessitate a convergence among stakeholders in the implementation of projects and activities with the enabling policy environment

of the LGUs. Thus, in crafting CRM plans more emphasis should be given to empower local communities to implement resource conservation initiatives and alternative livelihood activities that will lessen the pressure on the natural resources to provide for the needs of the coastal communities. The initiatives of LGUs and BFAR in establishing MSFR is well appreciated by the local community but to be able to sustain its benefits the local community should be empowered to manage their own resources through their fishers' organizations. LGUs can continuously support the *bantay dagat* in safeguarding the MSFR and apprehend the violators of municipal fishing ordinances. Lastly, an evaluation of the conservation projects is necessary to document the gains and lessons learned from their implementation for possible replication and modification of future related projects.

REFERENCES

Campos, M.A., J.B. Williams, V.V. Hilomen, H.C. Jalotjot, P.A. Tusi, & O.P.A. Alparce. 2006. Post Resource and Socioeconomic Assessment Monitoring of Ragay Gulf. Terminal Report.

CRMP. 2004. Completion Report: The Coastal Resource Management Project – Philippines 1996 – 2004. Coastal Resource Management Project of the Department of Environment and Natural Resources. Cebu City, Philippines, 179 pp.

Dequit, E.T., R.P. Smith, W.P. Jatulan, A.T. White. 2004. Participatory Coastal Resource Assessment Training Guide. Coastal resource management project of the Department of Environment and Natural Resources Management, Cebu City, Philippines. 134 p.

Philippine Statistics Authority (PSA). 2016. Population of Region V - Bicol (Based on the 2015 Census of Population). https://psa.gov.ph/content/population-region-v-bicol-based-2015-census-population

Philippine Statistics Authority (PSA). 2019. Fisheries Statistics of the Philippines 2016-2018. Volume 27. https://psa.gov.ph/sites/default/files/ Fisheries%20Statistics%20of%20the%20Philippines%2C%202016-2018.pdf

Philippine Statistics Authority (PSA). 2019. OpenSTAT database for Agriculture, Forestry and Fisheries. http://openstat.psa.gov.ph/PXWeb/pxweb/en/DB/ DB__2E__FS/ 0112E4GVFP0.px/table/tableViewLayout1/?rxid=bdf9d8da-96f1-4100-ae09-18cb3eaeb313

Reyes, C. et al. 2012. Poverty and Agriculture in the Philippines: Trends in Income Poverty and Distribution. PIDS Discussion Paper Series No. 2012-09. https://dirp4.pids.gov.ph/ris/dps/pidsdps1209.pdf

Vergara, S.G. 2001. ENRM 242: Coastal Zone Management. Quezon City, Philippines: University of the Philippines Open University.

STATUS OF CORALS AND CORAL REEF FISHES IN RAGAY GULF

Ronnel R. Dioneda Sr
Romeo B. Asejo Jr.
Bicol University, Legzpi City

Raul B. Burce
Partido State University-Caramoan Campus
Caramoan, Camarines Sur

Dioneda R.R., R.B. Asejo and R.B. Burce. 2019. Status of Corals and Coral Reef Fishes in Ragay Gulf. Pp 50-81. In Dioneda R.R., E.E. Torres and G. Naz. (Eds). 2019. Participatory Resource and Socio-Economic Assessment of Ragay Gulf-Bicol Side. Terminal Report Submitted for the Fisheries, Coastal Resources and Livelihood Project, Department of Agriculture-Bureau of Fisheries and Aquatic Resources, Quezon City. Bicol University, Center for Policy Studies and Development, Legazpi City. 200 pp.

ABSTRACT

The six MPAs reported in 2006 doubled in the present time, but just cover 0.88% of the entire municipal water of Ragay Gulf, Bicol side. This is way below the mandated protection of coastal waters outlined in the Fisheries Code. The MPA and non-MPA coral reefs are largely in fair condition with some in good state. Significant improvement to the live coral cover of the reef systems were noted in all locations except for Sabang in del Gallego. But despite of improving coral condition, macroalgal growth are seen expanding in coverage in all sites. Nutrient enrichment and intense fishing for wrasses and parrotfishes (Scaridae) and other economically-important grazers could have caused this. This will have some serious implication to the recolonization and full recovery of the coral reefs. The percentage of target and indicators reef species have declined while the major group increased based from a baseline in 2005. Herbivores are becoming less available as carnivores dominate now the reef fish assemblage. Reef fishes have now become less abundant and less diverse. This may indicate ecological disturbance despite improving live coral cover. Other factors, like the deterioration the other related coastal habitats, climate change-driven perturbations and intense fishing intensity could have impacted the species supported by the reef habitat. The detected increase of biomass was not from target species but due to dominance of some species like Pomacenthrids and other fishes from major group, which were likely favoured by the factors mentioned above.

The artificial reef in San Pascual is in bad state and shall be dismantled. Presence of crown of thorns, siltation, ghost nets, other fishing-related materials and solid wastes were some of the observed disturbances. Networking of the MPAs, revalidation of their location and coverage, careful investments of LGU to coal rehabilitation projects and the control of disturbances observed are hereby recommended.

Keywords: Ragay Gulf, coral reefs, reef fishes

INTRODUCTION

Ragay gulf is a 3,912 km^2 fishing ground that is found in the mainland of Luzon, bounded on the East by the Camarines Sur municipalities and the West by Quezon province. Lying at the South western section are water bodies that connect the gulf into Sibuyan Sea and into Burias Pass. These bodies of water sandwiched the island of Burias from which, the coastal water of San Pascual forms the southernmost boundary of the gulf. This elongated inland sea receives enormous discharges from rivers of Camarines and from Bondoc Peninsula of Mountain Province. There are 13000 fishermen reported here in 2006, making the gulf one of the fishing grounds with dense fishers.

The reef systems of Ragay are fringing types and are generally patchy, narrow and are occurring at shallow depths (Ticson et al, 2006), just like its extended reef system at the western coast of Albay right at its South (see Dioneda et al, 2015). REA of 1996 assessed 12 vital reef systems covering within the Bicol and Quezon Province coastal zones. The overall reef condition then of these reef systems was fair with a mean of 32.7% live coral cover (LCC). Only a station in Libmanan (Tres marias) was in good coral state then, with those in Caranan of Pasacao and Ogtok of Ragay are in poor state (<25% LCC). Biomass and abundance of reef systems here ranged from very low to high and poor to high respectively. In 2005, the Post resource and Socio-Economic Assessment (Post RSA) was undertaken by the University of the Philippines in Los Baños Foundation Incorporated (UPLBFI). There were 29 reef systems assessed throughout the gulf which generally yielded fair coral condition (33.63% LCC). Nineteen of these stations are Bicol sites, half of them are in fair condition and with three stations in good coral state (Tres Marias of Libmanan, Sabang out of Del Gallego and Payak Out of Bato) and the remaining are in poor condition. Likewise fish biomass and abundance also ranged from low to high (Ticson et al, 2006). There was an increase in fish biomass from 1996 to 2006 while coral reef health is almost maintained.

From 2005 to present, a lot of things have happened in the gulf. The expansion of the industries (i.e., oil depo, processing plants and marine transportation) alongside with the unprecedented growth of coastal communities have obviously affected the gulf of today. Likewise, the expansion of fisheries and the resorts and ecotourism projects are critical developments that may also alter the bio-physical complexion of a fishing ground. On the other end, the coastal resources management (CRM) initiatives instituted by the government and other agencies may have partly counteracted these disturbances. With all these occurring under the very dynamic gulf ecosystem, new round of follow-up assessments becomes paramount. The Fisheries, Coastal Resources and Livelihood (*FishCORAL*) *Projec*t *wa*s a very timely opportunity as it anticipates the need to update the bio-ecological foundation of fisheries for sustainable livelihood engagements. As part of the *FishCORAL Project*, the conduct of the Participatory Resource and Social Assessment (PRSA) offers opportunity to update the technical information (bio-physical and socio-economics) of the gulf. With the consideration of the climate change impacts, the importance of the present assessments cannot be overemphasized.

This paper focused on the assessment of coral reefs and the reef fishes in the marine protected areas (MPAs) and known artificial reef systems in Ragay Gulf. Some of the MPAs in the gulf are on their second decade of existence while some are just within 10-15 years old. These reef systems were worth assessing, especially along the aspects of its functionality in enhancing coastal

fisheries productivity through spill-over effects and protection of critical habitats. Alcala (1998) stressed that an MPA to be called functional, shall have addressed these two measures of functionality in 5-10 years. This paper also intended to know the status of coral reef systems and the resident and associated ref fishes. Specifically, this paper delved on the following:

1. Determination of extent/area covered by the coral reefs
2. Characterization of the MPAs based on percentage cover of live hard corals soft corals, dead corals, and other substrates/life forms
3. Estimate the diversity, abundance and other measures of community structures of resident and reef associated fish species
4. Provide comparison of coral reefs status and reef fish abundance and biomass between inside and outside sanctuaries
5. Provide notes on associated macro invertebrates and seaweed/algal colonization

METHODOLOGY

Review of existing reports and publications were carried-out. Principally, the terminal report of the Post Resource and Social Assessment of the gulf prepared by the University of the Philippines in Los Baños Foundation Incorporated (UPLBFI) in 2006 and the findings from the Resource and Ecological Assessment in 1996 were referred from. Gulf-wide occurrence of coastal habitats specifically coral reefs were worked out from landsat data and rendered in mapping software. The coral map was then used in validating their occurrence through actual ground truthing and community consultation. Coordination to LGUs and community partners were done both in writing and personal interactions. Selection of sampling stations were based on existence of MPA and the expanse of the coral reef systems. The preparation of base maps indicating the location and extent coral reefs was generated under Project 5.

Table 1. Coral cover condition

% Live Coral	Condition
0-24.99	Poor
25-49.99	Fair
50-74.99	Good
75-100	Excellent

Coral reef assessment used the conventional Line Intercept Transect (LIT) method (English et al 1987) which employed video documentation to enable off-water life form identification and intercept reading. This is undertaken in all MPAs situated inside the gulf. In addition, some stations were also surveyed at non-MPA reef system for comparison purpose. Location coordinates were obtained for these sampling stations using Garmin GPS76CSx. All transects used were at 50 meters in length. Coral reef status was evaluated based on criteria set by Gomez (1982, Table 1). Ecological indices such as Simpson and Shanon-Weiner index of Diversity, Dominance index and Equitability/evenness were computed using the following formulae:

- Simpson's Diversity measures the probability that two individuals randomly selected from a sample will belong to the same species (or some category other than species)

  $D=\Sigma\, pi^2$

  Where P_i is the proportion of each species in the sample

- Evenness (E) is the ratio of the actual H' value to the maximum value (and thus it ranges from 0 to 1). It is expressed as follows:

  $$E = \frac{H'}{H_{max}}$$

  where H' is the Shannon's diversity and

  H_{max} is derived by getting the natural logarithm of the total number of species

  Dominance = 1/D (total of the square of the proportion of each species (square of *pi*) defined as *pi* above)

Fish Visual Census (FVC) was also employed in the sampling stations. To assess the diversity of fish assemblage and estimate their approximate biomass. Stations for FVC were the same stations used for the coral health assessment. Along the 50-meter transect line, two and a half (2.5) meter observation area on both sides was used, accumulating a 250 m2 survey area covered per station. Within this observation area, reef fishes encountered were identified, counted and their lengths estimated. These length estimates were then converted into weights using established length-weight relationships from published and unpublished local works and from FishBase. Macro invertebrates were observed and noted for their occurrence and abundance. Comparison of the reef health/statuses and the reef fish diversity and biomass were done per MPA using available baselines.

Observable perturbations such as presence of garbage, crown of thorns, ghost nets, and bleaching were documented together with macro algal colonization, and presence of macro invertebrates. All diving activities used SCUBA equipment and with the knowledge and/or participation of barangay officials, designated bantay dagat members or with some community representatives.

RESULTS AND DISCUSSION

Extent/Area covered by the coral reefs

Figure 1 showed the map of Ragay Gulf, showing the extent of coastal areas for the Bicol side which constitute 76% of the entire gulf area. San Pascual dominate the area for municipal waters (1429 km^2), followed by Pasacao, Ragay and Libmanan. As noted in Post RSA of 2005, reef areas of the gulf provide narrow fringe forms in the shallow coastal areas.

Figure 1. Albay Gulf and the concentration of coastal habitats.

Status of MPAs and non-MPA coral reef systems of Albay Gulf

In a report in 2006, there were only six MPAs reported in the Bicol Side of the gulf. These were established in 1993 to 2005. It appeared that the oldest MPA in Ragay gulf Bicol side is the one in Caranan (Dalupaon) which was established in 1993. The sizes of these six Bicol MPAs ranged from 30 (Caorasan of Bula) to 119 (Salingogon of Minalabac) hectares.

Recently, this doubled in number with few proposed additional MPAs. Table 2 presented these 12 MPAs with area estimates. These 12 MPAs combine a total of 2664.34 hectares. This protection coverage represented just 0.88% of the total municipal water of 2993.53 km^2 for the Bicol side of the gulf. Again, this is way below the mandated protection of coastal waters outlined in the Fisheries Code. But this is slightly better than the protection provided by MPAs in Albay gulf which is just 0.26% (Dioneda et al, 2019). Not all of these Core areas or sanctuaries comprised the 22.6% while the sizable portion were reserves or buffer zones.

San Pascual MPA is the largest MPA in Ragay gulf with 1139 hectares. This represented 43% of the total MPA area in the Bicol side of the gulf. This is followed by the 526-hectare MPA in del Gallego. The remaining MPAs are smaller size ranging from 30 to 165 hectares. The smallest (30 hectares) MPA was the one established in 2005 at Caorasan in Bula Camarines Sur. These MPAs have substantially covered the 1356.4 hectares of coral reef in Ragay Gulf initially estimated in this report. Bulk of these are in San Pascual Masbate 79% while the remaining is shared by the Camarines Sur municipalities. MPA areas here just ranged from 1.35 to 209 hectares.

Table 2. Profile of MPAs in Ragay Gulf (hectares)

Municipality	Area in Hectares				Mun.Water
	Mun. Water	Total Area	Sanctuary	Reserve	Protection
Bato	7,779	78.79	78.79		1.01
Balatan	10,654	166.00	61.00	105.00	1.56
Bula	9,141	30.00			0.33
Minalabac	6,973	126.20	102.40	23.80	1.81
San Fernando	6,791	141.80	48.40	93.40	2.09
Pasacao	47,300	144.00	63.00	112.00	0.30
Libmanan	26,918				
Sipocot	659	140.00	40.00	100.00	21.24
Lupi	2,092	54.00	54.00		2.58
Ragay	30,460	98.55	68.48	30.07	0.32
del Gallego	7,604	526.00	18.00	508.00	6.92
San Pascual	142,982	1139.00	65.00	1074.00	0.80
Total	**299,353**	**2644.34**	**599.07**	**2046.27**	
% mun. water protected:		**0.88**			

Relative to coastal areas, Only Sipocot in Camarines Sur complied the 15% protection afforded to coastal zones as mandated in RA 8550 as amended by RA 10654. Through its 140-hectare MPA, it protects 21.24% of its very small municipal water (659 hectares). San Pascual, despite declaring 1139 hectares MPA, covered only 0.80% of its municipal water. The rest of the municipalities offered municipal water protection from 0.30 to 6.92% only.

The succeeding sections presented the recent technical information about the condition of reef systems and the associated reef fishes of the MPAs, artificial reefs and other non-MPA reef systems included in the assessment. This assessment established 20 high resolution transects containing benthic life forms and reef fish data within 11 major reef systems of Ragay Gulf on its Bicol side. Comparison from 1995 REA and 2006 Post RSA results would be highlighted whenever available.

Status of coral reefs of Payak, Bato, Camarines Sur

In the previous two assessments, Payak was the only MPA in Bato with an area of 51 hectares (Ticson et al, 2006). But recently, two more MPAs were added namely, Pagatpatan (12.58 hectares) and Palo (14.59 hectares). Only Payak was assessed here as attempts to dive the other MPAs failed due to bad sea condition.

Table 3 showed the summary of result of the coral reef assessment undertaken in major reef systems of Payak MPA in Bato, Camarines Sur. The 51-hectare MPA harbours a reef system that is in fair condition, with live coral cover ranging from 42-43%. Growth of macroalgae was also very extensive here, yielding 35-39% cover. Dead corals appeared to be minimal (6.7-11.6%), but

the big proportion of seaweed bed dominated by brown algal species are previously dead corals that are now colonized by the macroalgae. Coral condition inside this MPA was maintained based from the 2006 baseline which was 41.5% inside. A reference outside reef was found to be in good condition with a live coral cover (LCC) of 65%. This highlights opportunity for Bato to reconsider expansion of its Payak MPA to provide protection as well to the non-MPA reef systems. This was necessary as its three MPAs only provided an aggregate protection of 1.01% of its municipal water. The complete details of the assessment for Payak MPA in Bato is in Appendix A.

Table 3. Coral reef health in Payak MPA, Bato, Cam. Sur.

Lifeforms or Substrates	Percentage Cover	
	PayakT1	PayakT2
Hard corals (HC)	42.86	42.08
Sorf Corals (SC)	0.20	0.16
Dead Corals (DC)	6.70	11.62
Other Organisms (OT)	0.16	
Algae (ALG)	38.78	35.54
Substrate	11.30	2.80
LCC* (HC+SC)	43.06	42.24
Reef Health	Fair	Fair
**Live Coral Cover*		

Status of ref systems of Balatan, Camarines Sur

Balatan has a 106-hectare Pararao MPA with narrow and silted reef system. Assessment of this reef in 2005 showed poor coral condition (16.96 LCC), high dead corals (27.22%) and algal cover (36.7%). Presently, another site fronting Barangay Coguit is being proposed as additional MPA. Both of the reef systems are shallow, with expansive intertidal area accessible to daily gleaning, with presence of crown of thorns and left-out nets and parts of fishing paraphernalia.

Table 4 showed the summary of the benthic life form survey for the two reef systems in Balatan. Coguit transects were considered here as non-MPA reference reef while data for Pararao represents the mean MPA reef condition. The previously poor reef health in pararao MPA in 2005 improved a bit to fair condition, with 26.74% LCC. The occurrence of new coral formations and numbers of coral recruits were manifesting some good management couple of years back. Dead corals were considerable (19%). It was s 27.222% in 2005 assessment but now, they were largely covered by macroalgal assemblage.

Table 4. Coral reef health of Balatan, Camarines Sur.

Lifeforms or Substrates	**Percentage Cover**			
	Coguit T1	Coguit T2	Coguit T3	Pararao
Hard corals (HC)	31.76	50.62	55.28	26.64
Sorf Corals (SC)				0.10
Dead Corals (DC)		0.42	8.34	19.08
Other Organisms (OT)	5.74	2.84	7.04	5.86
Algae (ALG)	21.24	21.96	21.02	27.22
Substrate	17.74	8.32	8.32	7.76
LCC* (HC+SC)	**31.76**	**50.62**	**55.28**	**26.74**
Reef Health	Fair	Good	Good	Fair
**Live Coral Cover*				

The proposed MPA in Coguit showed some good condition on its reef system, especially those at the deeper part. These were transects 2 and 3, which yielded good coral cover ranging from 50.6-52.3%. Algae here was again considerable (21% cover) with also large area of barren hard substrate (8-17%). The shallow edge is frequented by gleaners during low tide, exposing the coral reef-sea grass and macroalgal assemblage to disturbances. The practice of setting the gillnet net during high tide impounds a lot of siganids and other economically important species when low tide comes. Likewise, boat anchorage was causing much damage and arresting recovery of the shallow reef area. The proposed additional MPA in Coguit was an opportunity to improve

municipal water protection of Balatan which was just 1.56%. Full detail of the coral assessment for Balatan was shown in Appendix B.

Status of reef systems of Bula, Camarines Sur

The smallest MPA in Ragay Gulf is located in of Barangay Caorasan. This 30 hectare MPA was just representing 0.33% of the entire municipal water of Bula, which is way smaller than the mandated 15% in the revised fisheries code. Established in 2005, this MPA harbors a reef system that was in poor to fair condition (11-26% coral cover) in 2005. The latest assessment showed tremendous improvement in the condition of its coral reefs which is now in good condition with live cover of 57.9%. Dead corals were also significantly reduced from 24-33% to just 21% in the recent assessment. Algae was also significantly reduced from 21-27% in 2005 to just 8.42%. Abiotic components were very high in 2005 (13-22%) while it was just 7.74% in the present assessment. All indicators in the present life forms were pointing to good development happening in the reef systems, unlike its neighboring reefs. This could be attributed to good MPA management in the area. The complete result of the benthic lifeform survey is in Appendix C.

Table 5. Coral reef health of Bula, front Camarines Sur.

	% Cover
Lifeforms or Substrates	Caorasan MPA
Hard corals (HC)	57.88
Soft Corals (SC)	
Dead Corals (DC)	21.16
Other Organisms (OT)	0.60
Algae (ALG)	8.42
Substrate	4.20
TWB	7.74
LCC* (HC+SC)	57.88
Reef Health	Good

**Live Coral Cover*

Status of reef systems of Gnaran and Cotmo MPAs in San Fernando

San Fernando has now two MPAs, namely Gnaran, the youngest with an area of 26.8 hectares and a nearly two decades old Cotmo MPA with an area of 115 hectares. In 2005, Cotmo reef was found to be in fair condition (28.98% LCC). Dead corals were 27.2% and abiotic factors comprised 24.5%. In the recent assessment, only Gnaran was assessed and was found out to be on fair condition with live coral cover of 34.7%. Bulk of this were hard corals but non-Acropora types. It was noteworthy to mention again the large coverage of macroalgae, covering 44.9% of the transects. Algae in the nearby Cotmo MPA was only 14% while abiotic was indeed large (24.5 %.). The prevalent proliferation of macroalgae, now colonizing dead corals and hard abiotic substrate would complicate the recovery of corals through recolonization. This was a prevalent trend in the country and globally wherein, corals were overtaken in recolonization by sea weeds due to host of reasons. Coastal area nutrient loading (Birrell et al, 2008 and McCook et al, 2001) and significant elimination of fish grazers by fishing (Stamoulis et al, 2017 and Edward

Table 6. Coral reef health of Pasacao, Camarines

	Percentage Cover	
Lifeforms or Substrates	Tinalmod	Sarimao
Hard corals (HC)	38.32	53.00
Sorf Corals (SC)	0.00	1.10
Dead Corals (DC)	3.67	5.54
Other Organisms (OT)	2.94	0.84
Algae (ALG)	54.91	36.54
Substrate	0.15	2.98
LCC* (HC+SC)	**38.32**	**54.10**
Reef Health	Fair	Good

**Live Coral Cover*

et al, 2014) were some documented causes that resulted to failure of reef recovery and continued coral degradation. Complete result of the assessment for Gnaran MPA is in Appendix D.

Status of reef systems of Tinalmod and Sarima-o, Pasacao, Cams. Sur.

Pasacao has two MPAs at present because of the addition of Tinalmod MPA with a total area of 144 hectares. Its original MPA in Dalupaon in Barangay Caranan/Sarimao was the oldest MPA in the Bicol side (established in 1993) which has an area of 112 hectares. Pasacao provided an aggregate coastal protection of 266 hectares from these MPAs but this only represented 0.30% protection of its municipal water. The assessment in 2006 under the Post RSA reported a coral cover of 22.9%. Data from REA in 1995 had reported coral cover to just 23% as well. There seemed to be a drastic improvement in the coral cover of the MPA in Caranan-Sarimao MPA in the latest assessment. Live coral cover was now at 54.10% which health is categorized as good.

Table 6. Coral reef health in San Fernando, Cams

Lifeforms or Substrates	Percentage Cover Ngaran
Hard corals (HC)	34.30
Sorf Corals (SC)	0.42
Dead Corals (DC)	8.38
Other Organisms (OT)	2.88
Algae (ALG)	44.88
Substrate	0.94
LCC* (HC+SC)	**34.72**
Reef Health	Fair
**Live Coral Cover*	

The reef system of the other MPA (Tinalmod) is in fair condition (38.3% LCC). Overall, the detected improvement of the coral cover could be attributed to the protection afforded by the LGU to the reef systems. However, it is also noteworthy to mention the large area of seaweed beds now thriving on top of dead corals and abiotic substrates in the two MPAs. Alarming is the 54.9% coverage of seaweed bed in Tinalmod area which was already very high (47%) in 2005. The microalgal bed was dominated by *Padina* and *Sargasum* species. Appendix E shows the full detail of the benthic lifeform assessment for the reef systems of Pasacao MPAs

Status of reef systems of Minalabac, Camarines Sur.

Table 7 showed the result of coral assessment in Minalabac, Camarines Sur. The MPA here had a total of 126.2 hectares, composed of a 23.8 hectares sanctuary and 102.4 hectares reserve. In Post RSA report, the reefs of an MPA in Salingogon was reported to be in poor condition, both inside (22.8% LCC) and outside (18.4% LCC). There was large cover of microalgae (31%) outside while inside, other fauna (52%) dominates the benthic life form coverage. In the present assessment, coral condition inside the sanctuary was in good condition, in fact, two transects yielded almost identical coral cover (50-50.4%). The low coral mortality was still

Table 7. Coral reef health of Minalabac, Cams.

Lifeforms or Substrates	Percentage Cover Transect 1	Transect 2
Hard corals (HC)	50.38	51.48
Sorf Corals (SC)	0.12	3.96
Dead Corals (DC)	6.76	3.90
Other Organisms (OT)	1.76	1.26
Algae (ALG)	38.70	41.84
Substrate	1.22	1.52
LCC* (HC+SC)	50.50	55.44
Reef Health	Good	Good
**Live Coral Cover*		

unchanged but the shift to macroalgal growth is evident, now climbing from 39 to 42% cover. Appendix F shows the complete detail of the assessment for Minalabac.

Status of reef systems of Lupi, Camarines Sur.

Lupi had the second smallest municipal water coverage among the Bicol municipalities bounding Ragay Gulf (2,092 hectares). It had the second smallest (54 hectare) MPA in front of Barangay Bangon which offers 2.58% protection to its small municipal water. Assessment here in 1995 (REA, 1995) showed a reef condition that's near to being in good state (49.9% LCC). This deteriorated to just 31.4% in 2005 (Ticson et al, 2006). Glaring from the 2005 status is the huge cover of dead corals (21%) and abiotic factors (38%). Algae (3.05%) was minimal during this assessment. The resent assessment showed a significant rebound of the coral condition in Lupi MPA. Two transects consistently yielded good coral condition (54-56.7% LCC). Coverage of dead corals and Algae here were almost insignificant. The present abiotic or substrate components were almost the same with those measured in 2005. Appendix G. shows the complete result of the benthic life form assessment held in the reef system of Bangon MPA.

Table 8. Coral reef health of Lupi, Cams. Sur.

Lifeforms or Substrates	Percentage Cover	
	Bangon T1	Bangon T2
Hard corals (HC)	56.74	54.20
Sorf Corals (SC)	0.56	0.42
Dead Corals (DC)	4.04	1.22
Other Organisms (OT)	5.30	1.72
Algae (ALG)	1.44	6.06
Substrate	31.72	36.38
LCC* (HC+SC)	**57.30**	**54.62**
Reef Health	Good	Good

**Live Coral Cover*

Status of reef systems of Ogtok, Ragay, Camarines Sur.

Table 9 presented the result of the benthic lifeform assessment for the reef system of Ogtok MPA of the municipality of Ragay in Camarines Sur. This 98.55-hectare MPA, which was established in 1997 is affording the town of Ragay of 0.32% protection of its municipal water. The core area of this MPA occupied the two thirds (2/3) of the MPA area while the remaining served as the buffer or reserve.

Historical coral condition record of this MPA showed poor coral cover (15.8%0 in 1995 and improved to fair (25.6%) in 2005 (Ticson et al, 2006). Outside transects yielded better coral condition (31% LCC). Common to inside and outside stations are the prevalence of dead corals (26-30%) and abiotic factors (20-28%).

Table 9. Coral reef health of Ragay, Cams. Sur.

Lifeforms or Substrates	Percentage Cover	
	MPA T1	MPA T2
Hard corals (HC)	54.24	49.52
Sorf Corals (SC)	0.13	0.04
Dead Corals (DC)	3.76	5.62
Other Organisms (OT)	1.75	1.87
Algae (ALG)	32.06	31.77
Substrate	7.91	11.18
LCC* (HC+SC)	**54.37**	**49.56**
Reef Health	Good	Fair

**Live Coral Cover*

The recent assessment showed marked improvement of the live coral cover of the reef system inside Ogtok MPA. Two transects yielded good coral reef condition (49.6-54.4% LCC). Dead corals are now almost negligible (3-5.6%) but the algae, dominated by *Sargassum, Padina* and other sea weeds have also spiked (32%). The complete result of the reef assessment for Ragay is in Appendix H.

Status of ref Status of reef systems of Sabang MPA in del Gallego, Camarines Sur.

Table 11 showed the result of the reef assessment for MPA of del Gallego, Camarines Sur. The corals condition here is fair, with live coral cover of just 32.9%. Corals appear in patches, hence gaps between patches would result to high cover of substrate component (56.9%). In contrast to other nearby ref system, dead corals and algae are minimal here. It's only the patchiness of the reef formation that resulted to fair coral health of this reef.

Table 11. Coral reef health of del Gallego, Cams. Sur.

Lifeforms or Substrates	% cover MPA T1
Hard corals (HC)	32.15
Sorf Corals (SC)	0.75
Dead Corals (DC)	9.05
Other Organisms (OT)	0.66
Algae (ALG)	0.44
Substrate	56.87
LCC* (HC+SC)	**32.90**
Reef Health	Fair

**Live Coral Cover*

In 2005, reef area outside this sanctuary was in good condition (52.6% LCC). Inside the MPA, the reefs were in poor state (15.84), with huge component covered by algae (27.8%) and substrate (40%). This MPA in Barangay Sabang covers 526 hectares. There is a need for Del Gallego to do revalidation study of the location and extent of coverage of Sabang sanctuary. The overall result of the assessment is in Appendix I

Status of ref Status of reef systems of Busing MPA, San Pascual, Masbate.

San Pascual had the biggest MPA in the Bicol municipalities bordering Ragay Gulf. Established in 2012, MPA in Busing encompass a total area of 2139 hectares, with a very small core area (65 hectares) and the rest are reserve/buffer zone. Because of the big municipal water, this MPA is only providing protection to 0.80% of its municipal water. In 2005, a reef system in a spot called Templo was assessed and yielded fair coral cover (38.9%). Dead corals, algae and abiotic substrates cover almost same area (12-18% cover) during this time.

Table 12. Coral reef health of San Pascual, Masbate

Lifeforms or Substrates	**Percentage Cover**			
	BusingT1	BusingT2	TinalisayanT1	TinalisayanT2
Hard corals (HC)	25.48	35.28	49.84	53.52
Sorf Corals (SC)		0.2		0.5
Dead Corals (DC)	9.74	4.58	25.86	22.2
Other Organisms (C	2	1.04	0.12	1.08
Algae (ALG)	26.04	24.1	6.16	6.28
Substrate	36.74	34.8	18.02	16.42
LCC* (HC+SC)	**25.48**	**35.48**	**49.84**	**54.02**
Reef Health	Fair	Fair	Fair	Good

*LCC=Live Coral Cover

The present assessment was focused on Busing Marine Reserve and Sanctuary and to non MPA shallow reef system located near Tinalisayan Island. It appears that the non-MPA reef system in Tinalisayan is in better condition than the ones inside the MPA. The coral cover here in MPA is only fair (25-35.4% LCC) as compared to the 49.8-54% coral cover of the non-MPA site in Tinalisayan. The relatively low live coral cover inside the MPA can be attributed to the growth of seaweed beds (24-26%) and the patchy occurrence of the coral formations, resulting to large cover (34-36.7%) of abiotic/substrate component. Right within the core area is the location of the four modules of artificial reef system installed by an NGO supposedly to showcase a coral plantation/garden. Appendix J shows the complete detail of the benthic life form assessment for San Pascual.

Diversity, abundance and community structures of resident and reef associated fish species

Table 13 showed the number of species, fish abundance and biomass estimate of reef fishes in at least 10 coral reef areas in Ragay Gulf. Biomass of coral reefs were conventionally used to infer potential fish yield. In fact, the importance of coral reef systems in providing near shore catch in the country is considerable, reaching a conservative estimate of 2-5 mt/km^2/year (Marten and Polovina. 1982). Here, the reef fish biomass is high frontlined by Caorasan (102 mt/km^2), Bangon (107 mt/km^2), Tinalmod (117.4 mt/km^2) and Sarimao (122.9 mt/km^2). The rest of the reef systems have modest fish biomass which ranged from 30.3 to 48.4 mt/km^2.

Table 13. Diversity, abundance and biomass of reef fishes in Ragay Gulf.

Municipality	MPA/Reef	Species	Fish No.	Biomass (kg/250 m^2)	Biomass (MT/km^2)
Pasacao, Cams. Sur	Sarimao	31	809	30.73	122.91
Tinalmod, Cams. Sur	Tinalmod	27	703	29.36	117.44
Ragay, Cams. Sur	Bangon	33	689	26.76	107.04
Bula, Cams. Sur	Caorasan	23	489	25.48	101.92
San Fernando, Cams. Sur	Gnaran	31	546	12.11	48.44
San Pascual, Cams. Sur	Tinalisayan (non MPA)	34	501	10.82	43.28
Bato, Cams. Sur	Payak	23	187	7.76	31.04
Balatan, Cams. Sur	Pararao	22	193	7.54	30.16
Del Gallego, Cams. Sur	Sabang	24	198	6.91	27.64
San Pascual, Masbate	Busing	21	481	6.56	26.24

These biomass estimates were collectively the highest so far computed in many locations in Bicol. The biggest biomass estimates of Sarimao (122.9 mt/km^2) had almost equaled the fish biomass estimate of 125.8 mt/km^2 in Itiw-itiw reefs of Monreal, Masbate (Dioneda et al, 2014). Very lately, Dioneda et al (2019) estimated the reef fish biomass in Albay gulf to just within the range of 9.8-56 mt/km^2. Corollary to this, estimates of reef fishes in the region vary widely, indicative of the quality of habitat and the magnitude of fishing pressure they receive. For instance, Dioneda and Burce (2018) estimated reef biomass range of 38.8-67.7 mt/km^2 within the twin MPA of Donsol, Sorsogon. This was comparable to estimates done in previous year in the same MPAs

(29.5-80.5 mt/km^2, Dioneda and Burce, 2017). The reef fish biomass of the narrow reef systems of the east coast of Albay, from Libon down to Pioduran (see Mendoza et al (2015) was inferior to these estimates in Ragay Gulf.

Figure 3. Ragay Gulf's Reef fish Classification
a. Economic/Ecological groupings b. Feeding niche

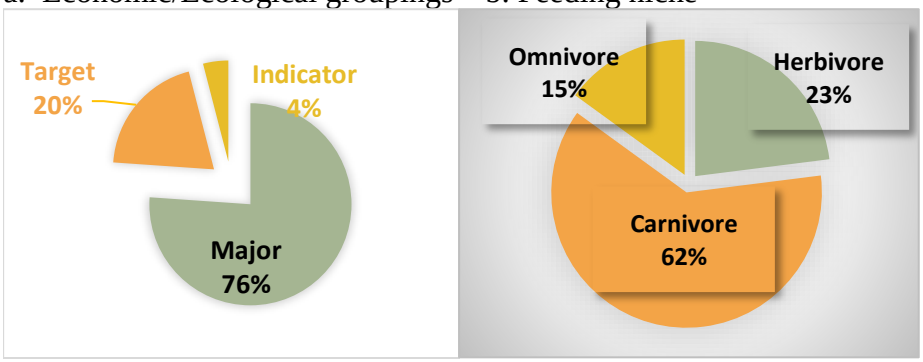
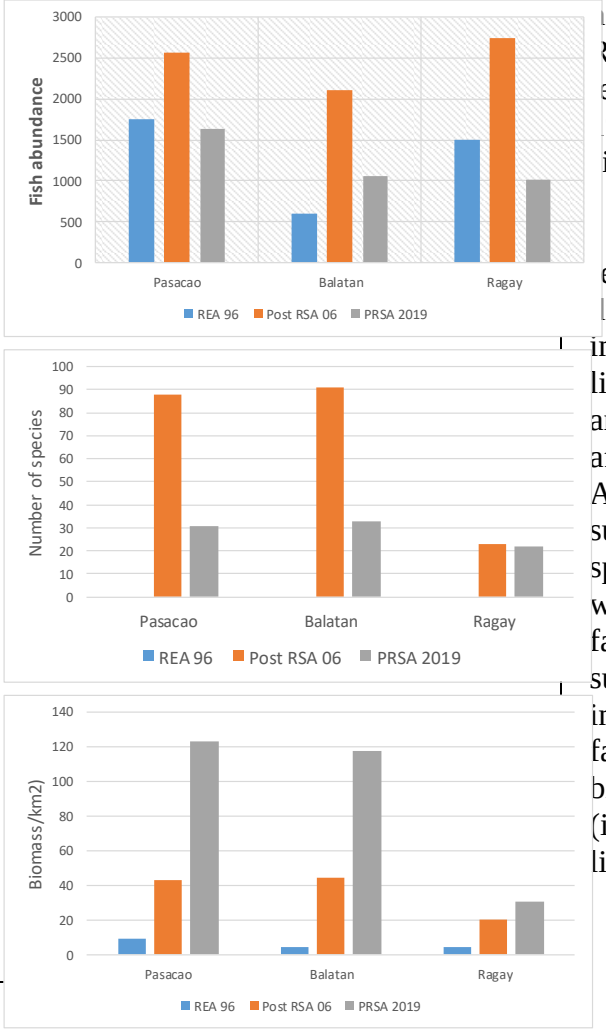


Figure 3a showed that target species in Ragay gulf is fairly better (20%) than the computed target group proportion in Albay Gulf (12%). This was 24% though in the 2005 Post RSA (Ticson et al, 2006). Target species are essentially the preferred species of fishing operations because of their inherent economic value. Less proportion of fishes from target species may mean intense fishing pressure challenging the regenerative capacity of the fish population. Indicators species are very minimal in fish count, representing just 4%, in fact in 2005, this is 7% in Ragay Gulf. Mostly represented by perturbation-sensitive species from Family Chaetodontidae (butterfly fishes) and some from Family Labridae (cleaner wrase), indicator species are represented by only 43 fishes or 4% of total number of fishes encountered in all the transects in Ragay Gulf. Less fishes from indicators species may mean some degree of deterioration of habitats. Bulk (1085 or 76%) of the fishes encountered are belonging to major group. Post RSA data in 2005 estimated this to be at 68% only. Fish assemblage dominated by major group have less to offer to fisheries as these fishes are of less economically important and are not normally part of any traditional fisheries. It is however important to stress that all fishes belonging to major groups, just like the target and indicator species are all ecologically important.

Figure 3b classified the reef fishes of Ragay Gulf according to their feeding habits. Most of the fishes encountered are carnivores (62%). In the Post RSA assessment in 2005, this was just 51% (Ticson et al, 2006). There seemed to be an imbalance now as these groups outnumber those that were at the lower trophic level, such as herbivores and omnivores which just represent 23 and 15% respectively. The very low count of herbivore fishes would directly connect to the significant elimination of grazers, which partly could have caused the macro algal growth along reef systems of the gulf.

Figure 4 showed the comparative reef fish data from REA 1995 to present. It is evident that reef fishes are more abundant during the 2005 assessment than the previous REA (1995) and with the present. Fishes are getting less abundant now, and if ever there is an improvement to fish counts, most of them are due to population growth of some major fish species. Notable for this are the abundance of Pomacentrids species which generally dominate most of the reef fish assemblage in terms of species count.

Figure 4. Reef fish abundance, biomass and species count of selected sites in Ragay Gulf from RA 1995, b) Post RSA 2006 and PRSA 2019.



In terms of number of species, there seemed a significant reduction in diversity of the reef fishes as represented by three locations in Ragay Gulf. In Pasacao and Balatan MPAs, more than alf of species count were lost. Species count of Ragay between two periods are comparable. In erms of biomass there is a significant climb from 995 to the present for the three representative ites.

The declining fish abundance and the educed variety of species indicate ecological isturbance. Although the reef habitat had improved from the 2006 condition, other factors, like the condition of the related seagrass/seaweed and mangrove habitats could have deteriorated, affecting the species supported by the reef habitat. Also, climate change factors (i.e., increasing sea surface temperature) may have favored those fish species that have competitive advantage under warm water condition. Fishing could also be a factor, as the economically important species are subjected to intense fishing, less economically important (here called as major group) have been favored and flourished. The detected increase of biomass can be due to dominance of some species (i.e., Pomacenthrids, and some wrasses) which are likely favored by the factors mentioned above.

Table 14 showed the basic ecological indices computed for selected reef assessment stations in Ragay Gulf. Reef fishes of Ragay, Bula, Pasacao (Sarimao) and Balatan registered the highest diversity indices as these areas harbor the most number of species and fishes encountered. Reef fishes of these municipalities were fairly distributed as well, with evenness indices ranging from 0.73 to 0.87. This means fair distribution of fishes to the encountered number of species. Notable were those reef systems with low diversity indices such

Table 14. Ecological indices of reef fishes in Ragay Gulf.

Municipality	Name of Reef Area	Diversity Simpson	Evenness	Simpson's Dominance
Pasacao	Sarimao	0.12	0.73	0.88
Pasacao	Tinalmod	0.07	0.82	0.93
San Fernando	Gnaran	0.06	0.87	0.94
Bula	Caorasan	0.14	0.75	0.86
Balatan	Pararao	0.11	0.87	0.89
Ragay	Bangon	0.15	0.74	0.85
San Pascual, Msbte	Busing	0.01	0.88	0.90

as Busing (0.01), Gnaran (0.06) and Tinalmod (0.07). These areas have either less species and fish abundance and/or a species or several species dominate in terms of fish abundance. This measure is provided by dominance index, which indeed, those locations with lower diversity indices generally have high values of dominance. Generally, reef fish species assemblage was less diverse in the present survey than in the 1995 (REA) and Post RSA of 2006.

Artificial reef assessment

The artificial reefs of Busing, San Pascual was assessed alongside with the assessment of corals in the MPA. Two modules of 4m x 4m frame of 14 mm steel bars were seen in the reef system of the MPA with some bleached corals intentionally attached on top of it. Based on the accounts of the representative from the LGU, the set-up was installed as showcase project of an NGO attached to the coral gardening initiative. The steel-made platform is now beginning to get consumed by the sea, some are already dislodged and coral growth is dismal (see Figure 5.). This AR was designed to fail as the steels corrode fast in salt water. When corals grew, they gained weight and may just fall off. Another problem with this AR is that it shaded the corals underneath, depriving the original corals from recovering from damage. The immediate dismantle of this structure is strongly recommended.

Figure 5. The artificial reef of Busing, San Pascual, Masbate

Associated macro invertebrates and observable perturbation

Crown of thorns were ubiquitous and were seen in almost all stations but seen more frequently in Busing, Coguit and Bangon reef of Balatan and Lupi, respectively. Ropes and ghost (abandoned) fishing gears such as entangled fish nets and bottom set long line were seen in all reef systems. There was less bleaching observed in Ragay Gulf than in Albay Gulf. But shallow reefs of Tinalmod and Sarimao of Pasacao were seen to have events of bleaching but they were recovering. The highlighted overgrowth of macroalgae was also everywhere.

CONCLUSION AND RECCOMENDATIONS

This assessment is the third salvo of comprehensive assessment undertaken in the gulf in a span of 24 years. The first was in 1995 when the Resource and Ecological Assessment was undertaken. The second was in 2005 during the conduct of the Post Resource and Social Assessment. This third comprehensive assessment is part of the Bureau of Fisheries and Aquatic Resources V under its under the FishCORAL Project.

Coral reef assessments were focused on the MPAs and some non-MPA reef systems in the gulf. In a report in 2006, there were only six MPAs reported in the Bicol Side of the gulf. The oldest MPA in Ragay gulf Bicol side is the one in Caranan (Dalupaon) which was established in 1993. The sizes of these Bicol MPAs are very variable but within the range of 30 to 119 hectares only. Recently, this doubled in number with few additional proposed. The 12 MPAs combine a total of 2664.34 hectares. This protection coverage represented just 0.88% of the total municipal water of 2993.53 km^2 for the Bicol side of the gulf. Again, this is way below the mandated protection of coastal waters outlined in the Fisheries Code but is slightly better than the protection provided by MPAs in Albay gulf. Core areas or sanctuaries comprise 22.6% while the sizable portion are reserves or buffer zones.

San Pascual MPA was the largest MPA in the gulf with 1139 hectares. This represented 43% of the total MPA area in the Bicol side of the gulf. This was followed by the 508-hectare MPA in Del Gallego, having 526 hectares. The remaining MPAs had smaller sizes ranging from 30 to 165. Again this 30-hectare MPA is the one located at Caorasan in Bula Camarines Sur, which was established in 2005. Relative to coastal areas, Only Sipocot in Camarines Sur complied the 15% protection afforded with coastal zone as mandated in RA 8550 as amended by RA 10654. Through tis 140-hectare MPA, it protected 21.24% of its very small municipal water (659 hectares). San Pascual, despite declaring 1139 hectares MPA, covered only 0.80% of its municipal water. The rest of the municipalities offered municipal water protection to area range of 0.30 to 6.92%.

Some coral reef systems were in good coral condition despite they were not afforded with protection by an MPA. Coral reef statuses have registered improvements from the last time they were assessed. It's only in the reef system of Sabang in del Gallego that the previously good state (52.6%) is just now under fair condition (32%). The rest have improved from fair to good or just maintained their fair and goof condition 14 years ago. But although coral cover was maintained or slightly improved, macro algal growth was noted to be happening in all reef systems. These macro algal community now thriving in coral reef systems were using dead coral hard substrates. This would have some serious implication to the recolonization and recovery of the coral reefs.

The percentage of target and indicators species have been reduced based on a baseline in 2005. These decreases were but to the corresponding increase of species belonging to major group. Likewise, herbivores are becoming less available as carnivores dominate now the reef fish assemblage. Fishing targeting wrasses and parrotfishes (Scaridae) and other economically-important grazers could have caused this. Reef fishes have now become less abundant and less diverse. The declining fish abundance and the reduced variety of species indicate ecological disturbance. Although the reef habitat had improved from the 2006 condition, other factors, like the condition of the related coastal habitats, climate change-driven perturbations and intense

fishing intensity could have impacted the species supported by the reef habitat. The detected increase of biomass can be due to dominance of some species (i.e., Pomacenthrids, and some wrasses) which are likely favoured by the factors mentioned above.

The artificial reef in San Pascual was in bad state and should be dismantled. The steel platforms are on advance stage of corrosion and few coral remnants were seen. This unstable substrate would not serve the purpose. Presence of crown of thorns were seen in all reef areas surveyed, but are more frequently encountered in the Coguit, Caorasan and Busing reefs. Fishing ropes ghost (abandoned) fishing gears such as entangled fish nets and bottom set long line are seen in all reef systems.

With all these findings on the background, the following are hereby recommended:

1. **Revalidation of the location and expanse of the MPAs**. Some of the MPAs are right in front of the mouth of the river (i.e., Kabunturan and Manito MPAs). With the presence of nearby other reef systems which are in better condition, expansion of this preexisting MPA can be considered. This addressed the issue that the municipalities bordering the gulf just offered protection through establishment of MPA to just 0.88% of the entire gulf area. In as much as Ragay gulf is entirely municipal water, this protection coverage is way below the mandated coastal environment protection under R.A. 8550.

2. **Networking of the MPAs.** The MPAs in Ragay Gulf are in isolation with each other and are managed at varied scales. Since all of them are within one ecological setting, their functionality could better serve the intended purpose of habitat and biodiversity protection if their operational and management mechanisms follow the same standards.

3. **Careful rehabilitation efforts**. Coral restoration in some areas which has the poor reef health status can be explored to improve and restore the diversity of the said habitat. There is a need to dismantle the set-up in San Pascual as it brings more harm than good to the coral reefs of the MPA. The LGUs shall carefully embark on coral restoration projects.

4. **Curbing coral ecosystem disturbances**. Solid and liquid wastes are the main killers of coral reefs. Liquid wasters introduce unnecessary high level of nutrient to supposedly oligotrophic reef ecosystem. This partly enhanced macro algal growth. This should be checked from land-based activities and practices. Regular clean-up operation for ghost nets shall be undertaken.

REFERENCES

Birrell CL, McCook LJ, Willis B, Diaz-Pulido G (2008) Effects of benthic algae on the replenishment of corals and the implications for the resilience of coral reefs.

de Jesus, S.C., R. .R. Dioneda, I.H. Revale1, A. D. Doloiras, A. L. Nolial, A. Ocampo and D.S. Alcazar. Assessment of the Ecological Habitats of Bacon District, Sorsogon City in the Philippines. Kuroshio Science 4-1, 43-52, 201

Dioneda R.R. and R.B. Burce. 2018. Coral and Fish Monitoring of the Marine Conservation Park in Donsol Sorsogon, Philippines. Project Terminal Report.

Dioneda R.R. 2013. Reef Fish assessment at Catundulan, Donsol, Sorsogon and San Miguel Island, Monreal Masbate. A Greenpeace assessment initiated activity.

Dioneda R.R., F.B. Bustamante and V.S. Soliman. MFR-focused site characterization for Panumbagan, Pilar Sorsogon. Terminal report.

Dioneda, R.R., R.B. Burce and X.A.A. Dioneda. 2014. Governance and Bio-Ecological Functionality Assessment of Guinhadap Fish Sanctuary and Marine Reserve Guinhadap, Monreal, Masbate, Philippines. Technical Report. World Wide Fund for Life-Philippines

Dioneda R.R., R.B. Burce and R.B. Asejo. 2019. Status of corals and coral reef fishes of Ragay Gulf. FiSHCORAL-PRSA Terminal report. Volume 2.

Dioneda, R..R, X.J.A. Dioneda and R.B. Burce. 2016. Bio-ecological status and Management Effectiveness of Donsol Marine Conservation Park, Donsol, Sorsogon, Philippines. BU R&D Journal (A CHED-Recognized Journal) Vol. XIX. ISSN 0016-4139

Mendoza, A.B., R.R. Dioneda and C.D. Cabiles. 2016. Assessment of Reef Fishes in selected Municipalities in Albay. BU R&D Journal (A CHED-Recognized Journal) Vol. XIX. ISSN 0016-4139

Dioneda R.R., H.P. Llana and R.P.O. Mijares. 2015. Status of governance of the Marine Protected Areas (MPAs) in the West Coast of Albay. BU R&D Journal (A CHED-Recognized Journal) Vol. XVIII. ISSN 0016-4139

Edwards, C. B. et al. Global assessment of the status of coral reef herbivorous fishes: evidence for fishing effects. Proc. R. Soc. Lond. B Biol. Sci. 281, 20131835 (2014).

Marten, G.G. and J.J. Polovina. 1982. A comparative study of fish yields from various tropical ecosystems. ICLARM Conf. Proc. 9:255-285.

McCook LJ, Jompa J, Diaz-Pulido G (2001) Competition between corals and algae on coral reefs: a review of evidence and mechanisms. Coral Reefs 19:400-417

McManus, J. W., Meñez, L. A. B., Gesner-Reyes, O. N., Vergara, S. G. & Ablan, M. C. Coral reef fishing and coral-algal phase shifts:implications for global reef status. ICES J. Mar. Sci. J. Cons. 57, 572–578 (2000

Mendoza A.B. C.B. Cabiles and R.R. Dioneda. Assessment of reef fishes in selected municipalities of Albay. Project report. SCREMP, DENR Region V.

Soliman V.S, A.B. Mendoza Jr., D.N. David and J.B. Buella. 1998. Assessment of Marine Fishery Reserves in Bicol for Local Government Action Planning. R&D Journal. Vol. XI. December 1998.

Soliman, V.S., A.B. Mendoza, R.R. Dioneda, and A. Nazareno. 2000. Assessment of Coastal Habitats and fisheries off Bantigue Point, Pilar, Sorsogon: Generating options for mfr establishment

Stamoulis, K. A. et al. Coral reef grazer-benthos dynamics complicated by invasive algae in a small marine reserve. Sci. Rep. 7, 43819; doi: 10.1038/srep43819 (2017).

Appendix A. Status of coral reefs insde Payak MPA of Bato, Cams. Sur.

Reefs				Payak MPA T1	Payak MPA T2
Live Coral	Hard Coral	Acropora	Acropora branching (ACB)	0.54	0.32
			Acropora digitate (ACD)		
			Acropora encrusting (ACE)		
			Acropora submassive (ACS)		
			Acropora tabulate (ACT)	0.5	
			Acropora Total	1.04	0.32
		Non Acropora	Heliopora (CHL)	0.44	
			Millepora (CME)	2.52	6.16
			Mushroom coral (CMR)	0.16	0.14
			Branching corals (CB)	6.66	5.56
			Encrusting corals (CE)	9.08	10.16
			Foliose corals (CF)	0.5	0.4
			Massive corals (CM)	19.62	10.32
			Submassive corals (CS)	2.84	9.02
			Non Acropora Total	41.82	41.76
		Hard Coral Total		42.86	42.08
	Soft Corals			0.2	0.16
	Live coral Total			43.06	42.24
Percent cover category				Fair	Fair
	Dead cora		Dead Coral (DC)		0.12
			Dead coral with algae (DCA)	6.7	11.5
			Dead Coral Total	6.70	11.62
	Other Organi		Other animals (OT)	0.16	
			Sponge (SP)		
			Zoanthids (ZO)		
			Other Organism Total	0.16	0.00
	Algae		Algal assemblages (AA)	31.26	24.54
			Coralline algae (CA)	1.64	0.88
			Halimeda (HA)	0.1	
			Macroalgae (MA)	5.78	10.12
			Turf Algae (TA)	0	0
			Algae Total	38.78	35.54
	Abiotic		Rock (RO)		
			Rubble (R)		1.7
			Sand (S)		0.5
			Silt (SI)		0.6
			Total		2.80
TWB				11.3	7.8
Total				100.00	100

Appendix B. Coral reef status in MPA and proposed MPAs of Balatan, Camarines Sur.

Reefs				Coguit T1	Coguit T2	Coguit T3	Pararao MPA T1
Live Coral	Hard Coral	Acropora	Acropora branching (ACB)	0.26	1.58	9.29	1.32
			Acropora digitate (ACD)				
			Acropora encrusting (ACE)				
			Acropora submassive (ACS)				
			Acropora tabulate (ACT)				
			Acropora Total	0.26	1.58	9.29	1.32
		Non Acropora	Heliopora (CHL)				
			Millepora (CME)	2.24	0.82		
			Mushroom coral (CMR)	0.20	2.00	0.20	0.52
			Branching corals (CB)	4.64	12.30	5.55	4.74
			Encrusting corals (CE)	7.30	13.90	11.10	14.30
			Foliose corals (CF)		2.60	20.60	
			Massive corals (CM)	14.04	13.12	8.12	4.72
			Submassive corals (CS)	3.08	4.30	0.42	1.04
			Non Acropora Total	31.50	49.04	45.99	25.32
		Hard Coral Total		31.76	50.62	55.28	26.64
	Soft Corals						0.10
	Live coral Total			**31.76**	**50.62**	**55.28**	**26.74**
Percent cover category				FAIR	GOOD	GOOD	FAIR
Dead corals			Dead Coral (DC)		0.42	0.24	
			Dead coral with algae (DCA)	22.20	7.46	8.10	19.08
			Dead Coral Total	22.20	7.88		19.08
Other Organism			Other animals (OT)	4.68	1.90	7.04	0.70
			Sponge (SP)	1.06	0.94		5.12
			Zoanthids (ZO)				0.04
			Other Organism Total	5.74	2.84		5.86
Algae			Algal assemblages (AA)	17.32	21.44	13.24	25.30
			Coralline algae (CA)	0.14	0.18	2.66	1.34
			Halimeda (HA)				
			Macroalgae (MA)	3.78	0.34	5.12	0.58
			Turf Algae (TA)				
			Algae Total	21.24	21.96		27.22
Abiotic			Rock (RO)				
			Rubble (R)	8.42	0.26	3.10	6.76
			Sand (S)	9.28	1.34	4.38	0.96
			Silt (SI)	0.04	6.72	0.84	0.04
			Total	17.74	8.32	8.32	7.76
TWB				1.32	8.38		13.34
Total				100.00	100.00	100.00	100.00

Appendix C. Status of coral reef at MPA, Caorasan, Bula, Cams.Sur.

Coral Lifeforms				Caorasan T1
Live Coral	Hard Coral	Acropora	Acropora branching (ACB)	14.60
			Acropora digitate (ACD)	
			Acropora encrusting (ACE)	
			Acropora submassive (ACS)	
			Acropora tabulate (ACT)	
			Acropora Total	14.60
		Non Acropora	Heliopora (CHL)	2.40
			Millepora (CME)	1.70
			Mushroom coral (CMR)	2.90
			Branching corals (CB)	13.70
			Encrusting corals (CE)	4.48
			Foliose corals (CF)	2.70
			Massive corals (CM)	12.30
			Submassive corals (CS)	3.10
			Non Acropora Total	43.28
		Hard Coral Total		57.88
	Soft Corals			
	Live coral Total			**57.88**
Percent cover category				GOOD
Dead corals			Dead Coral (DC)	8.60
			Dead coral with algae (DCA)	12.56
			Dead Coral Total	21.16
Other Organism			Other animals (OT)	0.60
			Sponge (SP)	
			Zoanthids (ZO)	
			Other Organism Total	0.60
Algae			Algal assemblages (AA)	6.32
			Coralline algae (CA)	2.10
			Halimeda (HA)	
			Macroalgae (MA)	
			Turf Algae (TA)	
			Algae Total	8.42
Abiotic			Rock (RO)	
			Rubble (R)	0.50
			Sand (S)	
			Silt (SI)	3.70
			Total	4.20
TWB				7.74
Total				100.00

Appendix D. Status of coral reefs at MPA, Ngaran, San Fernando, Cams.Sur.

Coral Lifeforms				Ngaran MPA
Live Coral	Hard Coral	Acropora	Acropora branching (ACB)	1.52
			Acropora digitate (ACD)	
			Acropora encrusting (ACE)	0.18
			Acropora submassive (ACS)	
			Acropora tabulate (ACT)	2.24
			Acropora Total	3.94
		Non Acropora	Heliopora (CHL)	
			Millepora (CME)	
			Mushroom coral (CMR)	0.60
			Branching corals (CB)	3.34
			Encrusting corals (CE)	7.62
			Foliose corals (CF)	
			Massive corals (CM)	15.68
			Submassive corals (CS)	3.12
			Non Acropora Total	30.36
		Hard Coral Total		34.30
	Soft Corals			0.42
	Live coral Total			**34.72**
Percent cover category				FAIR
Dead corals			Dead Coral (DC)	8.32
			Dead coral with algae (DCA)	0.06
			Dead Coral Total	8.38
Other Organism			Other animals (OT)	0.18
			Sponge (SP)	2.66
			Zoanthids (ZO)	0.04
			Other Organism Total	2.88
Algae			Algal assemblages (AA)	18.92
			Coralline algae (CA)	1.46
			Halimeda (HA)	
			Macroalgae (MA)	24.42
			Turf Algae (TA)	0.08
			Algae Total	44.88
Abiotic			Rock (RO)	
			Rubble (R)	
			Sand (S)	0.04
			Silt (SI)	0.90
			Total	0.94
TWB				8.20
Total				100.00

Appendix E. Status of coral reefs at Tinalmod and Sarimao MPAs, Pasacao, Camarines S

Coral Lifeforms				Tinalmod MPA	Sarimao MPA
Live Coral	Hard Coral	Acropora	Acropora branching (ACB)	0.97	3.78
			Acropora digitate (ACD)		
			Acropora encrusting (ACE)	1.12	0.28
			Acropora submassive (ACS)	0.00	
			Acropora tabulate (ACT)	5.34	8.50
			Acropora Total	7.42	12.56
		Non Acropora	Heliopora (CHL)	0.89	0.80
			Millepora (CME)		
			Mushroom coral (CMR)	0.12	0.08
			Branching corals (CB)	16.47	18.10
			Encrusting corals (CE)	7.66	4.30
			Foliose corals (CF)	0.04	0.84
			Massive corals (CM)	4.33	14.16
			Submassive corals (CS)	1.39	2.16
			Non Acropora Total	30.90	40.44
		Hard Coral Total		38.32	53.00
	Soft Corals				1.10
	Live coral Total			**38.32**	**54.10**
Percent cover category				FAIR	GOOD
Dead corals			Dead Coral (DC)	2.71	4.24
			Dead coral with algae (DCA)	0.97	1.30
			Dead Coral Total	3.67	5.54
Other Organism			Other animals (OT)	0.00	0.38
			Sponge (SP)	2.94	0.46
			Zoanthids (ZO)		
			Other Organism Total	2.94	0.84
Algae			Algal assemblages (AA)	41.69	18.18
			Coralline algae (CA)	1.70	0.46
			Halimeda (HA)		0.16
			Macroalgae (MA)	11.25	17.74
			Turf Algae (TA)	0.27	0.00
			Algae Total	54.91	36.54
Abiotic			Rock (RO)		
			Rubble (R)		
			Sand (S)	0.04	0.98
			Silt (SI)	0.12	1.46
			Total	0.15	2.44
TWB					0.54
Total				100.00	100.00

Appendix F. Status of coral reefs insde the MPA of Minalabac, Camarines Sur.

Reefs				Bagolatao T1	Bagolatao T2
Live Coral	Hard Coral	Acropora	Acropora branching (ACB)	2.2	2.26
			Acropora digitate (ACD)		
			Acropora encrusting (ACE)		
			Acropora submassive (ACS)		
			Acropora tabulate (ACT)	0.5	5.28
			Acropora Total	2.70	7.54
		Non Acropora	Heliopora (CHL)	0.26	
			Millepora (CME)		
			Mushroom coral (CMR)	0.78	
			Branching corals (CB)	5.48	3.8
			Encrusting corals (CE)	1.32	3.96
			Foliose corals (CF)	0.04	2.26
			Massive corals (CM)	39.42	30.62
			Submassive corals (CS)	0.38	3.3
			Non Acropora Total	47.68	43.94
		Hard Coral Total		50.38	51.48
	Soft Corals			0.12	
	Live coral Total			**50.50**	**51.48**
Percent cover category				GOOD	GOOD
Dead corals			Dead Coral (DC)	6.76	3.9
			Dead coral with algae (DCA)		
			Dead Coral Total	6.76	3.90
Other Organism			Other animals (OT)	0.54	0.24
			Sponge (SP)	1.08	1.02
			Zoanthids (ZO)	0.14	
			Other Organism Total	1.76	1.26
Algae			Algal assemblages (AA)	34.92	35.4
			Coralline algae (CA)	1.22	2.26
			Halimeda (HA)		
			Macroalgae (MA)	2.56	4.18
			Turf Algae (TA)		
			Algae Total	38.70	41.84
Abiotic			Rock (RO)		
			Rubble (R)		0.06
			Sand (S)		
			Silt (SI)	1.22	1.46
			Total	1.22	1.52
TWB				1.06	
Total				100	100

Appendix G. Status of coral reefs insde the MPA of Lupi, Camarines Sur.

Reefs				Bangon MPA T1	Bangon MPA T1
Live Coral	Hard Coral	Acropora	Acropora branching (ACB)	5.28	0.66
			Acropora digitate (ACD)		
			Acropora encrusting (ACE)		
			Acropora submassive (ACS)		
			Acropora tabulate (ACT)		
			Acropora Total	5.28	0.66
		Non Acropora	Heliopora (CHL)		
			Millepora (CME)		
			Mushroom coral (CMR)	7.42	11.64
			Branching corals (CB)	1.52	0.96
			Encrusting corals (CE)	7.34	2.2
			Foliose corals (CF)	9.66	3.86
			Massive corals (CM)	25.38	34.44
			Submassive corals (CS)	0.14	0.44
			Non Acropora Total	51.46	53.54
		Hard Coral Total		56.74	54.20
	Soft Corals			0.56	0.42
	Live coral Total			57.30	54.62
Percent cover category				GOOD	GOOD
Dead corals			Dead Coral (DC)	3.88	1.22
			Dead coral with algae (DCA)	0.16	0
			Dead Coral Total	4.04	1.22
Other Organism			Other animals (OT)	2.02	0.42
			Sponge (SP)	3.28	1.3
			Zoanthids (ZO)		
			Other Organism Total	5.30	1.72
Algae			Algal assemblages (AA)	1.32	6
			Coralline algae (CA)	0.12	0.06
			Halimeda (HA)		
			Macroalgae (MA)		
			Turf Algae (TA)		
			Algae Total	1.44	6.06
Abiotic			Rock (RO)		
			Rubble (R)	16.98	33.02
			Sand (S)	2.84	1.08
			Silt (SI)	11.9	2.28
			Total	31.72	36.38
TWB				0.2	
Total				100	100

Appendix H. Status of coral reefs insde the MPA of Ragay, Camarines Sur.

Coral Lifeforms				Ragay MPA T1	Ragay MPA T2
Live Coral	Hard Coral	Acropora	Acropora branching (ACB)	0.93	0.40
			Acropora digitate (ACD)		0.20
			Acropora encrusting (ACE)	0.88	
			Acropora submassive (ACS)		
			Acropora tabulate (ACT)	1.18	0.97
			Acropora Total	2.99	1.57
		Non Acropora	Heliopora (CHL)	0.13	0.99
			Millepora (CME)		0.28
			Mushroom coral (CMR)	0.28	0.04
			Branching corals (CB)	6.77	4.37
			Encrusting corals (CE)	16.22	12.05
			Foliose corals (CF)	0.75	1.13
			Massive corals (CM)	22.82	22.26
			Submassive corals (CS)	4.28	6.83
			Non Acropora Total	51.25	47.95
		Hard Coral Total		54.24	49.52
	Soft Corals			0.13	0.04
	Live coral Total			**54.37**	**49.56**
Percent cover category				GOOD	FAIR
Dead corals			Dead Coral (DC)	3.63	4.92
			Dead coral with algae (DCA)	0.13	0.71
			Dead Coral Total	3.76	5.62
Other Organism			Other animals (OT)	0.36	1.33
			Sponge (SP)	1.39	0.54
			Zoanthids (ZO)		
			Other Organism Total	1.75	1.87
Algae			Algal assemblages (AA)	30.52	31.27
			Coralline algae (CA)		0.06
			Halimeda (HA)		
			Macroalgae (MA)	1.31	0.32
			Turf Algae (TA)	0.23	0.12
			Algae Total	32.06	31.77
Abiotic			Rock (RO)		
			Rubble (R)	0.70	2.80
			Sand (S)	0.57	1.05
			Silt (SI)	6.64	7.33
			Total	7.91	11.18
TWB				0.15	
Total				100.00	100.00

Appendix I. Status of reef system in MPA of del Gallego, Camarines Sur

Coral Lifeforms				Del Gallego MPA
Live Coral	Hard Coral	Acropora	Acropora branching (ACB)	1.22
			Acropora digitate (ACD)	
			Acropora encrusting (ACE)	
			Acropora submassive (ACS)	
			Acropora tabulate (ACT)	1.02
			Acropora Total	2.24
		Non Acropora	Heliopora (CHL)	0.29
			Millepora (CME)	0.08
			Mushroom coral (CMR)	
			Branching corals (CB)	1.51
			Encrusting corals (CE)	0.21
			Foliose corals (CF)	0.60
			Massive corals (CM)	27.06
			Submassive corals (CS)	0.17
			Non Acropora Total	29.92
		Hard Coral Total		32.15
	Soft Corals			0.75
	Live coral Total			**32.90**
Percent cover category				FAIR
Dead corals			Dead Coral (DC)	9.05
			Dead coral with algae (DCA)	
			Dead Coral Total	9.05
Other Organism			Other animals (OT)	0.66
			Sponge (SP)	
			Zoanthids (ZO)	
			Other Organism Total	0.66
Algae			Algal assemblages (AA)	0.44
			Coralline algae (CA)	
			Halimeda (HA)	
			Macroalgae (MA)	
			Turf Algae (TA)	
			Algae Total	0.44
Abiotic			Rock (RO)	
			Rubble (R)	2.40
			Sand (S)	
			Silt (SI)	54.46
			Total	56.87
TWB				
Total				100.00

Appendix J. Status of MPA and non-MPA reef systems of San Pascual, Masbate.

Coral Lifeforms				Busing MPA T1	Busing MPA T2	Tinalisayan T1	Tinalisayan T2
Live Coral	Hard Coral	Acropora	Acropora branching (ACB)	8.94	9.90	15.54	12.44
			Acropora digitate (ACD)				
			Acropora encrusting (ACE)				
			Acropora submassive (ACS)				
			Acropora tabulate (ACT)				8.44
			Acropora Total	8.94	9.90	15.54	20.88
		Non Acropora	Heliopora (CHL)			1.32	2.34
			Millepora (CME)	0.14	0.12	0.46	2.14
			Mushroom coral (CMR)		0.14		
			Branching corals (CB)	2.10	2.94	21.10	10.90
			Encrusting corals (CE)	9.76	14.24	1.98	4.06
			Foliose corals (CF)	0.18	0.00	2.22	5.96
			Massive corals (CM)	3.04	4.98	6.06	4.80
			Submassive corals (CS)	1.32	2.96	1.16	2.44
			Non Acropora Total	16.54	25.38	34.30	32.64
		Hard Coral Total		25.48	35.28	49.84	53.52
	Soft Corals				0.20		0.50
	Live coral Total			**25.48**	**35.48**	**49.84**	**54.02**
Percent cover category				FAIR	FAIR	FAIR	GOOD
Dead corals			Dead Coral (DC)	0.46	0.36	0.30	1.68
			Dead coral with algae (DCA)	9.28	4.22	25.56	20.52
			Dead Coral Total	9.74	4.58	25.86	22.20
Other Organism			Other animals (OT)	0.78	0.26	0.12	0.70
			Sponge (SP)	1.16	0.60		0.38
			Zoanthids (ZO)	0.06	0.18		
			Other Organism Total	2.00	1.04	0.12	1.08
Algae			Algal assemblages (AA)	9.52	7.00	2.62	3.60
			Coralline algae (CA)	0.80	1.44		
			Halimeda (HA)			0.36	
			Macroalgae (MA)	15.72	15.66	3.18	2.68
			Turf Algae (TA)				
			Algae Total	26.04	24.10	6.16	6.28
Abiotic			Rock (RO)	0.00			
			Rubble (R)	24.04	17.76	14.64	14.46
			Sand (S)	12.70	17.04	1.62	1.96
			Silt (SI)			1.06	
			Total	36.74	34.80	17.32	16.42
TWB						0.70	
Total				100.00	100.00	100.00	100.00

ASSESSMENT OF MANGROVES IN RAGAY GULF (BICOL SIDE), PHILIPPINES

Allan Adonis L. Malvar
Grant Espinosa
Jed O. Masbate
Bicol University
Legazpi City

ABSTRACT

Mangrove ecological habitats were assessed in Ragay gulf. Line plot method was used to determine the present state and community structure of mangrove habitats. There were ten (10) true mangroves species identified. This contribute to one-fourth of the identified 47 "true mangroves" (26) families known in the country. Of all the species identified, *A. marina* appeared as the dominant species in Sabang Del Gallego while *S. alba*, *R. apiculata*, *R. mucronata* and *A. rumphiana* are dominant in San Juan, Halabang Baybay, Pinamasingan and San Rafael with highest density and frequency in the overall assessment and consistently present in almost all stations.

Community structure of different mangrove stations showed highest relative density, relative frequency, relative dominance and importance values. Few species were recorded among these include *R. apiculata* which appeared mostly in rehabilitated areas with monoculture plantations, *R. stylosa*, *A. marina* and *S. alba*. They represent the highest number of species, distribution, large stems for *A. marina* as important species among those surveyed. The Shannon biodiversity index (H') in San Rafael is H' =1.705 which reflect a high diversity while in San Juan is H'=1.279 it reflects a fair diversity (Table 3.1). The three remaining stations Halabang Baybay, Pinamasingan and Sabang fall under low diversity category.

Along regenerative capacity, very high probability of forest existence was observed in San Rafel, good for Pinamasingan. More disturbances and perturbations observed which include mangrove fishpond conversions in Sabang, land reclamation presence of wastes in some areas particularly in sabang and other small areas Humapon and Buyo and minimal cuttings. Mangrove diversity was considerably due to low species turnout. Mangrove habitat conditions in Ragay gulf; Sabang – fair to poor , San Juan-good, Halabang Baybay-good, Pinamasingan-good and San Rafael-good. Mangrove areas after massive rehabilitation significantly improve from poor to good but this has no guarantee of survival due to lack of good practices and management maintenance. Recommendations for management strategies were conveyed focused on poverty alleviation while the enforcement of regulations for the protection and rehabilitation of mangroves take place in a sustained basis. Community participation with support from government concerned agencies, non-government organizations, local government units and private sectors for long term sustainability.

Keywords: *biodiversity, ecological habitat, mangrove, regenerative capacity*

INTRODUCTION

Mangroves are considered critical habitats in coastal areas with great ecological and socio-economic importance. Mangroves span the interphase between marine and terrestrial environments, growing in the mouths of rivers, in tidal swamps, and along coastlines, where they are regularly inundated by saline or brackish water (Sterling et al. 2006). Mangroves play an important role within these areas as they guard the low-lying coastal land by forming a protective barrier. This biological barrier reduces damage caused by storms by limiting wave energy and preventing the land from being flooded. This has become even more apparent after the 2004 Asian tsunami (Radhika, 2006). Their intricate root systems provide protection and a food source for estuarine and coastal fishery food chains. Many fish, shellfish, birds, and other wildlife species adopt the mangrove areas as breeding, feeding, and nursery areas. However, threats are imminent both from resource use and climate change. Over-exploitation, population explosion, land classification conflicts and interest, wrong choice of species, lack of discipline and poverty pose great risks to the very existence of this very important resource.

Mangrove forests are recognized as the world's richest ecosystems for they serve as barriers against strong winds, waves, storm surges, and erosions. Moreover, they prevent silt, sediments, and pollutants from reaching fragile habitats such as seagrass meadows and coral reefs. Mangroves are salt-tolerant trees that have adapted to living in salt and brackish water. They also serve as shelter, spawning and breeding grounds for birds, fish, crustaceans, mollusks, and other organisms. They are unique community that forms a link between the land and the sea. Mangroves are a rich habitat that serve as life support systems to about 75 percent of fish species and to an indeterminate number of crustaceans and wildlife (Baldevarona, 2001). Typical mangrove zonation is observed as species with pneumatophores are found at the low-intertidal, prop and knee roots species are in the mid-intertidal, and buttress or plank root species are at high intertidal area (Samson & Rollon, 2011).

Ragay Gulf lies between the Bicol and Bondoc Peninsulas in Quezon and Camarines Sur Provinces, south-eastern Luzon. It is a protected gulf with an estuary in the northern part created by drainage from the mountains of the northern Bicol Region. Ragay Gulf is surrounded by municipalities and a city and extends down to the province of Masbate, where mangroves thrived. These municipalities include Del Gallego, Ragay, Pasacao, and San Pascual in Masbate. Through the years, people living in coastal barangays made significant impacts on these resource-rich habitats, both positive and negative. Many different activities, such as land conversion and reclamation, waste disposal, and the use of mangrove as a source of income and livelihood may contribute to its decline, and eventually, extinction. This may affect other ecosystems' health and survival, such as sea grasses and corals as part of a life support system. These ecosystems are interconnected and may cause interconnected problems, which may require integrated solutions. In this study, mangroves were assessed to determine what can be done to protect this resource-rich coastal habitat.

This study is a component of the Aquatic Ecology and Habitat Assessment under the BFAR-funded Participatory Resource and Socio-Economic Assessment (PRSA) conducted to gather information about the current status of mangrove habitats in Ragay gulf. Several parameters were taken to assess the mangrove community in each station. These generated awareness on the efforts required to enhance and protect the remaining mangrove stands in these areas.

The study focused on the assessment of mangroves in Ragay gulf. Specifically, it accomplished the following objectives:

1. Determine the status and condition of mangroves;
2. Characterize the community structure of the mangrove communities in terms of
   a. Diversity
   b. Density and relative density
   c. Frequency and relative frequency
   d. Dominance
   e. Basal area
   f. Importance value;
3. Assess biodiversity, ecosystem health and resource status of mangroves in the study site;
4. Estimate the regenerative capacity of the mangrove communities;
5. Provide notes on soil profile and zonation pattern of mangroves;
6. Document rehabilitation efforts, disturbances, and observable perturbations.

METHODOLOGY

The mangrove habitat condition was evaluated using the Habitat Criteria Rating Chart for Mangroves by Participatory Coastal Resource Assessment (PCRA).

Table 1. Habitat Criteria Rating Chart for Mangroves

Condition	Criteria
Excellent	Undisturbed, no cutting, clean, etc.
Good	Some cuttings for firewood, etc.
Fair	Heavy cuttings, fish pond conversions, etc.
Poor	Nearly destroyed, reclaimed or filled, pollution, etc.

Rehabilitation efforts were based on the actual interviews of local officials and residents in the area. Disturbances were observed based on the ocular inspection and reconnaissance. Disturbances were also noted and observed within the line plots.

Line Plot Method (English et al. 1997) was employed to assess the mangrove communities and determine their frequency, density, and species diversity. A 100-meter maximum transect line was laid perpendicular to the shoreline, segmented every 5 meters with established sample plots (5 m x 5 m). Sampling stations in every municipality were assessed using this method of line plots per station covered from the seaward margin, middle and land ward of the forest laid perpendicular to the shoreline. A 1m x 1m sub-plot was established inside each plot for the identification and counting of sapling and seedling required for the regenerative capacity characterization.

Each mangrove species along each transect was identified, counted, and the diameter of each tree was measured. This method provided quantitative descriptions of the species composition and community structure of the mangrove forest. Tree girth measurements were taken at breast height (i.e. approximately 1.3 m above the ground over the highest prop root or 30 centimeters above the ground for those species without prop roots). The girth measurements were converted into diameter at breast height (DBH) measurements by dividing it with 3.14.

Basal area is described as the average amount of an area occupied by tree stems. It is defined as the total cross-sectional area of all stems in a stand measured at breast height, and expressed as per unit of land area. To standardize measurements for basal area, tree diameter is also taken and computed as follows:

$$\text{Basal Area} = 0.005454 \times (\text{DBH})^2$$

Ecological Diversity Indices

Ecological diversity relates to the different species of a particular genus that are present in an ecological community. The measures or indices of ecological diversity are statistical summaries of the abundance vector, that is, the frequencies or proportions of each species in the community. These indices include the following:

- Shannon-Weiner Diversity Index (H**)** is a measure of the amount of information needed to describe every member of the community. It is calculated using the following equation:

$$H' = -\sum_{i=1}^{S} p_i \ln p_i$$

Where P_i is the proportion of each species in the sample

The Shannon diversity index is a quantitative measure of species richness (the number of species in a given area) and their relative abundances. Species diversity increases with the complexity of habitat. The more species there were in a community relative to the number of individuals, the more complex it is. If diversity is high, it is hard to predict the certainty of a randomly picked individual. Typical values of Shannon diversity index range from 1.5 to 3.5 in most ecological studies, and the index is rarely greater than 4.The descriptive rating and rating scale are 2.26 – 3.0 for very high diversity, 1.6 – 2.25 for high diversity, 0.76 – 1.5 for fair diversity and 0 – 0.75 for low diversity.

- Simpson's Index (D) is a measure of diversity, that takes into account both species richness and an evenness of abundance among the species present. The formula for calculating D is presented as:

$$D = \frac{\sum n_i(n_i - 1)}{N(N-1)}$$

Where n_i = the total number of organisms of each individual species
N = the total number of organisms of all species

- Evenness (E) is the ratio of the actual H' value to the maximum value (and, thus, it ranges from 0 to 1). It is expressed as follows:

$$E = \frac{H'}{H_{max}}$$

Statistical Analysis

From the collected data, the parameters below were computed using the following equations:

$$\text{Frequency} = \frac{\text{Total number of segments in which a species occurs}}{\text{Total number of segments sampled}}$$

$$\text{Relative Frequency} = \frac{\text{Frequency of a species}}{\text{Total frequency of all Species}} \times 100$$

$$\text{Density} = \frac{\text{Number of individuals of a species}}{\text{Total area sampled}}$$

$$\text{Relative Density} = \frac{\text{Density of a species}}{\text{Total density of all species}} \times 100$$

$$\text{Relative Basal Area} = \frac{\text{Total basal area of a species}}{\text{Total basal area of all species}} \times 100$$

$$\text{Importance Value} = \frac{\text{RF + RD + Rel. BA}}{\text{Area Sampled}}$$

$$\text{Relative Dominance} = \frac{\text{Basal of a species in a quadrat}}{\text{Total basal area of all species in a quadrat}} \times 100$$

Density is the number of individuals of a species found within the line plots per hectare, while the relative density is the density of individual species over the total number of species multiplied by 100, expressed in percent.

Frequency is the number of times an individual species appeared in every quadrat versus the total number of quadrats laid, while the relative frequency refers to the frequency of individual species versus the total frequency of all species multiplied by one hundred. The result would be the percentage of every species occurrence. This has something to do with the distribution of all species surveyed.

The basal area is computed using the girth diameter stem, usually in centimeter, of mangrove measured at 1.3 meters above the ground standard measurement divided by 3.1416 converted into diameter at breast height (DBH). This was converted into basal area using the standard formula. A high basal area means that trees with big diameters are present which will eventually dominate with high percentage compared to trees with smaller diameter trees regardless of the number of individual species present.

Importance value is the sum of the computed relative density, relative frequency, and relative dominance combined per species that appeared, or was included in the survey. This means that distribution, number of species appeared, and the sizes of mangrove species were included for them to be classified as species of importance. All species surveyed with any of the three relative frequency, relative density and relative dominance appeared with the highest value become species of high great importance to the mangrove stands

Mangrove rehabilitation was documented in each sampling area through actual field observations of disturbance and other perturbations. Also, interviews with local residents and barangay officials were done to know the history of the mangroves and the interventions done by the local government and other groups involved in rehabilitation efforts. All pertinent information was carefully examined, scrutinized, and analyzed for recommendation purposes.

RESULTS AND DISCUSSION

Table 2 shows the location, types, and status of mangroves in Ragay Gulf. The areas covered by the study include San Pascual in Masbate, and Del Gallego and Ragay in Camarines Sur.

Table 2. Location, types and status of mangroves in Ragay Gulf

Municipality	Stations	Coordinates	Mangrove Type	Status
San Pascual	Halabang Baybay	lat 13 2' 32.12 long 123 5' 59.89	fringing	good
	Pinamasingan	lat 13 6' 43.56 long 123 01' 29.82	fringing	good
Del Gallego	San Juan	lat 13 53'50.54 long 122 36'28.31	fringing	good
	Sabang	lat 13 53'51.60 long 122 35'25.44	fringing	fair to poor
Ragay	San Rafael	lat 13 49' 1.51 long 122 43' 17.90	fringing,riverine	good

Mangrove status

Mangrove areas under good condition include Halabang Baybay, Pinamasingan, San Juan, and San Rafael, while Sabang in Del Gallego falls under fair to poor condition due to massive fish pond conversion of mangrove areas. The mangrove areas converted were approximately one hundred hectares. Large fish ponds line the road sides from the town proper to the Sabang port. The back portions of the already converted fish ponds were converted into even smaller fishponds, which lead to their poor condition. Other mangrove areas covered as sampling sites have recover due to mangrove rehabilitation projects. However, these projects do not guarantee mangrove survival. Many mangrove areas in the coastlines of Ragay Gulf were already under poor conditions, such as the entire Balatan/Bato mangrove area, including San Cirilo, Sta. Rosa, Mainit, Balogo, and San Vicente mostly within the municipality of Pasacao. Most of the mangroves are in peril and in the brink of destruction. Other disturbances that contributed to the decline in mangrove area and survival include land reclamations and conversions. Some examples of these would be the construction of road networks, construction of residential areas, the presence of an oil depot near mangrove areas, and the presence of solid wastes that impede the growth of mangrove seedlings and saplings. Other threats to mangrove survival are rapid urbanization and population.

Some mangrove areas already caused siltation to the sea and affected the sea grass beds covering approximately 150 meters with mud soil and a depth of one meter. A typical example was observed in the Sabang area in the municipality of Del Gallego and in Pinamasingan in San Pascual. This happens due to a lack of frontline mangroves with filtering ability. Mangrove species with filtering ability include *Avicennia marina* (Bungalon) and *Sonneratia alba* (Pagatpat) because of their root structure with pen-like and cone-shape breathing roots.

Figure 1. Mud soil in Barangay Sabang, Del Gallego surpassed the ground area and already reached the sea floor.

Community structure analysis

Table 3 shows the mangrove species identified in Ragay Gulf present in line plots. Ten species were encountered belonging to five families of true mangrove species. This was comparably and remarkably very low mangrove species turnout than the recorded 47 true mangrove species in the Philippines. This is due to rampant fish pond conversion and illegal logging for several decades, as well as the limited areas covered in the survey. Most of the mangrove forests in the Pasacao area are small, without immediate rehabilitation and restoration efforts, are in the brink of destruction. Reforestation efforts made by concerned group or individuals used only one or two kinds of mangrove species with propagules planted not in the right zonation pattern.

Table 3. Mangrove species identified in Ragay Gulf

Family	Species	Local Name
Avicenniaceae	*Avicennia marina*	Bungalon
	Avicennia rumphiana	Miapi; Piapi
Sonneratiaceae	*Sonneratia alba*	Pagatpat
Rhizophoraceae	*Ceriops decandra*	Malatangal
	Rhizophora apiculata	Bakawan lalaki
	Rhizophora stylosa	Bakawan bato
	Rhizophora mucronata	Bakawan babae
	Bruguiera sexangula	Pototan
Myrsinaceae	*Aegiceras corniculatum*	Saging-saging
Combretaceae	*Osbornia octodonta*	Tawalis

Table 3.1 Diversity indices, dominance, and evenness of mangroves in Ragay Gulf

Municipality	Station	H	D	Evenness
San Pascual	Halabang Baybay	0.654	0.4717	0.944
	Pinamasingan	0.404	0.2458	0.583
Del Gallego	San Juan	1.279	0.722	0.923
	Sabang	0.271	0.1477	0.391
Ragay	San Rafael	1.705	0.8787	0.951

The Shannon biodiversity index (H') in San Rafael is H' =1.705, which reflects a high diversity, while the result in San Juan is H'=1.279, which reflects a fair diversity (Table 3.1). The three remaining stations - Halabang Baybay, Pinamasingan, and Sabang - fall under the low diversity category. This means that few species were encountered in the said mangrove areas.

The evenness values (E) of Halabang Baybay, San Juan, and San Rafael suggest a very high evenness index, while the mangrove areas of Pinamasingan and Sabang suggest a relatively equal to nearly equal distribution. The richness and evenness of the species present in an area are measured by Shannon diversity indices, but the dominance is not taken into account. If the area is dominated by just one species, the Simpson Dominance Index (C) is about one-half (0.5). Simpson's approach uses the premise that the chance of finding to find a pair of the same species of the population of all species at random is higher if the species diversity is low. Species diversity is the inverse of the dominance index. High dominance indices were recorded in the mangrove areas of San Rafael and San Juan, while other areas suggest a low dominance index.

Other measures of community structure

Thin mangrove areas were observed in the Sabang area, but the trees had big diameters. Only two species were recorded thriving in the shoreline (Table 4), an indication of old surviving trees and decades of surviving mangrove species. This area is dominated by mature Bakawan lalaki or *A. apiculata*. Few mature frontline species of Bungalon or *A. marina* were seen. Few seedlings were observed near the mature trees. In this area, rehabilitation efforts focus only on the production of propagules from Bakawan lalaki simply because it is easy to plant and carry. Nearby, a pier was constructed, which accommodates passengers from nearby areas. This everyday activity threatens the rehabilitation efforts because *bancas* pass through the river channels. Also, a residential area is just adjacent to the mangrove areas. At low tide, deep mud soil about a meter deep reaches the center to the river channel. This causes heavy siltation and euthropication, which greatly affect marine life. Also, the appearance of mud soil in the river channel is due to the lack of frontline species, such as Bungalon and Pagatpat, which trap the mud soil thereby protecting sea grass beds and corals. Heavy disturbance was observed. Large mangrove areas were converted into fish ponds along the road from Sabang to pier. According to local residents, mangrove areas at the back of the road and big fish ponds were converted into small fish ponds.

Table 4. Community structure of mangroves in Sabang, Del Gallego

Species	No. of stands	Density	RD	Frequency	RF	Basal Area	RDom	IV
R. apiculata	24	480.00	92.31	1.00	50.00	11.94	40.88	183.18
A. marina	2	40.00	7.69	1.00	50.00	17.27	59.12	116.82
Total	**26**	***520.00***	**100.00**	**2.00**	**100.00**	**29.21**	**100.00**	**300.00**

A thin mangrove community was observed in this area. At least four old growth mangrove species were recorded thriving along the shoreline. *S. alba* with large diameter sizes appeared as the most important species. The shore is rocky with little presence of mud soil. No rehabilitation effort was observed. Also, no disturbance was observed and the mangrove is a natural stand.

Table 5. Community structure of mangroves in San Juan, Del Gallego

Species	No. of stands	Density	RD	Frequency	RF	Basal Area	RDom	IV
A. marina	6	60.00	21.43	1.00	33.33	9.39	26.82	81.58
R. apiculata	7	70.00	25.00	0.75	25.00	3.5	10.00	60.00
S. alba	12	120.00	42.86	0.75	25.00	20.22	57.75	125.61
R. mucronata	3	30.00	10.71	0.50	16.67	1.9	5.43	32.81
Total	**28**	***280.00***	**100.00**	**3.00**	**100.00**	**35.01**	**100.00**	**300.00**

Thick riverine mangrove was observed in San Rafael. At least six mangrove species were recorded within the transect line and mostly secondary growth mangrove areas with a few old trees near the landward zone (Table 6). Only a few residents are seen near the mangrove area. A private fish pond was recorded inside the mangrove area with a fence and warning signs saying no trespassing. The rehabilitation efforts just like in other mangrove communities were confined to the same species. Other nearby areas with natural stands were planted with Bakawan species along the shorelines, covering the frontline species of *A. marina* and *S. alba*.

Table 6. Community structure of mangroves in San Rafael, Ragay

Species	No. of stands	Density	RD	Frequency	RF	Basal Area	RDom	IV
A. marina	2	40.00	16.67	1.00	25.00	0.53	11.50	53.16
R. apiculata	3	60.00	25.00	0.50	12.50	0.57	12.36	49.86
S. alba	1	20.00	8.33	1.00	25.00	0.72	15.62	48.95
C. decandra	2	40.00	16.67	0.50	12.50	0.08	1.74	30.90
O. octodonta	3	60.00	25.00	0.50	12.50	0.06	1.30	38.80
A. rumphiana	1	20.00	8.33	0.50	12.50	2.65	57.48	78.32
Total	**12**	***240.00***	**100.00**	**4.00**	**100.00**	**4.61**	**100.00**	**300.00**

Thick old growth mature stands were observed in this area and they are mostly *R. apiculata* found at the center of the mangrove community, while the frontline areas were fully rehabilitated and planted with Bakawan bato, *R. stylosa*. These planted mangrove species produced propagules that will regenerate the area. Very few seedlings were recorded within the mature old stands, an indication that without intervention, this mangrove community is in peril. Also, no frontline mangrove species was observed and purely confined only to the two species identified.

Table 7. Community structure of mangroves in Halabang Baybay, San Pascual

Species	No. of stands	Density	RD	Frequency	RF	Basal Area	RDom	IV
R. apiculata	30	133.33	63.83	0.89	72.73	32.78	72.33	208.89
R. stylosa	17	75.56	36.17	0.33	27.27	12.54	27.67	91.11
Total	**47**	***208.89***	**100.00**	**1.22**	**100.00**	**45.32**	**100.00**	**300.00**

Pinamasingan is a lagoon with an inlet from Ragay Gulf. Mangrove communities here are found almost side-by-side of the shorelines. A thick mature stand was observed composed of *R. mucronata* with large diameters as the dominant species together with *R. apiculata*. Massive rehabilitation efforts were recorded. Old and new planted species thrive together along the shorelines and nearby areas. Heavy deep mud soil present, the with depth of one meter. This extended 100 meters or more to the river channel. Lack of frontline species such as *A. marina* and *S. alba* in the shoreline caused this mud soil to extend and reach the river channel covering the entire sea grass ecosystem. One species of seagrass, which can survive even with the presence of deep mud soil, was seen thriving near the mangrove area.

Table 8. Community structure of mangroves in Pinamasingan, San Pascual

Species	No. of stands	Density	RD	Frequency	RF	Basal Area	RDom	IV
R. apiculata	6	40.00	13.95	0.83	83.33	9.92	30.23	127.52
R. mucronata	37	246.67	86.05	0.17	16.67	22.89	69.77	172.48
Total	**43**	***286.67***	**100.00**	**1.00**	**100.00**	**32.81**	**100.00**	**300.00**

Table 9. Mangrove Species with the highest relative density, relative frequency, relative dominance and importance values

Municipality/City	Station	Species	RD	RF	BA	Rdom	IV
Del Gallego	Sabang	*R. apiculata*	92.31	50	17.27	59.12 AM	183.18
	San Juan	*S. alba*	42.86	33.33 AM	20.22	57.75	125.61
San Pascual	Halabang Baybay	*R. apiculata*	63.83	72.73	32.78	72.33	208.89
	Pinamasingan	*R. mucronata*	98.82	83.33 RA	22.89	69.77	172.48
Ragay	San Rafael	*A. rumphiana*	25 RA	25 SA/AM	2.65	57.48	78.32

Legend: RD = relative density RF = relative frequency BA = basal area RDom = relative dominance IV = importance value

Figure 2. Mangrove species found inside Halabang Baybay mangrove forest with high density of *R. stylosa* seaward zone Bakawan bato but inside mostly old growth *R. apiculata*

Table 9 shows that mangrove species with the highest relative frequency was *R. apiculata* for Sabang and Halabang Baybay, with 50% and 72.73%, respectively. In San Juan, *A. marina* got the highest relative frequency of 33.33%. In San Pascual, particularly in Pinamasingan, *R. apiculata* had an overwhelming 83.33% appearance for the entire plots laid. The seaward mangrove species *A. marina* and *S. alba* were also frequently seen in the San Rafael area. The appearance of mangrove species depends on the number of plots laid and the thickness of the mangrove areas and the intervention of mangrove rehabilitation, which did not follow the prescribe zonation pattern. For the computations of the community structure per station please see appendices.

Table 10 shows that mangrove species that produce big stems are usually crown-forming tree species such as *A. marina* and *S. alba*. Other mangrove species that has an advantage in numbers are usually shrub-type with small basal area compared to those trees. Computations of community structure per station please see appendices.

Table 10. Basal area of all mangrove species surveyed in Ragay Gulf

Species	San Juan	Sabang	Halabang Baybay	Pinamasingan	San Rafael	TOTAL BA
A. marina	9.39	17.27			0.53	**27.19**
R apiculata	3.5	11.94	32.78	9.92	0.57	**58.71**
S alba	20.22				0.72	**20.94**
R mucronata	1.9			22.89		**24.79**
R. stylosa			12.54			**12.54**
C. decandra					0.08	**0.08**
O. Octodonta					0.06	**0.06**
A. rumphiana					2.65	**2.65**
TOTAL BA	**35.01**	**29.21**	**45.32**	**32.81**	**4.61**	**146.96**

In the case of areas with rehabilitation efforts artificial regeneration appeared with high value species. This means that, through time, these species survived and replaced the remaining few old growth mangrove species in the area. In areas with natural mangrove stands, surviving species with the highest sum are important. For the computations of community structure per station, please see the appendices.

Mangrove Regenerative Capacity

A mangrove forest is usually restored through natural regenerations or via artificial restoration using planted seedlings. Through natural re-colonization, most of the local species occupy the area and natural succession takes place. The major advantage of natural regeneration is that the resulting forest is expected to be more similar to the local mangrove structure.

The number of saplings and seedlings are more than 50% of the number of matured trees surveyed within the sample plots. This means that there is a high probability of the forest sustaining its existence given certain levels of disturbances. If the density is low, it can indicate high impact on the areas (Participatory Methods in Community-Based Coastal Resource Management, 1998). The difference in the density of seedlings and saplings among the stations is shown in Table 11. Sustainability of growth of mangroves in the stations that were assessed represent low, high, and very high probability of regeneration.

Few seedlings and saplings were observed in Halabang Baybay, San Pascual and San Juan, Del Gallego. Both has old mangrove stands. The frontlines of Halabang Baybay were recently planted with more propagules. Rehabilitation efforts were seen in these mangrove areas with low regenerative capacity, but with many threats to mangrove survival.

Table 11. Mangrove regenerative capacity in Ragay Gulf

Municipality	Stations	Trees	No. of seedlings/saplings	Regenerative capacity
San Pascual	Halabang Baybay	47	12	low
	Pinamasingan	43	36	good
Del Gallego	San Juan	28	8	low
	Sabang	26	7	low
Ragay	San Rafael	12	10	high

Figure 3. Mangrove seedlings in Pinamasingan, San Pascual - an indication of very high regenerative capacity

Observable Perturbations and Disturbances

Many disturbances were observed surrounding the Ragay Gulf. Among them is the conversion of huge mangrove areas into fishponds in Baranggay Sabang, Del Gallego. According to local residents, fish pond conversion continue to occur at the back of existing fish ponds. These are owned by families that raise shrimps, crabs, and bangus. Only a thin portion of old mature mangrove trees are left. The greatest threats to mangrove survival are humans that continuously exploit the area. This, in turn, pose great risks to other ecosystems such as seagrass and corals.

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

The diversity of mangrove species continues to decline due to non-inclusion of other mangrove species in the rehabilitation efforts by concerned groups, mostly fall under fair condition. The existence particularly those less or no seedlings and saplings are in great risk. They find them difficult to produce, expensive and time consuming thus confined only to propagule producing mangrove species such as Bakawan lalaki, babae and Bakawan bato. Also planting not in the right zonation pattern hinders their growth and survival but favors other species to proliferate. Natural stands with the right zonation of species were covered and replaced with new planted propagules particularly the seaward which disrupts their natural beauty.

R. apiculata appeared as the densest in Sabang, Del Gallego and Halabang Baybay in San Pascual. This mature old growth mangrove species originally thrived in the area. Big diameter stems and tall trees were present, an indication of their long years of survival. Mature *S. alba* trees line up the coastlines of San Juan in Del Gallego, together with *A. Marina*, because they are frontline species that can withstand direct tidal inundation. *R. mucronata* thrived mostly in the deep mud soil of Pinamasingan in San Pascual. The landward zones of San Rafael in Ragay was occupied by *A. rumphiana*, a crown-forming large mangrove trees. Efforts to replant mangrove species are for rehabilitation only, whose purpose is to increase the mangrove area but not to restore the original stand following the prescribed zonation pattern. For the computations of community structure per station, please see the appendices.

The decline in mangrove area and threats to its survival are all due to human-induced activities. Only humans have the ability to destroy ecosystems, but also have the power to restore them. Interconnected problems require integrated solutions.

With all these results, the following are highly recommended;

1. Delineate of boundaries for human settlements and mangrove areas to provide space between ecosystems.

2. Provide sustained livelihood opportunities to local residents, such as employment such as bantay bakawan vanguards.

3. Remove dead mangrove trees in plantation areas and replace them with new ones, specifically with *A. marina* and *S. alba* as frontline species.

4. Retain original mangrove habitat characteristics particularly frontline species *A. ma*rina and *S. alba*.

5. Enforce mangrove laws as well as non-regulatory conservation techniques such as public education, slide presentation, video presentations, seminars, and other interventions.

REFERENCES

Castillo, Evangeline T. *et al.* Rehabilitation and Ecological and Restoration R & D for Marginal and Degraded Landscapes and Seascapes, A Research Compendium for Damaged Coastal Areas, Department of Environment and Natural Resources, Ecosystems Research and Development Bureau, Laguna, May 2010

Coastal Resource Management Program. Department of Environment and Natural Resources with support from USAID. 1996-2004

Coastal Resources Management Project (CRMP). 1998. Our Seas Our Life: A Guide to understanding Ocean life and Its Importance to Us. Published by CRMP, Cebu, Philippines

Deguit Evelyn T. *et al.* Participatory Coastal Resource Assessment Training Guide, Habitat Assessment, 2004.

Dioneda Sr., R.R. *et al*. Assessment of the ecological habitats of Bacon district, Sorsogon City, Philippines. 2010. RRSA of Bacon district Project

DENR, ERDB. Rehabilitation and ecological restoration R & D for marginal and degraded landscapes and seascapes. A research compendium for damaged coastal areas. 2010

IIRR. 1998. Participatory Methods in Community-Based Coastal Resource Management. 3 Vols. International Institute of Rural Reconstruction, Silang, Cavite Philippines.

Malvar, AA *et. al*. Status of Mangrove in the East coast of Albay. SCREMP DENR funded Project

Melana, Dioscoro M. *et al*. Mangrove Management and Development in the Philippines. February 2000

Melana D.M *et al*. Mangrove Management Handbook. Coastal Resource Management Project
Department of Environment and Natural Resources. 2000

Mendoza, Antonio B. and Alura, Danilo P. Mangrove Structure on the eastern coast of Samar Island Philippines. 1999

Philippine Coastal Management Guide Book Series No. 4: Involving Communities in Coastal Management. DENR, BFAR, DILG, DA, CRMP with support from USAID. 2001

Primavera J.H. Field Guide to Philippine Mangroves. 2009

Primavera, J. H. (2004). Philippine mangroves: status, threats and sustainable development. In M. Vannucci (Ed.), Mangrove management and conservation: present and future (pp. 192–207). Tokyo, Japan: United

G.M. Wagner *et al*. Assessment of Marine Biodiversity, ecosystem health and resource status in Mangrove Forests Mnazi Bay Ruvuma Estuary Marine Park. IUCN December 2004

Soliman, Victor S. et al. 2004. Assessment of Mangroves in Lagonoy Gulf

Appendix A

Fishpond conversion/Sabang Del Gallego pier

San Rafael Ragay

Land reclamation/Sta. Rosa Pasacao

Wastes and cuttings Tinalmud, San Cirilo

Quarrying in Tinalmud

STATUS OF SEAGRASS AND SEAWEEDS COMMUNITIES IN RAGAY GULF (BICOL SIDE), PHILIPPINES

Maria Aurea B. Guiriba
Romeo Bo Asejo, Jr.
Ma. Teresa B. Bron
Grant Espinosa
Hannah Louis Maraña
Bicol University
Legazpi City

Guiriba, M.A. B., R.B., Asejo, M.T.B. Bron, G. Espinosa, and H.L. Marana. 2019. Status of Seagrass and Seaweeds Communities in Ragay Gulf (Bicol Side), Philippines. Pp 63-76. In Dioneda R.R., E.E. Torres and G. Naz. (Eds). 2019. Participatory Resource and Socio-Economic Assessment of Ragay Gulf-Bicol Side. Terminal Report Submitted for the Fisheries, Coastal Resources and Livelihood Project, Department of Agriculture-Bureau of Fisheries and Aquatic Resources, Quezon City. Bicol University, Center for Policy Studies and Development, Legazpi City. 138 pp.

ABSTRACT

Assessment of seagrass and seaweeds was conducted in the 8 municipalities of Ragay Gulf (bicol Side, Philippines). In order to identify seagrass and seaweeds species, determine the percentage cover and other measures of community structure and provide accounts on associated macroinvertebrates. Line quadrat method was used to gather data, while results of previous available studies were referred from. This study identified 11 species of seagrasses thriving in the eight municipalities surveyed. This represented 61% of the 18 sea grass species found in the Philippine waters. Dominating seagrass species in terms covered differ between municipalities. In Del Gallego, *Halophila ovalis* with was found to have covered at 60.80% followed by *Halodule pinifolia* (56.25%). In San Pascual, it is *Enhalus acoroide*s the covers the widest (48.87%) of Ragay, *Syringodium isoetifolium* (41.00%) of Balatan and *Cymodocea serrulata* (39.10%) of Pasacao. Among the municipalities, Balatan seagrass communities got the highest values in terms of Shannon-Weiner and Simpsons index of diversity. This might explain the presence of siganids and juvenile fish grazing in the area. Bato and Lupi generally has patchy and scattered seagrass beds and Minalabac has barren and almost devoid of seagrass species due to rampant beach seining. There were also 13 species of seaweeds noted. The species composition was different between municipalities. The highest number of species was found at San Pascual. Overall, San Pascual, Balatan, Ragay and del Gallego still harbour good seagrass community. With these, seagrass and seaweed beds could still support and provide ecological services to the macroinvertebrate fauna and fin fishes and thereby, contribute to the fishery and economy along the gulf.

Keywords: seagrass, seaweeds, Ragay Gulf

INTRODUCTION

Seagrass beds are submerged flowering plants with hard underground roots system. The Indo-Pacific region has the richest diversity of seagrass species in the world, and the home for megafauna such as dugongs and sea turtles. Seagrass as well as seaweeds provide a complex habitat for many marine organisms, which directly supports human livelihoods and economies. In the Philippines, little is known about sea grass and seaweed communities and few protections exist.

Seagrass communities contribute to about 50-64% of the organic carbon sequestered annually by coastal vegetated ecosystems (Duarte et al. 2013) and sink 20% of the carbon buried in the global ocean (Duarte et al. 2005; Kennedy et al. 2010). Seagrass meadows ranks the highest in terms of global loss rates among coastal vegetated habitats, declining annually at 7% (Waycott et al. 2009). The overwhelming degradation and loss of seagrass beds are due to physical impacts such as climate warming, thermal/desalination sewage disposal, anchoring of boats, fish trawling, coastal erosion, sea water turbidity and siltation.

Seagrass and seaweeds (SG/SW) like any other major ecosystems such as coral and mangroves must also be protected to maintain habitat connectivity thus, protecting the marine organism population. Due to the above-mentioned threats on seagrasses and seaweed beds, there is a glaring need to take a step-in order to protect, conserve and maintain the said resources. Since seagrasses and seaweeds are less studied ecosystems in the region, scientific studies need to be conducted in order to generate information concerning about the status and threats of the sea grass and seaweed ecosystems for management. The study was made to determine the status of seagrass and seaweeds in Ragay Gulf (Bicol side). Specifically, it dealt on the following:

1. Identification of seagrass and seaweeds species observed in the sampling stations;
2. Determination of percent cover by seagrass and seaweeds species;
3. Determination of other measures of community structure (diversity, dominance, and evenness indices) of seagrass and seaweeds communities, and,

METHODOLOGY

Population and sample. Seagrass and seaweeds habitat assessment was conducted along the Camarines Sur municipalities of Ragay Gulf (Bato, Balatan, Minalabac, Lupi, Ragay and del Gallego) and one in Burias, Masbate (San Pascual). Ragay Gulf is a small protected basin. Its basin is characterized by relatively wide insular shelf and steep insular slope. Terrigenous mud and riverine sands characterize the sea floor in the vicinity of Viñas river (Del Gallego) while sandy-silty ooze characterizes the bottom deposits of the deeper sections of the basin farther away from the rivers (Jamir, 1998).

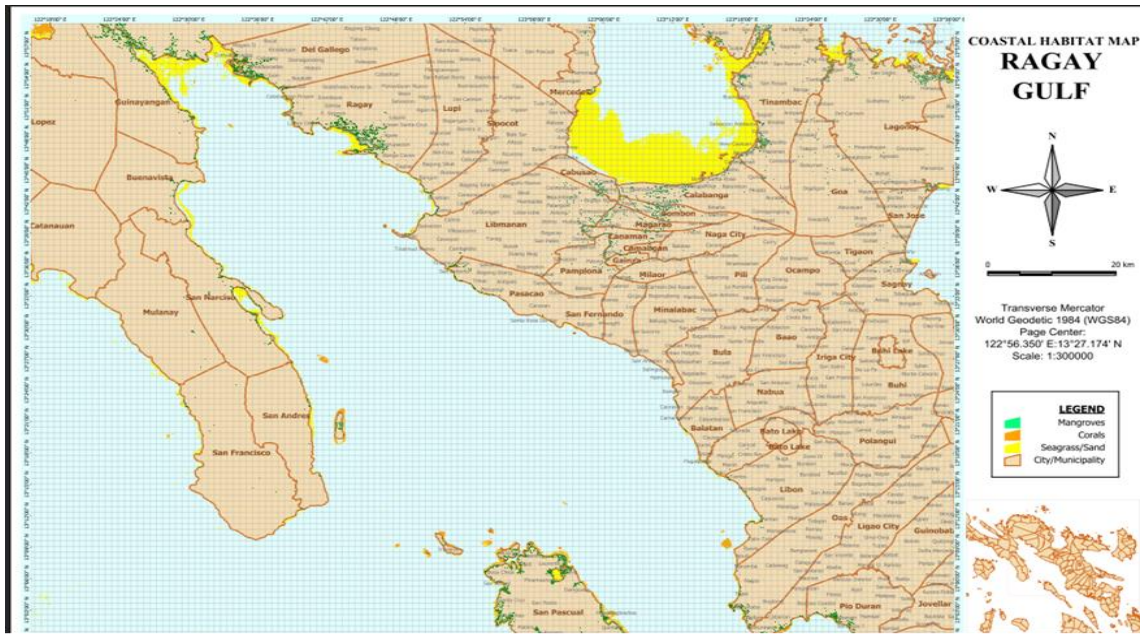


Fig. 1 Map of Ragay Gulf

The 11 sampling stations were purposively selected after conducting reconnaissance surveys with the locals and fishermen, confirming the seagrass and seaweeds beds locations. Figure 1 showed Ragay Gulf and the long stretch of internal seas which by bulk is municipal water of the gulf's Bicol side.

Methods of data collection

Sampling Techniques

Line Transect-Quadrat Method (LQM as described by English et al. 1994) was used. A 100 meter transect lines was laid along the subtidal zone perpendicular to the shoreline while quadrats were laid at 10m interval with dimension of 50 cm x 50 cm and composed of 25, 10 cm x 10 cm sub-quadrats. Locations of each sampling site were recorded using global positioning system (GPS). The study was carried out in one to three representative sites around each municipality.

Seagrasses and associated seaweeds that occurred inside the quadrat were taxonomically identified. The frequency of seagrass and seaweeds were also estimated by counting the occurrence of each species inside the quadrat. The cover of each species was also estimated using the standard technique developed by Saito and Atobe (1970). Table 1 shows the Saito and Atobe standard technique on estimating the cover of each species.
(Saito and Atobe (1970) not in the reference list)

Table 1. The Seagrass Meadows Coverage Percentage Category

The Seagrass Meadows Coverage Percentage Category			
Class Coverage Area	**% Cover Area**		**Midpoint**
5	1/2 to full	(50-100)	75
4	1/4 to ½	(25-50)	37.5
3	1/8 to ¼	(12.5-25)	18.75
2	1/16 to 1/8	(6.25-12.5)	9.38
1	< 1/16	(<6.25)	3.13
0	None	0	0

Percentage covered was estimated using the formula: $C= \sum (M_i \times f_i)/ \sum f$. where: M_i = mid point percentage of class i and f = frequency (number of sectors with the same class of dominance). The community structure of seagrass and seaweeds was determined using the conventional functional ecological indices such as diversity (Shannon H') and dominance (Simpsons D). Computation for these indices used the following formulae:

$$H=- \sum(n_i/N) \log(n_i/N), \qquad D= \sum(n_i/N)^2$$

The condition of overall seagrass coverage was determined using the criteria set forth by Fortes (1989) (Table 2).

Table 2. Criteria used to determine the condition of seagrass beds (Fortes, 1989)

Condition	*Criteria*
Excellent	76 – 100% coverage
Good	51 – 75% coverage
Fair	26 - 50% coverage
Poor	0 – 25% coverage

Source: PCRA manual

The taxonomic identification of seagrasses was based on a field guide to the common mangroves, seagrasses and algae of the Philippines, (Calumpong and Meñez, 1983). Moreover, colour and morphological differences between different genera/species and taxonomic characteristics were considered in identifying seaweeds. The taxonomic description of the specimen and anatomical characteristics of the specimen to be identified were referred from the field guide and atlas of the seaweed resources of the Philippines developed by Dr. Gavino Trono (1997), monograph and reference herbaria.

RESULTS AND DISCUSSION

The Seagrass and Seaweed Species in Ragay Gulf

There were eleven (11) species of seagrasses identified thriving in selected municipalities in Camarines Sur. The selected municipalities were Del Gallego, Ragay, Sipocot, Pasacao, Balatan, Bato, Bula and San Pascual, Masbate. This represents 61.11% of the eighteen (18) species occurring in the Philippines sea water (Fortes, 2012). Five (5) species belonged to family *Cymodoceaceae* namely *Cymodocea rotundata, Cymodocea serrulata, Halodule pinifolia, Halodule uninvervis, Syringodium isoetifolium.* There were also six (6) species encountered from family *Hydrocharitaceae* namely: *Enhalus accoroides, Halophila ovalis, Halophila minor, Halophila decipiens Halophila sp 2.* and *Thalassia hemprichii* (Figure 2).

The study recorded greater number of species of seagrass in the gulf when compared to other studies made by other researchers. Such as by PRSA-UPLB (2006) which reported seven species while, Licuanan et al., 2011 got six species for Ticao and Palaguige Islands. Figure 2 shows the eleven species of seagrass identified in Ragay Gulf (see also Figure 3).

Species assemblage and abundance were different between locations. For instance, *Cymodocea serrulata* was abundant in San Pascual, Balatan, Ragay and Del Gallego. While, *Halophila* and *Enhalus acoroides* species were found in almost all stations. This is understandable considering that these two seagrasses have the widest tolerance to varied substrates according to Fortes, 2012. *Cymodocea rotundata* and *Halodule pinifolia* were limited in occurrence in San Pascual and Balatan, respectively. Interestingly, *Halophila* sp. 2 was only encountered in Pasacao area.

According to Green and Short (2001) cited by Dioneda et al. (2015), the differences in the species present in an area was due to the differences in their substrate, temperature, light depth, current, salinity, nutrient and human factors. This was the reason why *Halodule pinifolia* only occurs in San Pascual and Balatan that is characterized with sheltered and semi-exposed bays. The rarity of this species in our assessment suggested that it is less tolerant to prevailing hydrographic and anthropogenic parameters as compared to other seagrasses (Meñez et al, 1983).

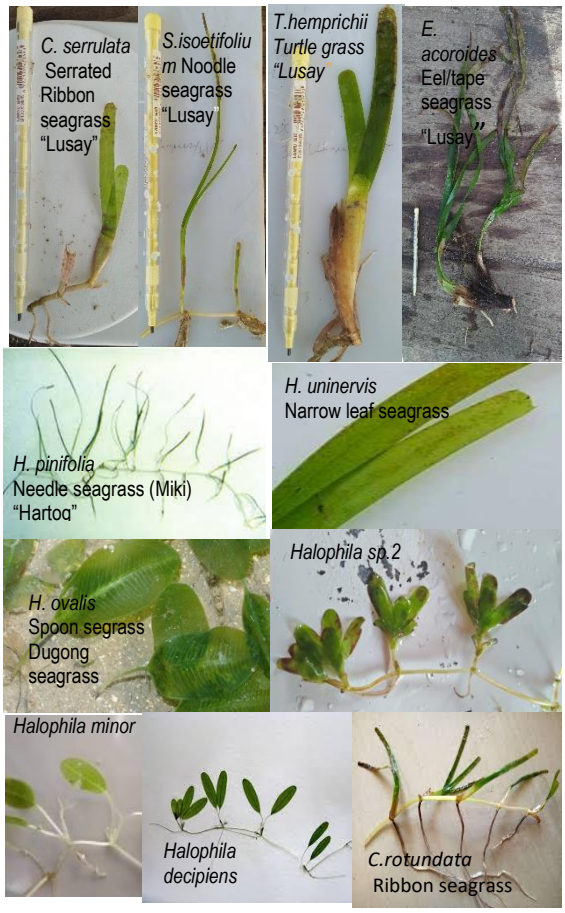


Figure 2. Sea grasses identified in Ragay Gulf.

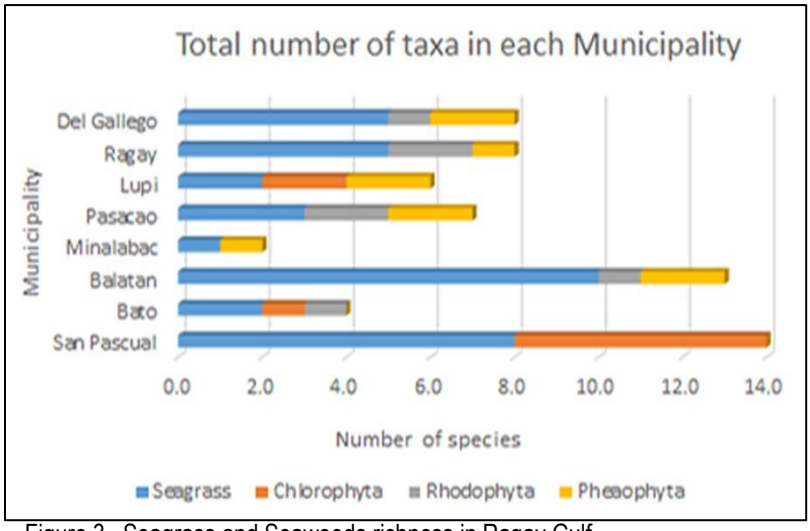


Figure 3. Seagrass and Seaweeds richness in Ragay Gulf.

For seaweeds, the highest number of species was found at San Pascual (6) followed by Pasacao (5), Lupi (4) and Balatan (4) (Figure 3). The identified seaweeds were from the three main groups namely, Chlorophyta (10), (green), Phaeophyta (2) (brown) and Rhodophyta ((red). Species belonging to Chlorophyta namely: *Batophora oerstedi*, *Halimeda cylindracea*, *Halimeda macroloba*, *Halimeda opuntia*, *Acetabolaria sp*., *Udotea flabellum*, *Caulerpa sertularioides* and *Boergenesia sp*. This was followed by Phaeophyta (Padina sp. and Sargassum) and Rhodophyta (*Galaxaura sp*. and *Dictyota sp.*). It was noticed that vast Sargassum bed had successfully flourished in some parts of Ragay Gulf specially at Balatan, Minalabac and Lupi. This affects the occurrence of seagrass from patchy to nonexistence specifically in Minalabac and Lupi areas.

Just like segrasses, the composition and abundance of seaweeds also differs between municipalities. San Pascual, Masbate harbours 6 species of Chlorophyta. Municipalities of Balatan and Lupi both with 4 species of seaweeds from Phaeophyta (2) and Chlorophyta (2). In Pasacao and Del Gallego 4 species of seaweeds were observed, two species from the green group and two species from red group. There were no seaweeds observed in the identified stations in the municipality of Ragay. This can be due to the murky-silty characteristic of water which is unfavorable for seaweeds growth.

Seagrass and Seaweeds percentage covered

For the purpose of providing disaggregated information, sea grass covered was presented by municipality.

Table 3. Seagrass and Seaweeds Cover in San Pascual, Masbate (Barangay Laurente)

Seagrass	% cover	**Seaweeds**	% cover
Thalassia hemprichii	39.1	*Batophora oerstedi*	3.13
Enhalus acoroides	3.13	*Halimeda cylindracea*	3.13
Haludole pinifolia	56.25	*Halimeda macroloba*	3.13
Haludole uninervis	3.13	*Halimeda opuntia*	3.13
Cymodocea serrulata	3.13	*Acetabolaria sp.*	3.13
Halophila ovalis	23.44	*Boergenesia sp.*	3.13
Halophila minor	3.13		
Halophila decipiens	3.13		

Table 3 showed the seagrass and seaweeds percentage covered in San Pascual, Masbate. There were eight (8) species of seagrass observed namely, *Thalassia hemprichii, Enhalus acoroides, Halophila minor, Halophila ovalis, Halodule uninervis, Cymodocea serrulata, Halodule pinifolia, and Halophila decipiens* and six (6) species of seaweed. San Pascual was dominated by *Halodule pinifolia* with 56.25 percent cover followed by *Thalassia hemprichii* (39.10%) and *Halophila ovalis* (27.5%). Seagrass meadows in San Pascual, Masbate were found to thrive immediately after the mangroves. In Barangay Laurente, it was immediately fronted by massive coral reef system. It was also observed that mangrove seedlings were planted in seagrass beds, as obvious attempt of transplantation and expanding mangrove coverage seaward. This is a classic example of improper mangrove rehabilitation initiative. The condition of this bed was categorized as good (Table 4).

Figure 4. *Avecinnia marina* seedling planted in the seagrass beds of Barangay Laurente, San Pascual, Masbate.

Table 4. Species Count and Habitat condition

Municipality	**Seagrass**	**Seaweeds**	**Condition**
San Pascual	8	6	Good
Bato	2	1	-
Balatan	10	4	Good
Minalabac	1	1	-
Pasacao	3	4	Poor
Lupi	2	4	Poor
Ragay	4	0	Good
Del Gallego	5	2	Good

In Bato, Camarines Sur, the three barangays namely Payak, Palo and Pagatpatan were verified/validated for seagrass/seaweeds occurrence. It was found out that the areas exhibited patches of *Halophila sp*. and *Thalassia hemprichii* only. The substrate was observed to be sandy-muddy-silty. Uprooted species of Halophila were abundant along the shoreline. This may be due to the fishing activities such as the use of beach seine and gillnets along and in nearby areas. Beach seine is operated by towing the net with ropes towards the beach targeting demersal and some pelagic fin fishes which is the possible reason for the uprooted seagrass along the shorelines of Bato.

In Balatan, Camarines Sur two distinct types of seagrass communities were present: in the silted-coralline southern part of the municipality (Bgy. Coguit, Camanghan) the patchy seagrass communities were markedly dominated by only one species (*Thalassia hemprichii*) and two species of seaweeds namely *Padina sp.* and *Sargassum sp*., while in areas (Bgy. Pararao) with clearer, less silted waters highly diverse mixed seagrass communities were found (Halodule, Cymodocea, Thalassia, Syringodium and Halophila). The relationship found between community structure and gradient of siltation is consistent with the results reported by other studies.

Table 5. Seagrass and Seaweeds Cover in Balatan, Cam Sur (Barangay Pararao)

Seagrass				Seaweeds			
	Trsct. 1	Trsct. ct 2	Mean		Trsct. 1	Trsct. t 2	Mean
Thalassia hemprichii	21.87	36.46	29.20	*Padina sp.*	3.13	3.13	3.13
Enhalus acoroides	5.80	5.20	5.50	*Halimeda macroloba*	3.13	4.40	3.77
Haludole pinifolia		21.90	21.90	*Caulerpa sertularioides*	0.00	3.13	3.13
Haludole uninervis	8.30	10.90	9.60	*Sargassum sp.*	3.13		3.13
Cymodocea serrulata	4.20	6.30	5.25				
Cymodocea rotundata	7.50	9.40	8.45				
Syringodium isoetifolium	62.50	19.50	41.00				
Halophila ovalis	4.00	7.50	5.75				
Halophila minor	3.13		3.13				
Halophila decipiens	3.13		3.13				

There were 10 species of seagrass present in Brgy. Pararao; *Thalassia hemprichii, Enhalus acoroides, Haludole pinifolia, Halodule uninervis, Halophila ovalis, Cymodocea serrulata, Cymodocea rotundata, Halophila minor, Halophila decipiens* and *Syringodium isoetifolium.* The most dominant species of seagrass is found in Brgy. Pararao (*Syringodium isoetifolium)* with the general average of 41% cover, followed by *Thalassia hemprichii* with the general average of 29.2% cover (Table 5). It was noted that *Halodule pinifolia* was only observed in Balatan, Camarines Sur and San Pascual, Masbate. These species demonstrated its 'pioneer' nature, being present at the shallowest portions of the sites. This implied that this species must have high nutrient requirements as the characteristics of near shore substrate (Fourqurean et al. 1992, Short et al. 1993, Duarte 1994). Its occurrence was not as pronounced as the other nine species, favouring the sandy substrate and clear water only. Only four species of seaweeds are present in Brgy. Pararao namely *Padina sp., Halimeda macroloba, Caulerpa sertularioides* and *Sargassum sp. Halimeda macroloba* with an average of 3.8% cover. Generally, the substrate characteristics of Balatan is sandy-muddy-silt. Anthropogenic activities such as boat anchorage, beach seine fishing, gillnetting and gleaning were observed to be the factors for a patchy distribution of seagrass/seaweeds beds in barangays Coguit and Camanghan. The status of this seagrass community was assessed as good (see Table 4).

In Minalabac, the reconnaissance survey for seagrass/seaweeds revealed the only occurrence of *Enhalus acoroides* and the overwhelming growth of *Sargassum sp*. The two mentioned species were known to be tolerant to wide arrays of substrate and high levels of siltation, a characteristic noted in the area.

Table 6. Seagrass and Seaweeds Cover in Pasacao, Cam Sur (Bgy.Sta Rosa del Norte)

Seagrass	% cover	**Seaweeds**	% cover
Thalassia hemprichii	31.8	*Padina sp.*	3.13
Cymodocea serrulata	39.1	*Galaxaura sp.*	3.13
Halophila sp 2	3.13	*Boergenesia sp.*	3.13
		Cladosphora sp.	3.13

Moreover, barangays of Tinalmud, Sta. Rosa Del Norte and Sitio Sarimao in Pasacao, Camarines Sur were visited for the same assessment. During the assessment in Brgy. Sta. Rosa Del Norte, it was found out that there were only three species of seagrass namely *Thalassia hemprichii* with 31.8% cover followed by *Cymodocea serrulata (*39.1%) and *Halophila sp*.2 (3.13%). While, several species of seaweeds were found namely, *Padina sp*., *Bathophora sp*. and *Acetabularia sp* (Table 6). All in limited occurrence with only 3.13 mean percent cover. Poor occurrence of seagrass in Pasacao coastal waters can be attributed to many stressors hampering the healthy growth of seagrass and seaweeds species. Interestingly, the *Halophila sp.2 or Halophila tricostata* in some authors was present in Pasacao, a seagrass species that are not found in the previous seagrass assessment done in other areas of Bicol region such as in Albay and Masbate. The condition of the beds at this site is poor.

Table 7. Seagrass and Seaweeds Cover in Lupi, Cam Sur (Bgy. Bangon)

Seagrass	*Transect 1*	*Transect 2*	Average	**Seaweeds**	*Transect 1*	*Transect 2*	Average
Enhalus acoroides	*25.89*	26.56	26.22	*Halimeda opuntia*	5.21		5.21
Halophila ovalis		10.42	10.42	*Sargassum sp.*	21.25	32.81	27.03
				Udotea flabellum	3.13		3.13

Barangay Bangon is the lone coastal barangay in Lupi, Camarines Sur. Huge Sargassum growth was observed there. This might have overshadowed the growth of seagrass in the area The first transect was mostly an *Enhalus acoroides* (25.89%) bed and were observed occurring along with several species of seaweeds namely *Sargassum sp*. (21.03%), Padina sp. (8.33%), *Halimeda opuntia* (5.21%) and *Udotea flabellum* (3.13%) (Table 7), while the second transect yielded two seagrass species (*Enhalus acoroides,* 26.56% and *Halophila ovalis*, 10.42%) and a seaweed species (*Sargassum sp*., 32.81%). The seagrass species found in this study was less than the six species

of seagrass found by the PRSA-UPLB in 2006. The decrease might be attributed to seagrass wastage as decaying and torn leaves of *Enhalus* were observed along the coasts. The seagrass community in this municipality was assessed as poor.

Table 8. Seagrass and Seaweeds Cover in Barangay San Rafael, Ragay, Camarines Sur.

Seagrass	*Transect 1*	*Transect 2*	Average
Thalassia hemprichii	13.94		13.94
Enhalus acoroides	68.75	29.0	48.87
Cymodocea serrulata	44.6		44.6
Cymodocea rotundata		45.0	45
Halophila ovalis		11.33	11.33

Generally, the seagrass in Ragay is composed of *Thalassia-Cymodocea-Enhalus* mixed meadows. The sampling stations were located at Barangay San Rafael, Sitio Cali and the seagrass were dominated by *Enhalus acoroides with mean value of* 48.87% cover followed by *Cymodocea serrulata* (45%) and *Cymodocea rotundata (44.46%), Thalassia hemprechii (13.94%) and Halophila ovalis (11.33%),* (Table 8). It was observed that *Halophila ovalis* showed some adaptive features specifically the larger leaves/fronds and longer stalks than those found in other areas. These features prevent the seagrass from getting overwhelmed and buried under the silt. The siltation and sedimentation was noticed due to the discharge by the Ragay river. The condition of the beds at this site is good.

Table 9. Seagrass and Seaweeds Cover in del Gallego, Cam Sur (Bgys. Peñafrancia, Magais &Sabang)

Seagrass	*Trsct . 1*	*Trsct . 2*	*Trsct . 3*	Mean	**Seaweeds**	*Trsct . 2*	*Trsct. 3*	Mean
Enhalus acoroides	*43.75*	*18.8*		31.27	*Padina sp.*	*3.13*		3.13
Haludole uninervis			*3.13*	3.13	*Galaxaura sp.*	*3.13*	*5*	4.06
Cymodocea serrulata	*21.09*		*75*	48.04	*Dictyota sp.*	*2.5*	*6.9*	4.7
Halophila ovalis		*60.08*		60.08				

In Del Gallego, 3 sites were assessed for seagrass and seaweeds status. These were in Barangays Peñafrancia (transect 1), Magais (transect 2) and Sabang (transect 3). The seagrass beds were composed of *Cymodocea-Halophila-Enhalus* mixed species (Table 9). It was dominated by *Halophila ovalis* with percentage cover of 60.08 which is only observed in transect one (1), followed by *Cymodocea serrulata* (48.04% mean cover), *Enhalus acoroides* (31.27% mean cover) and *Halodule uninervis* with only 3.13 percent cover. The former was only found in transect two. A minimal occurence of seaweeds species were found namely, *Dictyota sp*. (4.50%), *Galaxaura sp*. (4.05) and *Padina sp*. (3.13%). The distribution of seagrass and seaweeds in this municipality was influenced by the substrate and water quality of the area. For instance, terrigenous mud and

riverine sands characterize the seafloor along the vicinity of Viñas River. The status of the beds at this site is good.

Community Structure

Table 10. Ecological indices per seagrass community along Ragay Gulf.

Municipality	Diversity (Shannon's H')	Dominance (Simpsons D)	Evenness
San Pascual, Masbate	1.72	0.19	0.82
Balatan, Cam Sur	2.14	0.13	0.93
Pasacao, Camsur	0.98	0.4	0.16
Lupi, Cam Sur	0.65	0.53	0.46
Ragay, Cam Sur	1.55	0.22	0.96
del Gallego, Cam Sur	1.45	0.25	0.9

Table 11. Ecological indices per seaweeds bed in Ragay Gulf

Municipality	Diversity (Shannon's H')	Dominance (Simpsons D)	Evenness
San Pascual, Masbate	1.72	0.21	0.88
Balatan, Cam Sur	1.28	0.13	0.79
Pasacao, Camsur	1.57	0.04	0.97
Lupi, Cam Sur	1.37	0.25	0.98
del Gallego, Cam Sur	0.99	0.4	0.9

A total of 11 seagrass species and 13 seaweeds species were identified in all of the 11 transects assessed in Ragay Gulf. Table 10 and 11 showed the community structure characteristic of the seagrass/seaweed community per municipality along Ragay Gulf. The Shannon's diversity values for seagrass were high in Balatan (2.14) and moderately high in the municipalities of San Pascual (1.72), Ragay (1.55) and del Gallego (1.45) and lowest in Lupi (0.65). This result is consistent to substrate characteristics preference where seagrass communities were observed to be most diverse in sandy-coralline type (Balatan and San Pascual) than in muddy silty sites (Lupi, Minalabac and Bato). Also, diversity values for each municipality confirmed by higher values for evenness which provides measure of occurrence equitability of encountered species (Table 10). In terms of dominance, relatively higher values were observed in the municipalities of Lupi and Pasacao with 0.53, 0.40, respectively. This means that there are some species that tend to dominate (*Enhalus acoroides* in Lupi and *Cymodocea surrulata* for Pasacao), resulting to lower diversity.

In contrast, seaweeds in Ragay gulf appear to be moderately diverse across municipalities (Table 11). Seaweeds species per municipalities were different and is relatively minimal except for the occurrence of S*argassum sp*. which is abundant in Minalabac and Lupi areas.

It was observed that local gleaners usually flock in the coastal and mangrove areas during low tide to gather edible invertebrates' species such as bivalves, sea urchins, mud crabs and sea cucumbers. No commercial harvests of seagrass and seaweeds and associated fauna was observed during the study period, although some fishermen were noted using beach seine gears in the shore of Balatan. However, a malpractice in mangrove re-forestation was observed in San Pascual

Masbate where mangrove seedlings were seen planted in the dense meadows of seagrass. This habitat encroachment is disadvantageous to both to seagrass and seaweeds and the planted mangroves. Mendoza et al., (2019) conducted an assessment to areas with and without planted mangroves in Bantayan Island Cebu, found that seagrass beds unplanted with mangrove had more species and higher percent cover of seagrass than in areas with mangrove planting. Furthermore, the population of seagrass and seaweeds in Pasacao, Camarines Sur were in threatened condition due to the economic activities and presence of critical industries such as the oil depots, construction of dock sites for large ships along its coastal areas. These factors caused the continued decline in seagrass meadows along the gulf, although the current seagrass and seaweeds populations are diverse but in patchy occurrence. This was corroborated by the study conducted in 2006 by the UPLB revealed that densities of seagrass beds in Ragay and Balatan declined from 100-200 shoots/m^2 in 1995 to >50-100 shoots/m^2 in 2005.

CONCLUSIONS

Seagrass/seaweeds beds play a very important role in the entire coastal environment Ragay gulf. There were eleven (11) species of seagrasses identified thriving in the selected municipalities of Camarines Sur and Masbate. These represent 61.11% of the eighteen (18) species occurring in the Philippines (Fortes, 2012). The composition and abundance of seagrass and seaweeds differ between municipalities. This is due to habitat differences in their substrate, temperature, light depth, current, salinity, nutrient and human factors. *Thallasia hemprichii* dominates among the seagrass species while Sargassum is observed to be present in all the stations surveyed *Cymodocea – Thalassia-Halodule mixed* species were observed an indication of a productive ecosystem for both fin fishes and macro-invertebrates. Dominating seagrass species in terms covered differ between municipalities. In del Gallego, *Halophila ovalis* with was found to have cover at 60.80% followed by *Halodule pinifolia* (56.25%). In San Pascual, it is *Enhalus acoroide*s the covers the widest (48.87%) of Ragay, *Syringodium isoetifolium* (41.00%) of Balatan and *Cymodocea serrulata* (39.10%) of Pasacao. The Shannon's diversity values for seagrass were high in Balatan (2.14) and moderately high in the municipalities of San Pascual (1.72), Ragay (1.55) and del Gallego (1.45) and lowest in Lupi (0.65). The presence of siltation has a negative influence on the seagrass/ seaweed beds in Ragay gulf on its occurrence and diversity. But this is countered by the presence of lush population of mangrove along the shore because its roots system serves as filtering mechanism against siltation coming from the mainland during heavy rains and flooding. This can be explained further by the existence of seagrass communities immediately after the mangrove areas such as in San Pascual having eight species, del Gallego and with five, and Ragay with four types of seagrass despite the silted substrate.

RECOMMENDATIONS

Seagrass/seaweeds cover and diversity can be improved through strict implementation of management measures such as coastal use zonation to conserve marine ecosystem. Regular monitoring to permanent monitoring sites should be in place to determine whether the seagrass /seaweeds beds resource are stable, improving or declining. However, with the prevalent population increase along coastal areas, strong political will is needed to effectively implement management schemes.

Moreover, the seagrass areas should be included in the management plans in every municipality. Integrated management plans should be prepared gulf wide including seagrass beds inside the managed areas. Local awareness on the economic and ecological benefits of the seagrass beds must be conducted. Another effort could be resource enhancement projects such as re-population of invertebrates and siganid farming should be explored along the gulf.

The management plans should determine the habitat zones whenever reforestation or restoration activities are being conducted. As it was cited in the PRSA-UPLB, 2006 report that mangrove reforestation must not plant propagules in the seagrass beds.

REFERENCES

Duarte, C.M., Middleburg, J.J., Caracao, N. (2005). Major role of marine vegetation on the oceanic carbon cycle. Bigeosciences, 2, 1-8.

Duarte. C. M. (1994). Submerged aquatic vegetation in relation to different nutr~ent regimes. Ophelia (in press).

Fortes, M.D., 1988. Indo-West Pacific Affinities of Philippine Seagrass. Bot Mar 31: 237-242

Fourqurean, J. W., Zieman, J. C., Powell, G. V. N. (1992). Relationships between porewater nutrient and seagrasses in a subtropical carbonate environment. Mar. Biol. 114: 57-65.

Jamir, Vergel C. 1998. Distribution, seasonality and Variation and Community Structure of the Demersal Trawl Fauna of Ragay Gulf, Philippines. Dissertation, 9-12.

Kennedy, H., Beggings, J., Duarte, C.M., Fourqurean, J. W., Holmer, M., Marba, N., &Middleburg, J. J. (2010) . Seagrass sediments as a global carbon sink: Isotopic constraint. Global Biogeochem Cycles, 24, 38-48.

Jr, Mendoza, & Soliman, V.S.. (2017). Coastal habitats of asid gulf, masbate, Philippines: Assessment and role of marine protected areas for management development. AACL Bioflux. 10. 1351-1359.

Meñez E.G., Phillips R.C. and Calumpong H.P. 1983. Seagrasses from the Philippines. Smithsonian Contributions to the Marine Sciences 21.

Ragay Gulf, Participatory Resource and Socioeconomics Assessment report, 2006. University of the Philippines, Los Baños, Laguna.

Short F.T., Coles R.G., Pergent-Martini C, 2001. Global seagrass distribution. In Short F.T., Coles R.G. (eds) Global seagrass research methods, pp. 5-30. Elsevier Science BV, Amsterdam, The Netherlands.

Short, F.T., Coles, R., Waycott, M., Bujang, J.S., Fortes, M., Prathep, A., Kamal, A.H.M., Jagtap, T.G., Bandeira, S., Freeman, A., Erftemeijer, P., La Nafie, Y.A., Vergara, S., Calumpong, H.P. & Makm, I. 2010. *Halophila spinulosa*. The IUCN Red List of Threatened Species 2010.

Trono, G. Jr., 1985. The commercially important seaweeds of Lingayen Gulf, Philippines. AGRIS, Food and Agriculture Organization of United Nations.

Trono G.C.1997. Atlas of the Seaweed Resources of the Philippines. Vermaat J.E., Fortes M.D., Agawin N.S.R., Duarte C.M., Marba N., Uri J.S., 1995. Meadow maintenance, growth and productivity in a mixed Philippine seagrass bed. Mar Ecol Prog Ser 124: 215-225

Waycott, M.,Duarte,C.M.,Carruthers,T.,Orth,R.,Dennison,W. C., Olyarnik, S., Calladine, A., Fourqurean, J., Heck, K., Hughes, R., Kendrick, G., Kenworthy, W., Short, F., & Williams, S. (2009). Accelerating loss of seagrasses across the globe threatens coastal ecosystems. Proceedings of the National Academy of Sciences of the United States of America, 106, 12377–12381.

WATER QUALITY ASSESSMENT IN RAGAY GULF

Grace L. Aytona
Shindy O. Logoc
Bicol University
Legazpi City

Aytona, G.L. and S.O. Logoc. 2019. Water Quality Assessment in Ragay Gulf. Pp 77-91. In Dioneda R.R., E.E. Torres and G. Naz. (Eds). 2019. Participatory Resource and Socio-Economic Assessment of Ragay Gulf-Bicol Side. Terminal Report Submitted for the Fisheries, Coastal Resources and Livelihood Project, Department of Agriculture-Bureau of Fisheries and Aquatic Resources, Quezon City. Bicol University, Center for Policy Studies and Development, Legazpi City. 138 pp.

ABSTRACT

Water quality assessment was carried out from selected stations scattered along the Ragay gulf. Selection of number and locations of these stations was based on prevailing situations and issues in the gulfs. Philippine water quality is assessed based on the set of beneficial use as defined in a set of standards. Accordingly, a water body must meet the corresponding criteria of each applicable parameter 100 percent of the time to maintain its designated classification. This study aims to establish baseline measurements for primary water quality parameters for marine waters and assess the conditions of the water in the identified gulf.

Two approaches were employed in the assessment of primary water quality parameters in Ragay gulf. These are in-situ measurements and laboratory analysis. All measured primary parameters were compared to standards and minimum and range limits set under the DAO 2016-08 for SB classifications and usage. In-situ measurement of water quality parameters was conducted in Ragay Gulf. This study revealed that the condition of Ragay gulf as of assessment conforms to the standards set by DAO 2016-08 considering the water classification and usage of marine waters. The mean values recorded for the in-situ parameters such as temperature (28.17-30.94°C), pH (8.00-8.10), and DO (6.85-8.19 ppm) and the predominant activities encountered in the area further implies good water condition prevailing within the gulf. This is based on its comparison against the existing DAO 2016-08 water quality guidelines

Keywords: Water quality, standards, laboratory tests

INTRODUCTION

Water quality is an essential factor for public health, ecosystem health and even in the economy. Deviations and degradation of water quality may occur as a result of pollution from discharges, agricultural run-off and sediment run-off. This would also impact the exposure to diseases and harmful chemicals, reduction in viability of economically important fisheries species, hypoxia events and destruction of ecosystems. As population in coastal areas continues to increase, coastal environment become at a greater risk for water quality issues.

Water quality is one of the characteristics that is of paramount importance in determining how society and humans associate to natural resources and aquatic environment. Water quality refers to the bacteriological, chemical, physical, biological and radiological characteristics which indicates the condition and acceptability of water relative to its proposed or present use. Water quality assessments were carried out from selected stations scattered along the identified locations in Ragay Gulf. Selection of number and locations of these stations were based on prevailing priorities, situations and issues in the gulfs. These are the areas like marine protected areas (MPAs), aquaculture sites, recreational zones and presence of industries with potential of perturbing coastal environment.

Basically, water quality of gulfs is influenced by natural environmental processes and human activities. The Department of Environment and Natural Resources (DENR) – Environmental Management Bureau (EMB) has issued DENR Administrative Order (DAO) No. 2016-08: Water Quality Guidelines (WQG) and General Effluent Standards (GES) of 2016 on May 24, 2016. The release of the Guidelines repealed DAO 1990-34 (Revised Water Usage and Classification/Water Quality Criteria) and DAO 1997-23 (Updating DAO 1990-34), as modified DAO 1990-35 (Revised Effluent Regulations of 1990). Under this DAO, there are 10 primary parameters that define the desired water quality per water body classification. Accordingly, a water body must meet the corresponding criteria of each applicable parameter 100% of the time to maintain its designated classification. Water body classification and usage of marine waters was also specified in the standard such as Class SA (protected waters, fishery water class I), SB (fishery water class II and tourist zones), SC (Fishery water class III, marshy and mangrove areas) and SD (navigational waters). As outlined in Department Administrative Order No. 2016-08, primary parameters are set as minimum water quality parameters to be monitored in a water body. The quality guidelines (WQG) enumerates Dissolved oxygen (mg/L), Fecal Coliform (MPN/10ml), nitrate as NO_3-N (mg/L), pH (range), Phosphate (mg/L), temperature (0C and Total suspended solids (TSS, mg/L).

This study determined the status of the basic water quality of Ragay gulf by establishing baselines of the primary water quality parameters for marine waters.

Specifically, the study aims:

a. To establish baseline measurements for primary water quality parameters for marine waters in Ragay gulf such as:

1. pH
2. Dissolved oxygen (DO)
3. Temperature
4. Total Suspended Solids
5. Nitrates
6. Phosphates and
7. Fecal coliform

b. Assess conditions of waters in Ragay gulf based on established stations

METHODOLOGY

Ragay Gulf is a large gulf in the Bicol Peninsula of Luzon island, part of the Sibuyan Sea. It is separated from Tayabas Bay by the Bondoc Peninsula in the west. The gulf covers the provinces of Quezon and Camarines Sur. In Ragay Gulf, there were twenty five (25) identified water quality stations. These stations were prioritized based on the locations of marine protected areas, aquaculture, projects, ecotourism facilities such as resorts and proximity of potential discharging industries.

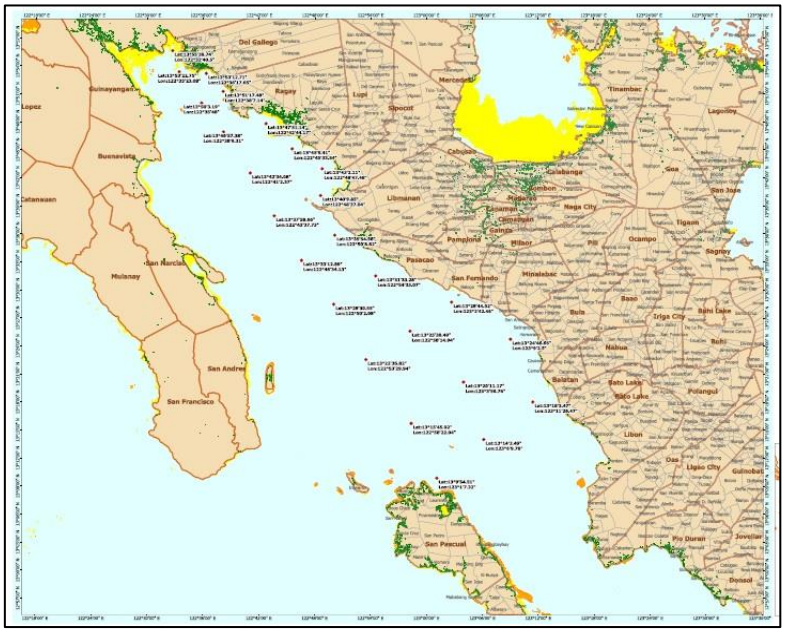


Fig. 1. Sampling station in Ragay Gulf

Water quality stations in Ragay Gulf are mainly covered by the municipalities of Del Gallego, Ragay, Balatan, Bula, and Libmanan. Deviations on the target number of stations for laboratory analysis of nutrients and total suspended solids were set due to the emerging safety concerns in terms of continual disturbance of surface wave.

Two approaches were employed in the assessment of primary water quality parameters in Ragay Gulf. These are in-situ measurements and laboratory analysis. Laboratory analyses for color, nutrients (phosphate ad nitrate), fecal coliform and TSS were undertaken at Regional Center for Food Safety and Quality Assurance laboratory of the Office of the Vice President for Research Development and Extension of Bicol University.

Sample Collection

Water samples were collected at specified stations at three (3) and five (5) meters depth, using Kemmerer water sampler. At least 25 sampling stations were established in Ragay gulf for water sampling and sanctuaries are priority for their identification and assignment. Samples were collected following the recommended sampling protocols and were immediately conditioned in sterile polyethylene bottles as part of the proper sample handling prior to laboratory analyses.

In-situ measurements

Physical parameters such as temperature, dissolved oxygen and pH were obtained using Hanna multi-parameter water quality meter (HI 91894) with the capacity to read simultaneous recordings of at least 7 parameters with instrument probe deployable to up 5 meters maximum

depth. This instrument could also measure temperature, salinity, conductivity, oxidation-reduction potential (ORP) and others.

Laboratory Analyses

Fecal Coliform (MPN/100mL). For this analysis, the Multiple Tube Fermentation Technique (MTFT) was employed. Fecal coliform may be distinguished from another coliform by means of EC medium. All presumptive fermentation tubes or bottles showing formation of gas, growth, and/or acidity were subjected to fecal coliform test.

Nitrate as NO_3-N (mg/L). Brucine colorimetric method using UV-Vis Spectrophotometer is applicable for the analysis of surface, drinking, saline, domestic and industrial wastes. However, certain modifications could be made to remove/correct the turbidity, color, salinity, or dissolved organic compounds in the collected samples. This method was based on the reaction of nitrate ion with brucine sulfate in a 13N H_2SO_4 solution at a temperature of 100^0C. The color of the resulting complex was measured at 410nm. Temperature control of the color reaction was extremely critical.

Phosphate (mg/L). The Vanadomolybdophosphoric Acid Colorimetric Method was used. Phosphate content of water samples were determined using the Vanadomolybdophosphoric Acid Colorimetric Method with Spectrophotometer as Colometric equipment to measure the yellow intensity of the solution when vanadomolybdophosphoric acid is formed. In a dilute orthophosphate solution, ammonium molybdate reacts under conditions to form a heteropoly acid, molybdophosphoric acid. In the presence of vanadium, yellow vanadomolybdophosphoric acid is formed. The intensity of the yellow color is proportional to phosphate concentration.

Total suspended solids (mg/L). The conventional filtration, and drying method was employed. Mixed sample was filtered through a weighed standard filter and the residue retained on the filter is dried to a constant weight at 103 to 105^0C. The increase in weight of the filter represents the total suspended solids.

All measured primary parameters were compared to standards and minimum range limits set under the DAO 2016-08 for SB classification and usage. GIS maps to depict selected water quality conditions within each gulf were made.

RESULTS AND DISCUSSION

In-situ measurements of water quality assessment

Summarized in Table 1 are the in-situ water quality parameters (pH, temperature, DO, electrical conductivity, TDS, and salinity) that were measured for the assessment.

Table 1. Physical -Chemical Characteristics of Ragay Gulf Water Quality Stations

Station	*Site Description*	pH	Temp (^{0}C)	DO (mg/L)	Cond (µS/m)	TDS (ppt)	Salinity (PSU)
DAO 2016-08		***6.5-8.5***	***25-31***	***5-6***			
RA 1	Magais 1, Del Gallego Near FSMR	8.07	30.94	7.08	14.80	24.20	34.41
RA2	Sinagawad Del Gallego	8.10	30.64	7.24	14.70	24.17	34.38
RA3	Sabang, Del Gallego Near FSMR	8.03	30.81	7.21	14.80	24.25	34.49
RA4	Open water	8.10	30.43	7.36	14.70	24.13	34.33
RA5	Near Catabangan Proper Aquaculture	8.01	30.63	7.26	14.80	24.20	34.44
RA6	Near MPA, open water	8.00	30.42	7.52	14.80	24.15	34.28
RA7	Near MPA, open water	8.03	30.53	7.43	14.80	24.09	34.28
RA8	Open water, Ragay (mid water)	8.02	29.87	7.45	14.80	24.09	34.34
RA9	Open Water, Ragay (near shore)	8.05	29.96	7.00	14.80	24.08	34.38
RA10	Open water, Lupi	8.05	29.79	7.02	14.80	24.07	34.30
RA11	Open water, Sipocot	8.07	29.88	7.01	14.80	24.06	34.27
RA12	Open water, Sipocot (mid)	8.02	30.06	7.37	14.80	24.14	34.30
RA13	Open water, Libmanan	8.05	29.38	6.98	14.80	23.98	34.20
RA14	Tinalmod Viejo	8.03	29.30	7.60	14.73	24.27	34.13
RA15	Open water, Libmanan (mid)	8.00	28.84	7.86	14.80	23.98	34.24
RA16	Barangay Dalumpaon	8.00	29.01	7.88	14.80	23.67	35.08
RA17	Open water, Pasacao	8.01	28.60	8.19	14.80	23.97	34.25
RA18		8.01	29.03	8.16	14.80	23.36	34.26
RA19	Near Naranac island	8.05	28.71	6.89	14.80	23.94	34.22
RA20	Palo, Bato Coral Reefs	8.02	28.48	7.71	14.80	23.96	34.24
RA21	Caorasan Bula MPA	8.01	28.83	7.77	14.80	23.96	34.27
RA22	Barangay Hamoraon Near FS	8.09	28.30	6.85	14.77	23.80	34.35
RA23	San Pascual	8.03	29.39	7.08	14.73	23.99	34.20
RA24	Minalabac MPA	8.02	28.32	7.29	14.70	23.95	34.31
RA25	Near Balatan Coguit MPA	8.04	28.17	7.04	14.70	23.94	34.24

Note: Results are reflected as means of three (3) determinations

Temperature and Salinity

Temperature and salinity are important water quality and environmental parameters that play a major role to aquatic life.

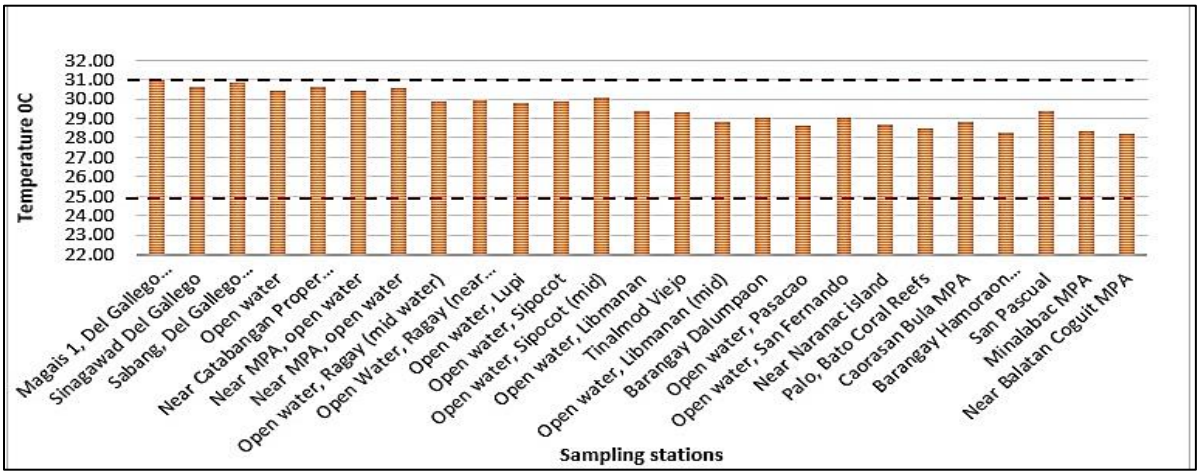


Fig. 2 Temperature readings at Ragay Gulf

Sampling stations in Ragay Gulf exhibited values for temperature ranging from 28.17^{o}C-30.94^{0}C. All of which were within the standards stated in DAO 2016-08. Highest temperature was recorded at Near Del Gallego while lowest was recorded at water sampling station near Balatan MPA. Readings vary in different stations, but with only minimal differences that do not exceed 1°C. These differences may be due to the time samples were taken. However, this observed range in difference in the recorded temperatures of the water is still within the allowable temperature range as stipulated in DAO 2016-08 which is 25-31^{0} C for SB classification of water.

Salinity in all stations were considered high. The lowest salinity with 34.13 PSU was encountered at RA 14 that lies in Tinalmod Viejo, while the highest was recorded in RA 16 with 35.08 PSU located near Barangay Dalumpaon. There were no standards set for the allowable limits of salinity measurements required in DAO 2016-08. However, salinity values normally range from 34-36 psu. Salinity of water varies from one place to another. Variation can be observed on the recorded salinity measurements of the sampling stations. This variation might probably due to the presence of minerals that contributes to water salinity of sampling stations that acts as carrier of chemicals dissolved out of rock and soil. Salinity is controlled by a balance between water removed by evaporation, freshwater added by rivers and amount of rain experienced by a sampling station.

Total Suspended Solids (TSS) and Total Suspended Solids (TDS)

Total suspended solids (TSS) on the other hand, measures the concentration of undissolved solid particles in water and is a significant factor in observing water clarity. These solids include anything drifting or floating in the water from sediments and silts. Even chemical precipitates are considered a form of suspended solids. TSS values from water quality stations in Ragay gulf ranges

from 2.62 – 50.00 mg/L. All stations gave TSS values lower that the limits set by DAO 2016-08 for SB classification.

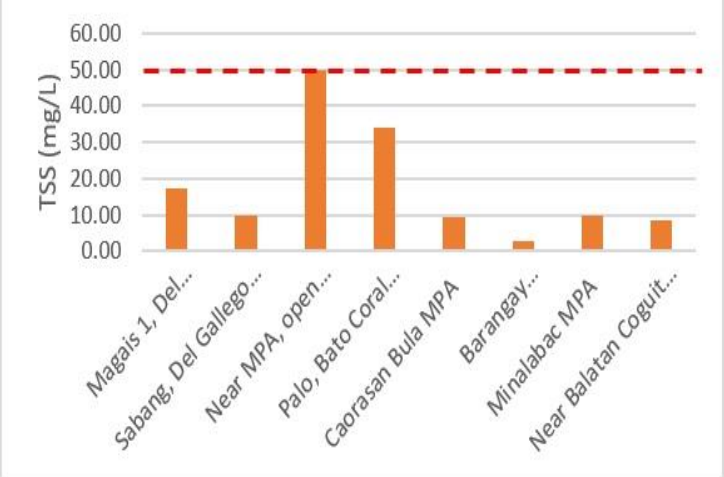


Fig. 3 Total Suspended Solids

Total dissolved solids (TDS) was another parameter that have been considered in this assessment. Total dissolved solids measure the number of particles that are dissolved in water and may include all suspended solids that may or may not pass through a filter. This comprised all the disassociated electrolytes that made up salinity concentrations as well as other compounds such as dissolved organic matter and may even include organic solutes such as hydrocarbons and urea in addition to salt ions. The measured values along the stations in Ragay Gulf showed variety in terms of total dissolved solids. Recorded values exhibited slight variations ranging from 23.36 ppt as the minimum value and 24.25 ppt as the highest recorded value for TDS. There was no known standard value for TDS indicated in DAO 2016-08. These recorded values however are still acceptable for seawater since a constant level of minerals in water is necessary for aquatic life. This further supports the density of total dissolved solids that determines the flow of water in and out of an organism's cells. This can also be attributed to the contribution on the TDS levels brought about by urban run-offs while some dissolved solids come from organic sources such as leaves, silt and other waste and sewage.

Electrical Conductivity (EC)

Conductivity is a well-known measure of water's capacity to pass electrical flow and this ability is directly related to the concentration of ions in the water. These ions came from dissolved salts and inorganic materials such as chloride and sulfides. Seawater was expected to have a very high conductivity due to the presence of salt ions which conducts electricity as an effect of positive and negative charges. The conductivity values recorded for the sampling stations in Ragay Gulf ranges from 14.70-14.80 mS/cm. Conductivity is not a pollutant itself rather it served as an indicator of the presence of pollutants. The conductivity was affected by the presence of dissolved substances in the water including salts and even heavy metals. Some of these substances were known to be harmful to aquatic life and to humans especially at high concentrations. DAO 2016-08 had no standard for the EC values of marine waters.

pH and DO

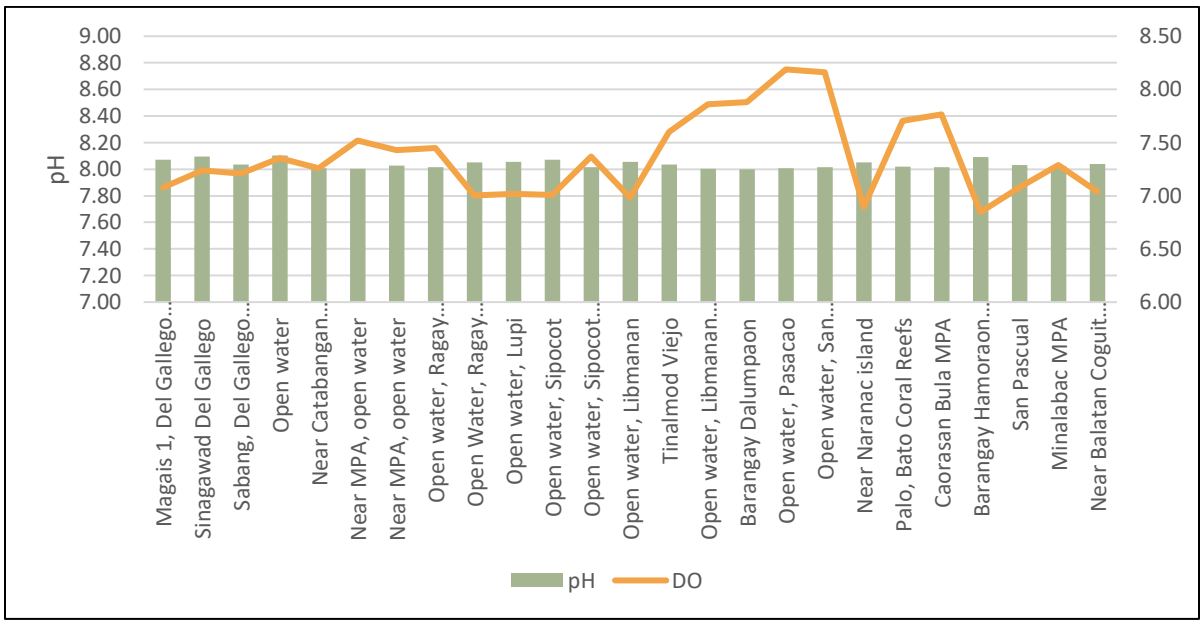


Fig. 4 pH and DO levels at Ragay Gulf

pH (power of hydrogen) is the measure of hydrogen ions, or normally the acidity of water. As known, water has hydrogen ions paired with hydroxyl ions that are, when in equal numbers, the water becomes neutral. pH was measured on a logarithmic scale of 0-14. Most aquatic organisms have a narrow pH tolerance range of 6.5-8.5 which was also stated as the allowable pH range in DAO 2016-08 for class SB classification. Acidic waters could cause toxic heavy metals to be released into the water. pH is almost similar in all sampling stations in Ragay gulf which ranged from 8.00 to 8.10. This range is normal, in which ocean water is nearly alkaline because of numerous dissolved ions that most are alkaline in nature. All recorded values fell within the standard allowable pH value for Class SB marine waters. This further indicates that water is in good condition in terms of pH buffering system. As pH moved away from the standard range, either up or down, it could stress the system and reduced hatching and survival rate. In addition to these biological effects, extreme pH levels usually increased the solubility of elements and compounds, which further made toxic chemicals more mobile and increasing the risk of absorption by aquatic life.

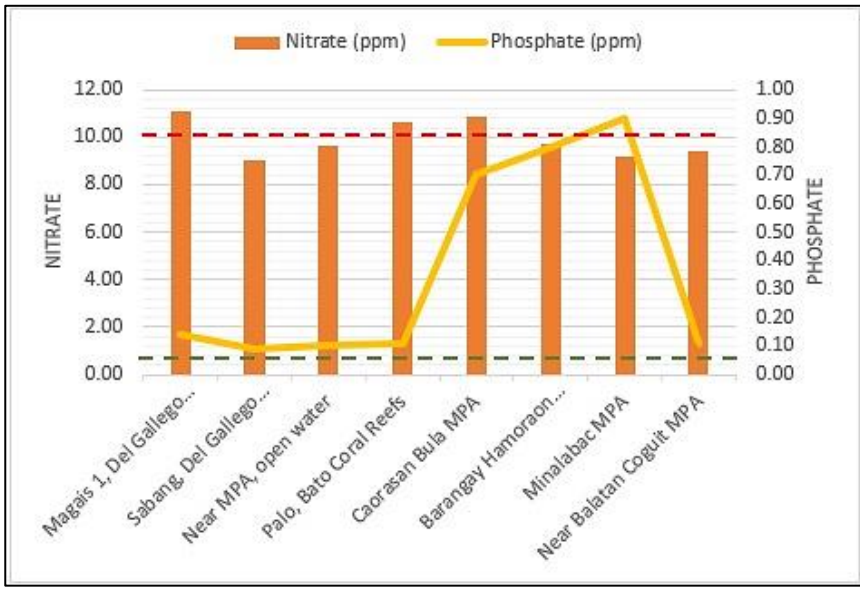
With regards to DO, all stations have normal readings with a range of 6.85-8.19 ppm. Highest DO was encountered at Open Water, Pasacao. Dissolved Oxygen (DO), on the other hand, was also one of the parameters of paramount importance in terms of aquatic system. It was a measure of the amount of gaseous oxygen that is dissolved in an aqueous solution, in this case, the seawater, and this was also an essential basic requirement for the metabolism of aerobic organisms thriving along the gulf. It was an important parameter in assessing the water quality because it highly influences the organisms living within the specified body of water. High DO levels or even too low values can harm aquatic life which could eventually detrimentally affect the water quality.

Higher TDS values sites hampers light penetration which further resulted to reduced mechanisms of photosynthesis hence, contributed to a lower dissolved oxygen level.

Nutrient Levels

Table 2 presents the nitrate and phosphate levels measures along water quality stations in Ragay gulf.

Table 2. Nutrient Levels in Ragay Gulf Water Quality Stations



Phosphates (mg/L)
0.5
0.14
0.09
0.10
0.11
0.70
0.80
0.90
0.11

Note: Results are reflected as means of three (3) determinations

Nitrates (NO_3-) as nitrogen and Phosphates as phosphorous were measured along water quality sampling stations in Ragay Gulf. Unlike temperature and dissolved oxygen, the presence of normal levels of nitrates usually did not directly affect aquatic life. However, excess levels of nitrates in water could create conditions that could make it difficult for aquatic life to survive. All aquatic organisms excrete wastes and aquatic plants and organisms eventually. These activities created ammonia and some bacteria in the water changes this ammonia to produce nitrite which was then converted by other bacteria to nitrate. Nitrates also came from the earth. Soil contained organic matter, which contained nitrogen compounds. Although nitrates occured naturally in soil and water, an excess level of nitrogen could be considered to be contaminants. Nitrate levels in Ragay gulf ranged from 9.06-11.06 mg/L (ppm), the highest of which was recorded at RA 1 (Near Del Gallego) and the lowest from RA 3 (Near Sabang). Comparing these obtained values with the

standard limits set by DAO 2016-08, it could be deduced that majority of the identified water quality stations were within the values for SB classification.

On the other hand, the phosphate levels measured along the water quality stations ranged from 0.09 – 0.90 mg/L (ppm). These values suggested strong variation among the stations. Phosphates in water come from a variety of sources and runoff from fertilizer was one contributor. Other factors may be due to sewages, runoff from areas lacking sufficient vegetation to hold soil in place and even use of detergents that contains phosphates from surrounding communities. Phosphates were chemicals containing the element phosphorous and they affected water quality by causing excessive growth of algae that eventually lead to algal blooms that could produce neurotoxins and hepatoxins.

Fecal Coliform levels

Table 3. Fecal coliform levels

Station	***Site Description***	**Fecal Coliform (MPN/100ml)**
DAO 2016-08		
RA1	Magais 1, Del Gallego Near FSMR	90.00
RA2	Sabang, Del Gallego Near FSMR	60.00
RA3	Near MPA, open water	100.00
RA4	Palo, Bato Coral Reefs	80.00
RA5	Caorasan Bula MPA	90.00
RA6	Barangay Hamoraon Near FS	70.00
RA7	Minalabac MPA	90.00
RA8	Near Balatan Coguit MPA	90.00

Table 3 presented the fecal coliform levels within the water quality stations in Ragay Gulf. As observed, RA 3 had the highest fecal coliform levels followed by Magais 1, Minalabac MPA, and Near Balatan Coguit MPA. Fecal coliform (FC) have been widely used as standard indicators if sewage pollution and potential health hazard associated with fecal pollution. Although fecal coliform was generally not harmful themselves, they indicate the possible presence if pathogenic (disease causing) bacteria, viruses, and even protozoans that also live in human and animal digestive systems. Therefore, the presence of fecal coliform in water suggested that pathogenic microorganisms might also be present and that swimming and eating shellfish might be a health risk. Majority of the alarming values obtained from the water quality sampling stations in Ragay gulf was within the limits set by DAO for SB classification. The presence of fecal coliform bacteria in aquatic environments indicated that the water had been contaminated with the fecal material of man or even animals. Fecal coliform bacteria can enter these rivers through discharge of waste, from agricultural and storm runoff, and from untreated human sewage. Agricultural practices such

as allowing animal wastes to wash into nearby streams during the rainy season, spreading the manure and fertilizer on fields during rainy periods, and allowing livestock watering in streams could all contribute fecal coliform contamination.

CONCLUSIONS AND RECOMMENDATIONS

In Ragay Gulf, there were 25 identified water quality stations for in-situ measurements but only eight (8) were covered for the laboratory analyses. These stations were prioritized based on the locations of marine protected areas, aquaculture, mariculture, near discharge zones and areas with important geographical locations. In-situ parameters such as pH, dissolved oxygen, total dissolved solids, temperature, salinity and conductivity were measured using Hannah multiparameter water quality meter while water samples were collected from the identified water quality stations for nitrates, phosphate, TSS and fecal coliform determinations.

All sampling stations along Ragay Gulf exhibited normal values for *in situ* parameters which are temperature, salinity, pH and DO. Water temperature of the identified sampling stations ranged from 28.17-30.94°C. These readings are within the normal range set forth by DAO 2016-08 for class SB water bodies. Salinity values ranged from 34.13- 35.08 PSU. The lowest salinity with 34.13 PSU was encountered at RA 14 which lied in Tinalmod Viejo, while the highest was recorded in RA16 with 35.08 PSU located near Barangay Dalumpaon. There were no standards set for the allowable limits of salinity measurements required in DAO 2016-08. TSS values from water quality stations in Ragay gulf ranged from 2.62 – 50.00 mg/L. All stations gave TSS values lower than the limit set by DAO 2016-08 for SB classification which is 50 mg/L. pH is almost similar in all stations that ranged from 8.00-8.10. This range is normal, in which ocean water is nearly alkaline because of numerous dissolved ions that most are alkaline in nature. All recorded values fell within the standard allowable pH value of 6.5 to 8.5 for Class SB marine waters. This further indicates that water is in good condition in terms of pH buffering system. With regards to DO, all stations have normal readings which ranged from 6.85-8.19 ppm. Highest DO was encountered at RA17. Nitrate levels in Ragay gulf ranged from 9.06-11.06 mg/L (ppm), the highest of which was recorded at RA 1 (Near Del Gallego) and the lowest from RA 3 (Near Sabang). On the other hand, the phosphate levels measured along the water quality stations ranged from 0.09 – 0.90 mg/L (ppm). These values suggest strong variation among the stations. Phosphates in water come from a variety of sources and runoff from fertilizer is one contributor. Comparing these obtained values with the standard limits set by DAO 2016-08, it can be deduced that majority of the identified water quality stations are within the values for SB classification.

Generally, the water in Ragay Gulf was compliant to the standards set by DAO 2016-08. However, the nitrate levels recorded within the identified water quality stations were also within the limits for class SB for these parameters except for one station. The high nitrate concentration could be ascribed from agricultural runoff in addition to nutrient load of the seawater and could be attributed to sources like runoffs, waste discharge, domestication of animals, and poor sanitation compliance along coastal area. In view thereof, local government within municipalities along Ragay gulf should strictly impose and practice responsible and sustainable agriculture to minimize the impending harmful effects of excessive nitrate levels in water body systems.

REFERENCES

Aydinol, F., Kanat, G., Bayhan, H., 2012. Sea water quality assessment of Prine Islands beaches. Environ Monit Assess. DOI 10.1007/s10661-011-1954-5

Bacteriological Analytical Manual (BAM) online. US Food and Drug Administration.

Charles, G., 2015. Current and future impacts on the marine environment: The challenge to achieve good environmental status.

Dhage, S. Chandorkar, A., Kumar, R., Srivastava, A. Gupta, I., 2006. Marine water quality assessment at Mumbai West Coast. Environment International 32 pp 149-158

Garside, C., 1985. The vertical distribution of nitrate in open ocean surface water. Deep Sea Research, Vol. 32, No. 6, pp. 723 to 732

Harvey, H.W., 1986. Nitrate in the sea. Journal of the Marine Biological Association. Pp 121-124

Lessin, G., Raudsepp, U., 2006. Water quality assessment using integrated modeling and monitoring in Narva Bay, Gulf. Environ Model Access 11:315-332. DOI: 10.1007/s10666-006-9045-7

Rice, E., Baird, R., Eaton, A., Clescen, Lenore., Standard methods for the examination of water and wastewater. 22nd edition.

Scavia, D., Bricker, Suzanne., 2006. Coastal eutrophication assessment in United States.

Nitrigen Cycling in the Amaericas: Natural and Anthropogenic Influences and Controls. pp 187-208.

Strain, E., Edgar, G., Ceccarelli, D., 2018. A global assessment of the direct and indirect benefits of marine protected areas for coral reef conservation. Biodiversity Research, DOI: 10:1111/ddi;12838

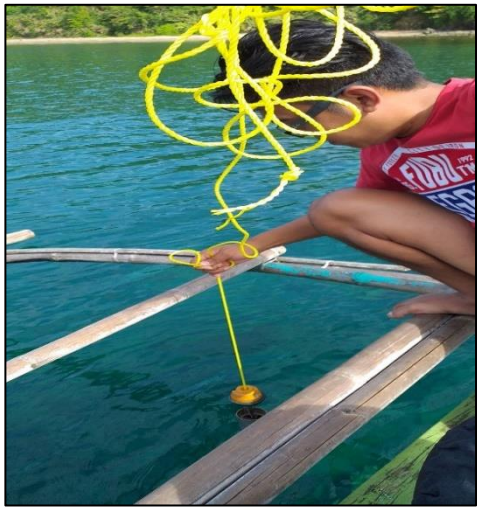
Strezov, V., Jahan, S., 2017. Water quality assessment of Australian ports using water quality evaluation indices.

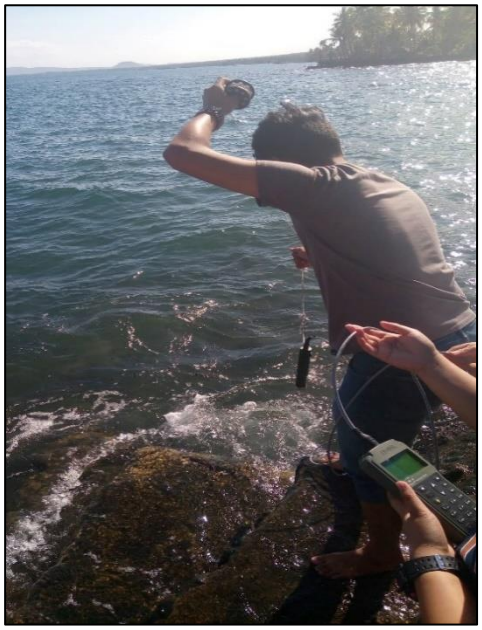
Sylaios, G., 2005. Monitoring water quality and assessment of land-based nutrient loadings and cycling in Kavala Gulf. Water Resource Management. Vol 10, Issue 6, pp 713-735

Water quality criteria and standards for freshwater and marine aquaculture. PHILMINAQ: Mitigating impact from agriculture in the Philippines

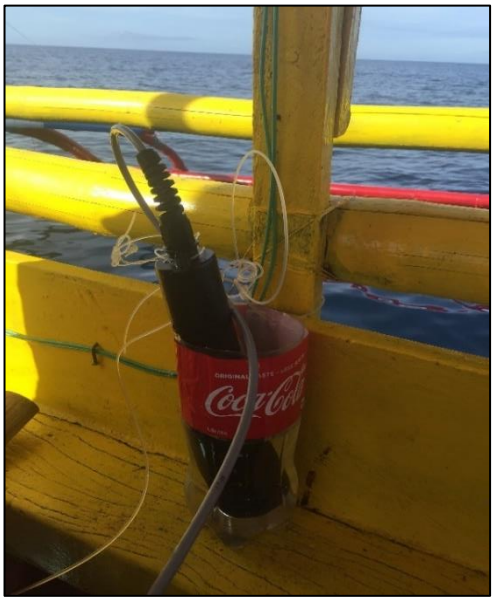
Water quality assessments – a guide to use of biota, sediments and water in environmental monitoring. 2nd edition. ISBN 0 419 21590 (HB) 0 419 21600 6 (PB)

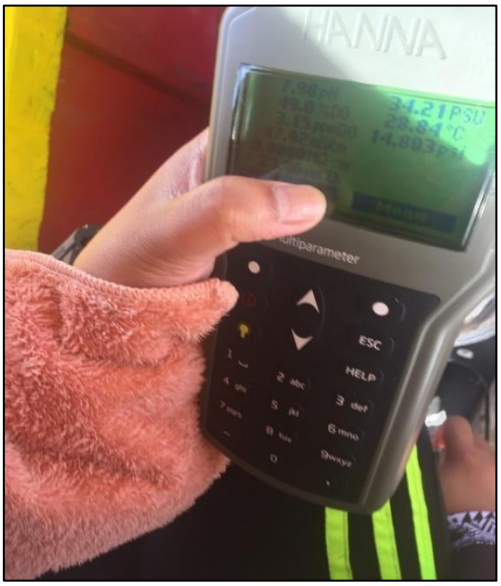
APPENDIX A
DOCUMENTATIONS

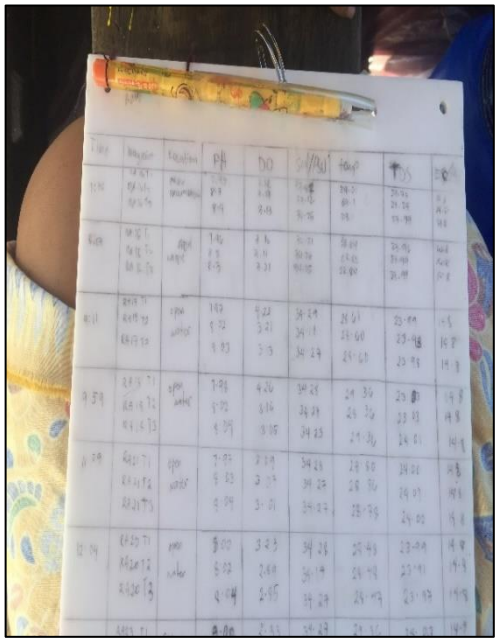




Method standardization on the use of multiparameter water quality meter and kemmerrer bottle







In-situ measurements at Ragay Gulf

CATCH AND EFFORT STATISTICS OF RAGAY GULF (BICOL SIDE) PHILIPPINES

Renan U. Bobiles
Bicol University Tabaco Campus
Tabaco City

Angelo P. Candelaria
Ronnel R. Dioneda, Sr.
BU Research and Development Management Division
Legazpi City

Bobiles, R.U. A.P. Candelaria, and R.R. Dioneda. 2019. Catch and Effort Statistics of Ragay Gulf (Bicol Side), Philippines. Pp 92-111. In Dioneda R.R., E.E. Torres and G. Naz. (Eds). 2019. Participatory Resource and Socio-Economic Assessment of Ragay Gulf-Bicol Side. Terminal Report Submitted for the Fisheries, Coastal Resources and Livelihood Project, Department of Agriculture-Bureau of Fisheries and Aquatic Resources, Quezon City. Bicol University, Center for Policy Studies and Development, Legazpi City. 138 pp.

ABSTRACT

Catch and effort statistics of fishing grounds provided vital information for policy makers to come up with sound management approach for rational utilization of marine resources. Catch and effort assessment of Ragay Gulf was conducted to determine the number of gear unit and types that exploit its fishery; seasonality of different gear unit and types; catch rates and composition; fishing efforts and estimate the fishery production. Ragay Gulf is among the traditional fishing grounds in the Philippines and provide livelihood to ~13,000 fishers in the Provinces of Quezon, Camarines Sur and Masbate. Key informant interview (KII) was conducted to gather relevant data on number of gear units and type, seasonality of fishing gears, fishing operation and catch rate. KII data complemented with actual landing survey were utilized for catch composition analysis then estimate fishing efforts expressed as the average annual fishing trips multiplied by the number of gear unit. Likewise, fishery production was estimated by obtaining the product of catch rate per specific gear unit multiplied by the product of fishing frequency and the number of gear unit. Results showed that the gulf is characterized as entangling and handline fishery. Major operation of most gear types occurs during the Northeast monsoon period. Dominant species of fishery production are comprised by small pelagics such as scad and sardines. Mean catch rates of dominant gear type (Entangling nets) ranges from 9.5 kg/trip (Bottom set-gill net) to 17.5 kg/trip (Encircling nets) and total fishing efforts was estimated to 1,404,711.9 trips per year yielding production estimates of 30,286.3 metric tons. Catch and fishing efforts statistics of the gulf are indicative of high exploitation level. Extraction rate of these fishing gear assemblage is estimated at 7.76 MT/km^2.

INTRODUCTION

Coastal and nearshore ecosystems are some of the richest areas of marine biodiversity globally. Stewart et al., (2010) states that coastal regions also support considerable human populations; at least 50% of people on earth live and work within 200 km. of a coast. Coastal zones are threatened by many factors – pollution, habitat loss and degradation, intense harvest of marine resources – that are driven by human activities on land and at sea.

In the Philippines, where 56% of the total 1,634 municipalities are coastal, where fishing is an important way of life as well as a major or sometimes the only source of livelihood for many coastal villagers (Pollnac et al., 2001, Muallil et al., 2011, Muallil et al., 2013). In the early 19th century, including the famous English biologist Thomas Huxley, thought fish stocks were inexhaustible (Smith, 1994). Conversely, recent advancements in fishing technology coupled with increasing fish demands from the fast-growing population have resulted in widespread depletion of global fish stocks (Pauly et al., 2005).

Post Resource and Socioeconomic Assessment of Ragay Gulf indicated that the resources in the gulf are overfished. Catch rates of 8 out of 14 fishing gears declined by 48-90% between 1994-1995 and 2005-2006 (Fragillano et al., 1996). Catch composition shifted to less commercially important species between 1994-1995 and 2005-2006 (Jimenez et al., 2006). This study strongly suggest that the stocks of commercially valuable species is severely reduced.

Fishery dynamics of a given fishing grounds provide vital information for rational management of its marine resources. However, this requires timely, adequate and reliable information about the resource and its user be made available for the policy makers. The study intends to assess the catch and effort of fishery in Ragay Gulf. Specifically, to determine the number of gear unit and gear types that exploit fishery resources in the gulf; seasonality of different gear unit and types; catch rates and come up with fishery production estimates of the gulf.

MATERIALS AND METHODS

Study Site

Ragay Gulf together with Burias Pass make up a basin located in the Bicol Region southeast of Luzon, Philippines and lies between latitudes 13° 00' N and 14° 00' N and longitudes 122° 25' E and 123° 20' E. Jamir (1990), it has a maximum width of about 25 nautical miles and longitudinal length of about 75 nautical miles with the main axis oriented along the northwest – southeast axis. The gulf covers an aggregate area of more than 3,900 km^2 and a total coastline of about 340 km (Jimenez et al. 2006). Municipal demersal fisheries can only utilize about one-seventh of the area because of its depth (Warfel and Manacop, 1950). It is bordered on the east by the Sierra Madre mountain range and on the west by the Bondoc peninsula. Ragay Gulf is connected to the Sibuyan Sea to the west through the narrow gaps of Burias Pass and Between Bondoc Peninsula and Burias Island. The Gulf is one of the major fishing ground in the Bicol region being monitored by National Stock Assessment Program (NSAP) of the Department of Agriculture, Bureau of Fisheries and Aquatic Resources (DA-BFAR)

Gear Inventory

Key Informant (KI) interviews were carried out to gather vital information pertaining to the number of fishing gear unit, fishing frequency and seasonality of fishing operation of various fishing gears. KI interview as a form of gear inventory was conducted in 57 coastal barangays of Ragay Gulf constituting 11 municipalities surrounding the gulf. Salient data, e.g. number of fishing gear unit and type for specific localities (e.g. coastal villages and municipalities) were obtained for characterization of Ragay Gulf as fishing ground based on dominant fishing gear.

Catch and Effort Analysis

Fish catch, fishing operations and seasonality of various fishing gear types per categories were determined through recall interview. KI interviews per fishing village were conducted to reconstruct historical data pertaining catch rate (e.g. kg/trip), fishing operation (e.g. trips per week, per month and year) and gear seasonality (peak and lean months) were validated in a series of KI interview. Fishing efforts was estimated by multiplying the average annual fishing trips and count of gear unit. Furthermore, catch and landing survey was also done for some instances during the KI interview in fishing villages surrounding the gulf. Information gathered were analyzed to determine realistic estimates of catch per fishing efforts exerted by different types of fishing gears to the resource as valid indicators of its status.

Catch composition data were obtained through recall interview with the key informants who are those individuals (fishers) whose primary source of income and livelihood are fishing. Fishers with fishing experience of at least five years were the primary source of catch composition data. Incidental catch and landing survey in some coastal villages during the KI interview were also sources of data. Furthermore, secondary data from government agencies (e.g. NSAP of DA- BFAR) were also utilized to estimate the fishery contribution of major finfishes to the total fishery production of the gulf.

Fishery Production Estimation

Validated and monitored catch rate, fishing operation frequency and number of fishing gear units were used to estimate the production contribution of fishing gear types and per municipality. Fishery production for specific gear types were estimated by obtaining the product of catch rate per specific gear unit multiplied by the product of fishing frequency and number of specific gear unit. Total fishery production of the gulf was estimated by obtaining the summation of total fishery production per municipality for its specific gear units.

RESULTS

Fishing gear types and gear units used by fishers operating in Ragay Gulf

Various fishing gears (as much as 38 distinct variants) were used by fishers to exploit the multispecies resources in Ragay Gulf. A total number of 7,798 fishing gear units and 38 fishing gear variants were used by fishers in Ragay Gulf (Table 1). In terms of gear variants per gear categories, entangling nets with thirteen variants dominate the gears used by majority of fishers in the gulf followed by handlines and impounding nets with seven variants. Then barriers and traps, and spear with five and four variants, respectively. Likewise, longlines, miscellaneous hand instruments and other gears with only one variant. Furthermore, handlines and entangling nets constitute more than 50% of fishing gear units used by fishers exploiting the gulf.

Table 1. Total number of fishing gear variants and number of gear units per gear categories in Ragay Gulf

Gear Categories	Number of Variants	Total Number of Gear Units
Entangling nets	13	1,793
Handlines	7	3,558
Longlines	1	536
Barriers and Traps	4	391
Impounding nets	7	398
Spear	4	407
Miscellaneous hand instruments	1	714
Others	1	1
Total	**38**	**7,798**

The most numerous gear units were simple handline (928), multiple handline (914), typical gillnet (878), troll line (536), bottom set long line (535) (see; Appendix A). Except for the ring net and stop seine or purse seine with gear unit of 29 and 4, respectively the rest of the fishing gears identified were all considered municipal fishing gears which are permitted to fish within the fifteen kilometers from the shoreline of Ragay Gulf. The gulf is characterized as handline and gillnet fisheries primarily this gear category and gear types dominate the fishing gear units. Presented in Table 2 were the relative proportion of fishing gear units per municipality. The municipality of San Pascual (32%) contributed more than a quarter (32%) of the total number of gear units operating in the gulf, followed by Ragay and Balatan with 14% and 13% respectively, while other municipalities shared < 10% to the total number of gear units.

Table 2. Relative proportion of Fishing gear units per Municipality to the total number of gear units operating in the gulf

Municipality	Total Number of Gear Units	Relative Proportion of Gear Unit per Municipality (%)
San Pascual	2521	32
Ragay	1107	14
Balatan	1005	13
Pasacao	635	8
Minalabac	617	8
Del Gallego	526	7
San Fernando	434	6
Bato	372	5
Bula	248	3
Sipocot	174	2
Lupi	159	2
Total	**7,798**	**100**

Fishing Efforts, seasonality of fishing gear types and gear units used by fishers operating in Ragay gulf

Fishing efforts exerted to the gulf were estimated to be around 1,404,711.9 trips per year (Figure 2). More than a quarter of fishing efforts come from the Municipality of San Pascual, an effort equivalent to 500,800.9 fishing trips per year. It dominated effort apparently as San Pascual looms over other municipalities in terms of total number of gear units comprising about 2,521. This was followed by Ragay with 13% (181,220.7 trips/year), Pasacao 10% (142, 495.4 trips/year). The rest of municipalities contributed less than 10% of individual fishing efforts equivalent which ranges from 21,705.5 – 97,110 trips per year.

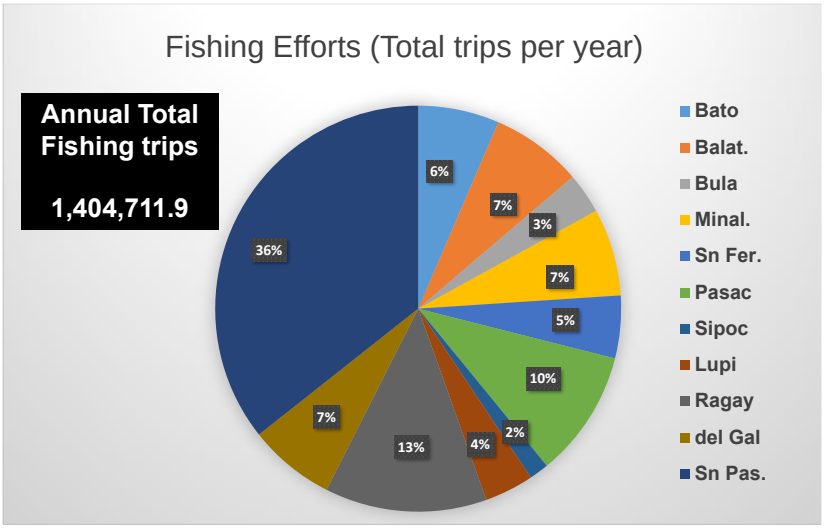


Figure 2. Relative fishing efforts of municipalities in Ragay Gulf

Major fishing activities in Ragay Gulf started during the onset of the Northeast monsoon (November – late March) and last until the onset of Southwest monsoon (June-October). Fishing activities here are dictated by the prevailing monsoon as function of fishery production (Figure 3). Fishing gear categories such as impounding nets, entangling nets and spear fishing primarily operates during the northeast monsoon as indicated by higher fishery production and low during the southwest monsoon. On the other hand, gear category such as handlines, long lines and barriers and traps peaks of operation during the periods southwest monsoon and lean during northeast monsoon.

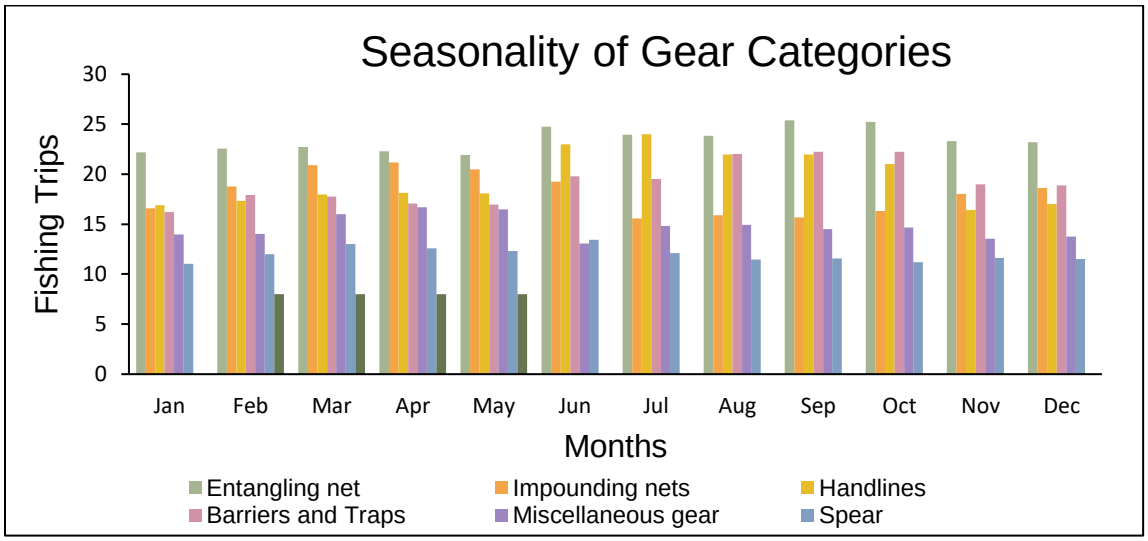


Figure 3. Seasonality of fishing efforts and fishery production contribution of fishing gear category

In terms of annual fishing operation were predominantly dominated by the gear categories of entangling net (e.g. bottom set gillnet “Palubog”, drift gillnet “Palutang”) and Handlines (e.g. simple handlines “Kawil” and artificial bait “Buyod-buyod”) were found in almost all municipalities in Ragay gulf (see; Appendix B). The cumulative fishing operation of municipality of San Pascual (13%), Pasacao (13%), Minalabac (13%) and Bato (10%) relative contribution to the fishing operation (Trips/year) comprise almost half of the total fishing operations in the gulf. The rest of the municipalities contributed less than 10% to the total fishing efforts in the gulf.

Catch rates of fishing gear types operating in the gulf

Catch rates of fishing gear types varies within gear categories, presented in Table 3 were the top 20 gear types in terms of kilogram caught per fishing trips. In terms of the gear types or variants, more than 50% were dominated by entangling nets and the highest among the gear types is the encircling gillnet with catch rate ranging from 47.8 to 212.1 kg/trip. This was followed by impounding nets with 25% in terms of number of variants, followed by barriers and traps, handlines, long lines and spear with 5%. Furthermore, other fishing gear types with mean catch

rates of 9.0 kilogram and below per fishing trip mostly belong to fishing gear categories of handlines (see; Appendix C). Mean catch rates of these handlines ranges from 8.9 to 2.5 kg/trip for Multiple handline and Pole and line respectively. Other gear types e.g. Fish corral with 19.3 kg per operation were relatively higher compared to other gear types under the same category such as fish pot (6.9 kg/trip), crab pot (3.4 kg/trip) and squid pot (kg/trip).

Table 3. Catch rates of top 20 fishing gear unit in terms of kilogram caught per fishing trips

Fishing Gears			Catch rate (Kg/trip)		
English Name		Local name	Min	Max	Mean
Entangling nets					
	Encircling gill net	Patalang	47.8	212.1	117.5
	Drift gill net	Kurantay	9.0	52.6	26.1
	Drift gill net	Largarete	8.0	65.0	26.0
	Drift gill net	Pangkanoos	5.4	44.8	25.1
	Drift gill net	Panke-palutang	7.9	54.6	23.1
	Drift gill net	Barangay	7.9	54.6	23.1
	Drift gill net	Patitig	8.0	48.0	21.1
	Drift gill net for halfbeaks	Bugkat (Pambugiw)	3.2	35.6	18.1
	2-ply	2-ply	6.7	15.0	9.5
	Bottom-set gill net	Panke-palubog	5.4	14.1	9.5
	Bottom-set gill net	Rabnot	5.4	14.1	9.5
Impounding nets					
	Stop Seines	Pangulong	80.0	1000.0	435.8
	Ring net	Kalansisi	30.0	324.7	175.1
	Beach Seine	Sinsuro	8.1	281.6	79.8
	Bagnet	Basnig	20.0	85.0	38.1
	Push net	Pansilo	5.9	87.6	32.8
Barriers and traps					
	Fish corral	Bunoan	11.5	26.7	19.3
Handlines					
	Multiple troll line	Rambo	5.9	17.1	9.3
Longlines					
	Bottom-set long line	Kitang	7.0	13.1	9.7
Spear					
	SPGN using compressor	Pana-compressor	2.3	83.0	38.1

Fishery Production Estimates of Ragay Gulf

Fishery production of Ragay Gulf was estimated to be at 30,286.3 metric tons (Table 4). The bulk of fishery production (90%) were coming from impounding nets (14,729.9 MT), entangling nets (6,875.9 MT) and handlines (5,420.4 MT) with relative contribution of 49 %, 23% and 18% respectively. Moreover, other gear categories contributed less than 10% of the total fishery production of Ragay Gulf.

Table 4. Relative fishery contribution per gear categories to the total production estimates of Ragay Gulf

Gear Categories	Fishery Contribution (Mt)	Relative Contribution per Gear Category (%)
Impounding nets	14,729.9	49
Entangling nets	68,75.9	23
Handlines	54,20.4	18
Longlines	1,721.9	6
Barriers and Traps	1,170.7	4
Spear	242.3	1
Miscellaneous hand instruments	124.8	< 1
Others	0.28	< 1
Total	**30286.3**	**100**

In terms of fishery production contributed by the 11 municipalities, almost a quarter (23%) of it came from the municipality of Balatan with 6,890.5 MT (see; Appendix D), this was followed by municipalities of San Pascual with 15% (4,488.9 MT), Bula 13 % (3,987.3 MT), San Fernando 11 % (3,259.9 MT), Minalabac 11% (3,184.9 MT), Pasacao 10% (2,924.9 MT), Ragay 8% (2,429.5 MT), Del Gallego 4% (1,214.4 MT), Lupi 3% (858.1 MT), Bato 3% (905.0 MT) and Sipocot < 1% (142.6 MT). The bulk of contribution from the municipality of Balatan came from the purse seine (2,688 MT) which is actually commercial fishing gear which is not permitted in the municipal waters of the gulf. Considering that very small portion of the gulf is commercial water which lies between San Fernando and San Pascual area, its operation within the gulf is generally construed as encroachment to the municipal water. Likewise, push net was found to contribute relatively high, which ranges from 1.12 (San Pascual) to 2926.9 MT (San Fernando) compared to other fishing gears.

Species composition of Finfishes caught in Ragay Gulf

Presented in Figure 4 were the dominant fish family contributing to the bulk of fishery production in the gulf of more than 10% came from family Carangidae (28%), Scombridae (21%) and Clupeidae (12%) while other contributed < 10%. The top 20 species of finfishes that comprised the bulk of fishery production in Ragay Gulf belonged to seven families that are mostly pelagic fish (Table 5). Species composition of the dominant family Carangidae constituted seven species, six of which belong to the genus *Decapterus* and one in genus *Selar*. This was followed by family scombridae with six species belonging to the genus *Auxis, Euthynnus* and *Rastrilliger.* Then family Clupeidae with three species belonging to the genus *Sardinella* and *Spratelloides.* Other fish families such as Priacanthidae, Engraulidae, Sphyraenidae and Myctophidae with one genus.

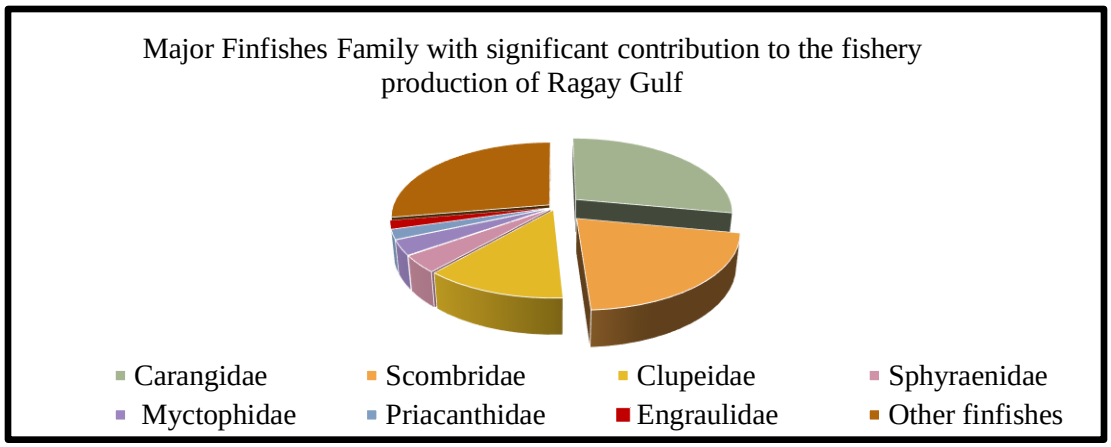


Figure 4. Fishery contribution of major finfishes amily to the total fishery production in the Gulf

Table 5. Fishery contribution of major finfishes caught in Ragay Gulf

Finfishes			***Relative composition**	**Fishery Production contribution (Mt)**
Family	**Scientific name**	**Local Name**		
Carangidae	*Decapterus kurroides*	Pulang buntot	6.8	2058
	Decapterus macrosoma	Sibubog	3.8	1148
	Selar crumenophthalmus	Matangbaka	3.6	1089
	Decapterus macarellus	Sibubog	2.8	846
	Decapterus tabl	Sibubog	2.8	847
	Decapterus russelli	Sibubog	2.5	756
	Decapterus maruadsi	Sibubog	2.1	635
Clupeidae	*Sardinella gibbosa*	Tunsoy	5.1	1543
	Sardinella lemuru	Tamban	4.6	1392
	Spratelloides gracilis	Bolinao	2.7	816
Engraulidae	*Encrasicholina punctifer*	Bolinao	1.8	544
Myctophidae	*Diaphus phillipsi*	Sirum-sirom	3.2	968
Priacanthidae	*Priacanthus macracanthus*	Kuwaw	2.1	636
Scombridae	*Auxis rochei*	Turingan bilugon	9.5	2876
	Euthynnus affinis	Turingan	4.2	1270
	Rastrelliger kanagurta	Kabalyas	3.6	1089
	Auxis thazard	Turingan lapad	3.1	937
	Rastrelliger faughni	Buraw	2.7	816
	Katsuwonus pelamis	Rayado	1.7	513
Sphyraenidae	*Sphyraena barracuda*	Baracuda	3.7	1119
Others	*Others finfishes < 1%*	--	27.7	8388
Total		**--**	**100**	**30,286.3**

DISCUSSION

A main effect of high fishing pressure as result of higher number of gear units is the reduction of average size of fishes. It is not common to observe such occurrence in tropical fish stocks such as those in the Philippines (Armada, 2004). Fishers continuously develop fishing gears in response to the changes in fish stock they exploit. One such adaptation is the modification of gear types into different variants e.g. troll line and drift gillnet to target specific group of fish. Likewise, most fishers will be using nets with bigger mesh sizes and will spend less time fishing. Pauly, (1998), as the stock becomes more exploited, as a consequence the fishes become progressively smaller while fishers adapt by making nets with smaller mesh sizes. This continues until fish depletion will force the fishers to use fine-meshed nets and spend more time fishing.

Philippine small pelagic fishery indicates overfishing. Supporting this was an observed change in species composition, i.e., anchovies have partially replaced sardines, scads and mackerels in the catch, an indication of gradual stock collapse. In Ragay Gulf, fishery production of 969.3 MT or 3% of its total production contributed by *Diaphus phillipsi* locally called "Sirom-sirom" deep water fish species with slight resemblance to anchovies (see; Table 5). Furthermore, since this species are the cheapest pelagic fish, the absolute value of total catch is beginning to decline. This vicious cycle of overfishing and deterioration of catch quality directly affected the fishers who rely primarily on fishing for subsistence and income. This situation drove them to fish even more for an ever-declining catch, a classic example of economic overfishing.

About 70% of the species of finfishes caught in Ragay gulf were subjected to exploitation of the major fishing gear types. Total fishery production of the gulf of 30,286.3 MT relative to the total area of 3,900 km^2 (Jimenez et al., 2006) with total fishing efforts of 1,404,711.9 trips per year showed that an average of 7.76 MT/ km^2 very low compared to adjacent fishing ground the San Miguel bay with 20,173.5 MT with total fishing efforts of 840, 960 trips per year showed 18.1 MT/km^2 (Hilomen et al., 2003). These higher fishing efforts equivalent to low fishery production suggested that the fishing ground was indeed overfished.

In the Philippines, comparison with recent production indicates the occurrence of biological and economic overfishing, particularly in coastal and traditional fishing grounds. Reports also showed a substantive reduction in catch rates from the early 1950s to the mid-1980s (Zaragosa et al., 2004). Furthermore, species-specific assessments of small pelagic fishes in various fishing grounds (Ingles and Pauly 1984; Corpuz et al. 1985; Lavapie-Gonzales et al. 1997) yielded very high exploitation ratios a clear manifestation of overfishing. Ragay Gulf is no exception to these fishery scenarios wherein the gulf is considered traditional fishing grounds for small pelagic. Collectively, these indicated that exploitation had reached levels which threatened the viability of small pelagic stocks. Assessments indicated the need to decrease fishing pressure by about 50-65%

(Dalzell and Ganaden 1990; Trinidad et al. 1993).

Silvestre and Pauly (2004), pointed out that high fish demand, burgeoning fishing populations combined with a lack of livelihood opportunities in rural areas, advances in fishing technology and accelerated industrial fisheries development have led to excessive fishing pressure and overfishing in many coastal areas. This had resulted in a leveling-off (if not decline) in landings; reduced catch rates, incomes and resource rents; and intense competition and conflict among fishers.

CONCLUSION

Ragay Gulf is characterized as entangling and handline fishery dominated by bottom set gillnet, drift gillnet, simple handline and multiple handline. Seasonality of gear types was evident and species dependent, major operation of most gear types occurs during the Northeast monsoon period except for some gear types e.g. handlines that capitalize on rough sea condition during southeast monsoon to increase catch. Catch rates and fishing efforts were indicative of higher exploitation level, similar rate to other heavily exploited fishing grounds in the Philippines. Fishery production relative to the area of the gulf clearly showed overfished fishing grounds.

REFERENCES

Armada, N.B. 2004. Size limits on fish caught, p. 202-205. In DA-BFAR (Department of Agriculture-Bureau of Fisheries and Aquatic Resources). In turbulent seas: The status of Philippine marine fisheries. Coastal Resource Management Project, Cebu City, Philippines. 378 p.

Corpuz, A., J. Saeger and V. Sambilay, Jr. 1985. Population parameters of commercially-important fishes in Philippine waters. College of Fisheries, University of the Philippines, Quezon City, Philippines. Tech. Rep. Dept. Mar. Fish. No. 6, 99 p.

Dalzell, P. and P. Corpuz, 1990. The present status of small pelagic fisheries in the Philippines, p. 25-51. In C.R. Pagdilao and C.D. Garcia (eds.) Philippine tuna and small pelagic fisheries: Status and prospects for development. PCAMRD Book Ser. No. 7, 160 p. Philippine Council for Aquatic and Marine Research and Development, Laguna, Philippines.

Fragillano, J.N., Crusio, R.I., Jimenez, L.F.F., Caylan, E., Hilomen, V.V., 1996. Resource and Ecological Assessment of Ragay Gulf, Terminal Report. University of the Philippines Los Baños Foundation, Inc., College, Laguna.

Hilomen, V.V., J. Fragillano, F. Torres Jr., C. Luna, J. Jovellana and R. Crusio. 2003. Post-RSA of San Miguel Bay: Fisheries component. Project Report submitted to the Fisheries Resource Management Project, Department of Agriculture. SEAMEO Regional Center for Graduate Study and Research in Agriculture, Laguna, Philippines.

Ingles, J. and D. Pauly. 1984. An atlas of the growth, mortality and recruitment of Philippine fishes. ICLARM Tech. Rep. 13, 127 p.

Jamir, T.V., 1990. The Marine Biogeography of Ragay Gulf and Burias Pass, Philippines. Unpublished Master's Thesis, Department of Geosciences, Colege of Science Oregon State University Corvalis, Oregon.

Lavapie-Gonzales, F. S., R. Ganaden and F.C. Gayanilo, Jr. 1997. Some population parameters of commercially-important fishes in the Philippines. Bureau of Fisheries and Aquatic Resources, Quezon City, Philippines. 114 p.

Pollnac R, Pomeroy R, Harkes I., 2001 Fishery policy and job satisfaction in three Southeast Asian fisheries. Ocean Coastal Manage; 44:532–44.

Muallil RN, Geronimo RC, Cleland D, Cabral RB, Doctor MV, Cruz-Trinidad A, et al., 2011. Willingness to exit the artisanal fishery as a response to scenarios of declining catch or increasing monetary incentives. Fish Res;111(1):74–81.

Muallil RN, Cleland D, Aliño PM., 2013. Socioeconomic factors associated with fishing pressure in small-scale fisheries along the West Philippine Sea biogeographic region. Ocean Coastal Manage; 82:27–33.

Pauly D, Watson R, Alder J., 2005. Global trends in world fisheries: impacts on marine ecosystems and food security. Philos Trans Roy Soc B: Biol Sci;360 (1453):5–12.

Pauly, D. 1988. Some definitions of overfishing relevant to coastal zone management in Southeast Asia. Trop. Coast. Area Manage. 3(1): 14-15.

Smith TD., 1994. Scaling fisheries: the science of measuring the effects of fishing, 1855–1955. Cambridge University Press; 412.

Silvestre, G., Pauly, D., 2004. Management of tropical coastal fisheries in Asia: An overview of key challenges and opportunities, p. 150-167. In DA-BFAR (Department of Agriculture-Bureau of Fisheries and Aquatic Resources). In turbulent seas: The status of Philippine marine fisheries. Coastal Resource Management Project, Cebu City, Philippines. 378 p. (ICLARM Contribution No. 1379)

Trinidad, A.C., R.S. Pomeroy, P.V. Corpuz and M. Aguero. 1993. Bioeconomics of the Philippine small pelagic fishery. ICLARM Tech. Rep. 38, 74 p.

Appendix A. Number of Gear Units Per Fishing Gears Types Identified per Municipalities in Ragay Gulf

Fishing Gears		Municipality											Total
English Name	Local name	Bato	Balat.	Bula	Minal.	Sn Fer.	Pasac	Sipoc	Lupi	Ragay	del Gal	Sn Pas.	
Entangling nets													
Bottom-set gill net	Panke-palubog	44	16	40	28	31	152	35	50	173	61	248	878
Bottom-set gill net	Rabnot		2										2
Trammel net	3-ply	3					1			7	52	76	139
2-ply	2-ply	10										40	50
Gill nets for crabs	Pangasag	35	13	5				15		6	12	31	117
Drift gill net	Panke-palutang	38	45		10		15	5	9	59	9	72	262
Drift gill net	Largarete	30	25	7	11	6	15			3	4	62	163
Drift gill net	Barangay	10	26	3	1					6			46
Drift gill net	Kurantay			5			15						20
Drift gill net	Patitig											7	7
Drift gill net for halfbeaks	Bugkat (Pambugiw)	4	3	1	2					1	1	1	13
Drift gill net	Pangkanoos					2						70	72
Encircling gill net	Patalang						3			21			24
Handlines													
Simple handline	Kawil	55	175	32	30	7	61	25	30	171	64	278	928
Multiple troll line	Rambo	12	18	8	20		15					210	283
Troll line	Kasikas	15	130		80	70	20		15	60		145	535
Pole and line	Bigawnan				20	15		5		25	54	50	169
Squid jigger	Tina-tina		25	11	3	60	6	10		103	3	221	442
Artificial bait (variable)	Buyod-buyod	21	39	10	23		3	3	5	45	73	65	287
Multiple handline	Og-og	20	165	25	160	100	155			108	1	180	914
Longlines													
Bottom-set long line	Kitang	5	117	5	36	31	84	7	5	47	5	194	536
Barriers and Traps													
Fish corral	Bunoan							19		21	84	57	181
Fish pot	Bobo Pansira				5		6		9	3	4		27
Crab pot	Bobo pangasag				15		6	15	10	36	30		112
Squid/cuttlefish pot	Bobo panglokus/kanoos	8	2		5	3	7	15		30	1		71
Impounding nets													
Push net	Pansilo	6	50	30	75	50				37	7	3	258
Crab lift net	Bintol (Kasag/Alimango)				15	0	5	0	1	1	2	9	33
Shrimp lift net	Bintol (pasayan)						3						3
Bagnet	Basnig									13			13
Beach Seine	Sinsuro	1	4	25	5		13					10	58
Ring net	Kalansisi		10		7	1	8			3			29
Stop Seines	Pangulong		3				1						4
Spear													
Spear gun at night	Flashlight		5	5	24	8			12	7	5	215	281
Spear gun	Pamana	2	2	6	10		11		12	6		65	114
Spear	Salapang with light										3		3
SPGN using compressor	Pana-compressor								1	6		2	9
Miscellaneous hand instruments													
Gleaning	Panagun-has	53	130	30	32	50	30	20		108	51	210	714
Others													
Blast fishing	Putok									1			1
	TOTAL	372	1005	248	617	434	635	174	159	1107	526	2521	**7798**

Appendix B. Annual Fishing Trips of Fishing Gear Types in Different Municipalities in Ragay Gulf

Fishing Gears		Municipality (Trips/yr)											Mean
English Name	Local name	Bato	Balat.	Bula	Minal.	Sn Fer.	Pasac	Sipoc	Lupi	Ragay	del Gal	Sn Pas.	
Entangling nets													
Bottom-set gill net	Panke-palubog	453	137	304	162	227	349	113	672	314	174	227	285
Bottom-set gill net	Rabnot		145										145
Trammel net	3-ply	96					128			52	368	217	172
2-ply	2-ply	672								84		60	272
Gill nets for crabs	Pangasag	152	88	240				192		116	284	70	163
Drift gill net	Panke-palutang	178	139		98		279	90	224	122	150	128	156
Drift gill net	Largarete	176	148	112	102	85	280			122	160	145	148
Drift gill net	Barangay	236	198	112	60					84			138
Drift gill net	Kurantay			272			256						264
Drift gill net	Patitig											320	320
Drift gill net for halfbeaks	Bugkat (Pambugiw)	336	92	112	98					136	192	204	167
Drift gill net	Pangkanoos					68						336	202
Encircling gill net	Patalang						280			153			217
Handlines													
Simple handline	Kawil	307	159	296	352	226	176	175	280	140	195	207	228
Multiple troll line	Rambo	236	153	168	544		144					160	234
Troll line	Kasikas	247	132		44	184	84		196	170		162	152
Pole and line	Bigawnan				224	68		20		141	61	96	102
Squid jigger	Tina-tina		72	56	52	148	176	85		141	32	203	107
Artificial bait (variable)	Buyod-buyod	136	80.75	68	90		84	102	120	130	130	153	109
Multiple handline	Og-og	401		232	202	108	172			141	288	216	220
Longlines													
Bottom-set long line	Kitang	56	123	112	151	166	245	60	192	141	157	191	145
Barriers and Traps													
Fish corral	Bunoan							83		248	218	207	189
Fish pot	Bobo Pansira				80		116		90	236	180		140
Crab pot	Bobo pangasag				80		96	271	90	102	180		137
Squid/cuttlefish pot	Bobo panglokus/kanoos	136	288		36	60	296	92		120	180		151
Impounding nets													
Push net	Pansilo	28	84	9	100	272				101	164	192	119
Crab lift net	Bintol (Kasag/Alimango)				56		96		240	84	144	94	119
Shrimp lift net	Bintol (pasayan)						204						204
Bagnet	Basnig									133			133
Beach Seine	Sinsuro	240	108	256	170		136					104	169
Ring net	Kalansisi		244		101	16	252			94			141
Stop Seines	Pangulong		168				208						188
Spear													
Spear gun at night	Flashlight		188	70	192	17.5			192	83	119	288	144
Spear gun	Pamana	40	188	63	192		136		192	137		276	153
Spear	Salapang with light										68		68
SPGN using compressor	Pana-compressor								80	62		80	74
Miscellaneous hand instruments													
Gleaning	Panagun-has	126	54	122	101	162	106	68		127	162	166	119
Others													
Blast fishing	Putok									32			32
	TOTAL	4252	2989	2604	3287	1808	4299	1351	2568	3744	3607	4502	**35009**

Appendix C. Catch Rate of Fishing Gear Types Exploiting Ragay Gulf

Fishing Gears		Catch rate (Kg/trip)		
English Name	**Local name**	**Min**	**Max**	**Mean**
Entangling nets				
Bottom-set gill net	Panke-palubog	5.4	14.1	9.5
Bottom-set gill net	Rabnot	5.4	14.1	9.5
Trammel net	3-ply	1.0	11.0	5.0
2-ply	2-ply	6.7	15.0	9.5
Gill nets for crabs	Pangasag	2.0	6.4	3.3
Drift gill net	Panke-palutang	7.9	54.6	23.1
Drift gill net	Largarete	8.0	65.0	26.0
Drift gill net	Barangay	7.9	54.6	23.1
Drift gill net	Kurantay	9.0	52.6	26.1
Drift gill net	Patitig	8.0	48.0	21.1
Drift gill net for halfbeaks	Bugkat (Pambugiw)	3.2	35.6	18.1
Drift gill net	Pangkanoos	5.4	44.8	25.1
Encircling gill net	Patalang	47.8	212.1	117.5
Handlines				
Simple handline	Kawil	4.5	13.4	7.3
Multiple troll line	Rambo	5.9	17.1	9.3
Troll line	Kasikas	4.9	14.1	8.3
Pole and line	Bigawnan	1.5	3.7	2.5
Squid jigger	Tina-tina	2.4	7.8	4.6
Artificial bait (variable)	Buyod-buyod	2.4	4.3	3.4
Multiple handline	Og-og	6.2	15.1	8.9
Longlines				
Bottom-set long line	Kitang	7.0	13.1	9.7
Barriers and Traps				
Fish corral	Bunoan	11.5	26.7	19.3
Fish pot	Bobo Pansira	3.7	11.0	6.9
Crab pot	Bobo pangasag	1.7	6.1	3.4
Squid/cuttlefish pot	Bobo panglokus/kanoos	1.8	4.2	3.0
Impounding nets				
Push net	Pansilo	5.9	87.6	32.8
Crab lift net	Bintol (Kasag/Alimango)	1.8	6.0	4.0
Shrimp lift net	Bintol (pasayan)	2.5	6.5	3.0
Bagnet	Basnig	20.0	85.0	38.1
Beach Seine	Sinsuro	8.1	281.6	79.8
Ring net	Kalansisi	30.0	324.7	175.1
Stop Seines	Pangulong	80.0	1000.0	435.8
Spear				
Spear gun at night	Flashlight	1.7	4.2	3.0
Spear gun	Pamana	0.6	3.2	2.0
Spear	Salapang with light	1.0	2.0	1.8
SPGN using compressor	Pana-compressor	2.3	83.0	38.1
Miscellaneous hand instruments				
Gleaning	Panagun-has	1.2	2.1	1.6
Others				
Blast fishing	Putok	5.5	12.5	8.75

Appendix D. Fishery Production of Various Fishing Gear Types per Municipalities in Ragay Gulf (MT)

Fishing Gears		Municipality											Total
English Name	Local Name	Bato	Balat.	Bula	Minal.	Sn Fer.	Pasac	Sipoc	Lupi	Ragay	del Gal	Sn Pas.	
Entangling nets													
Bottom-set gill net	Panke-palubog	74.16	30.86	70.40	61.52	33.51	435.33	28.20	666.40	370.32	281.54	735.07	2787.3
Bottom-set gill net	Rabnot		2.86										2.9
Trammel net	3-ply	2.74					1.61			2.52	92.11	91.39	190.4
2-ply	2-ply	26.04										26.00	52.0
Gill nets for crabs	Pangasag	10.88	15.96	3.58				6.89		3.24	6.79	6.14	53.5
Drift gill net	Panke-palutang	27.34	218.34		27.72		167.00	3.33	90.47	80.32	29.00	173.26	816.8
Drift gill net	Largarete	119.88	91.20	21.70	27.81	0.99	32.86			3.42	8.93	164.81	471.6
Drift gill net	Barangay	381.36	313.72	13.02	1.03					22.82			732.0
Drift gill net	Kurantay			175.10			371.35						546.4
Drift gill net	Patitig											132.28	132.3
Drift gill net for halfbeaks	Bugkat (Pambugiw)	16.86	7.30	3.36	0.51					3.38	4.93	2.81	39.1
Drift gill net	Pangkanoos					0.38						222.46	222.8
Encircling gill net	Patalang						3.50			825.31			828.8
Handlines													
Simple handline	Kawil	79.20	379.90	39.81	66.92	9.82	38.39	14.37	41.58	220.00	37.82	883.56	1811.4
Multiple troll line	Rambo	42.06	89.72	7.60	172.96		7.56					312.71	632.6
Troll line	Kasikas	10.75	135.78		30.76	53.34	3.84		11.55	108.44		134.04	488.5
Pole and line	Bigawnan				33.04	0.84		0.07		5.90	4.40	25.41	69.7
Squid jigger	Tina-tina		4.20	4.08	0.90	85.46	5.81	0.94		49.38	0.18	271.46	422.4
Artificial bait (variable)	Buyod-buyod	7.57	18.93	2.13	10.66		0.58	0.71	3.21	8.84	18.45	29.91	101.0
Multiple handline	Og-og	35.84	726.18	33.54	263.21	45.40	334.05			122.68	0.97	333.08	1895.0
Longlines													
Bottom-set long line	Kitang	2.86	285.76	4.20	196.54	89.84	552.09	2.52	9.79	56.13	7.71	514.48	1721.9
Barriers and Traps													
Fish corral	Bunoan							76.00		143.52	690.44	158.33	1068.3
Fish pot	Bobo Pansira				1.95		3.82		8.98	10.41	1.23		26.4
Crab pot	Bobo pangasag				3.38		2.38	7.52	4.13	14.15	18.68		50.2
Squid/cuttlefish pot	Bobo panglokus/kanoos	2.98	3.70		0.10	0.30	6.30	1.28		10.72	0.44		25.8
Impounding nets													
Push net	Pansilo	1.68	860.40	9.45	1773.25	2926.90				16.20	1.93	1.12	5590.9
Crab lift net	Bintol (Kasag/Alimango)				6.30	0.00	2.76	0.00	0.25	0.21	1.06	8.38	19.0
Shrimp lift net	Bintol (pasayan)						0.56						0.6
Bagnet	Basnig									238.36			238.4
Beach Seine	Sinsuro	52.80	120.55	3586.20	348.95		477.40					13.79	4599.7
Ring net	Kalansisi		886.34		145.68	0.57	362.24			86.99			1481.8
Stop Seines	Pangulong		2688.00				111.56						2799.6
Spear													
Spear gun at night	Flashlight		1.86	1.33	3.83	0.13			10.27	3.22	1.08	145.15	166.9
Spear gun	Pamana	0.11	0.21	0.70	5.40		1.22		10.18	1.08		38.27	57.2
Spear	Salapang with light										1.86		1.9
SPGN using compressor	Pana-compressor								1.32	1.74		13.37	16.4
Miscellaneous hand instruments													
Gleaning	Panagun-has	9.97	8.69	11.13	2.52	12.45	2.76	0.85		19.90	4.84	51.67	124.9
Others													
Blast fishing	Putok									0.28			0.3
TOTAL		905.1	6890.5	3987.3	3184.9	3259.9	2925.0	142.7	858.1	2429.5	1214.4	4488.9	**30286.3**

FishCoral-PRSA Management Information System for Ragay Gulf

Benedicto B. Balilo Jr
Ronnel R. Dioneda Sr.
Jayvee Christopher Vibar
Davie Balmadrid
Darell James Sy
Hannah Louis Maraña
Bicol University
Legazpi City

Balilo, B.B., R.R. Dioneda. J.C. Vibar, D. Balmadrid, D.J. Sy, and H.L. Marana. 2019. FishCoral-PRSA Management Information System for Ragay Gulf. Pp 112-138. In Dioneda R.R., E.E. Torres and G. Naz. (Eds). 2019. Participatory Resource and Socio-Economic Assessment of Ragay Gulf-Bicol Side. Terminal Report Submitted for the Fisheries, Coastal Resources and Livelihood Project, Department of Agriculture-Bureau of Fisheries and Aquatic Resources, Quezon City. Bicol University, Center for Policy Studies and Development, Legazpi City. 138 pp.

ABSTRACT

This study aimed to develop an information system to enhance the capability of providing updated information for resource and socio-economic assessment for Ragay gulf. The assessment parameters were used to develop the USE CASE diagram and database schema together with geographical information system (GIS) features to generate the referenced spatial location of target coordinates for corals, seaweed/seagrass and mangrove. The study used a descriptive and developmental model using Rational Unified Process (RUP). The GIS applications and API were used to develop the baseline map for sample target sites. The results showed that the developed system was able to systematically record and manage the assessment results. The use of GIS simplified the activities in locating and generating the coordinates of stations for corals, seaweed/seagrass, water quality, and mangrove assessments. The results of which shall be the basis in crafting the LGUs framework for coastal resource management (CRM). Additionally, the assessment results from various components were compiled and made available in this information system as ebook material. The system was evaluated based on the Black-box and White-box testing. Based on this evaluation, the internal and external characteristics of the developed system satisfied the standard functional system requirements. Thus, the system offers the features of information system and may serve as a model of future IS projects.

Keyword: *information system (IS), government project, GIS, software testing, ragay gulf*

INTRODUCTION

The purpose of this study is to develop and implement an information system that would serve as repository for resources and socio-economic assessments. The term Information system (IS) refers to software and hardware systems that operates as a whole and supports data-intensive applications. It is concerned with the design, modelling, algorithms and hosting of hardware for a system to run smooth [Information System, 2019]. The benefits of which provides user with updated information**,** leads to better business productivity and efficiency, better decision making, better communication and better data and better knowledge of customer needs. Also, this provides the building blocks for the Government Information System Projects (GISP). This covers the projects under the ICT developments of our country. The Public Services Information System (PSIS) and Electronic Procurement System (EPS) to name a few, provides users with a range of government services and information useful to the public in a fast and convenient way (Strategies and Solutions, n.d). In general, IS can perform multiple tasks all at the same time which increases efficiency and productivity (Babaei & Beikzad, 2013).

Some literatures integrated the features of geographical information system (GIS) to capture and display spatial patterns. Maliene, Grigonis, et al. (2011) used GIS technologies into a single analytical model, in which diverse data are 'geo-referenced' to cartographic projections. This integration makes it easy for users to mark certain geographical locations with corresponding data needed for processing needed information. GIS have the ability to handle much larger databases and to integrate and synthesize data from a much wider range of relevant criteria than might be achieved by manual method (Wright & Bartlett, 2001). Although, there had been utilizations of various technologies, however, its implementations are limited only on system features not on the raw data of the project/program activities. Thus, this study aims to design and implement an information system model for project designed to capture the raw information of the project components aside from the important features like component information profiling and registration. The system may serve as a prototype concept for future project-based activities. It offers a user-friendly GUI (Graphical User Interface), easy access to system features not limited to CRUD management, updated data entry, provide GIS mapping to target sampling areas and printing solutions for prompt report requests. The Government in its efforts and pursuit to establish an electronic government in the country using development and innovations in ICT adopted a digital transformation strategy that will greatly improve the Philippines governance capability, socio-economic development and services to the people (Philippine Digital Transformation Strategy 2022).

The study aimed to design, develop and implement an information system for Ragay gulf that would help project stakeholders adopts an effective and efficient database management system for Ragay gulf. This paper used use case diagram, identify key components, and proposed an information system to improve data management and access to system features.

METHODOLOGY

The study used Rational Unified Process (RUP) an Agile methodology which relates on building the essential output requirements of the system. This methodology is based on set of building blocks and content elements, describing what is to be produced (artifacts), deals with a lifecycle that ends with a milestone. The key benefits of RUP is that it provides a specific plan for each step of the development process; helps prevent resources from being wasted and reduces unexpected development costs.

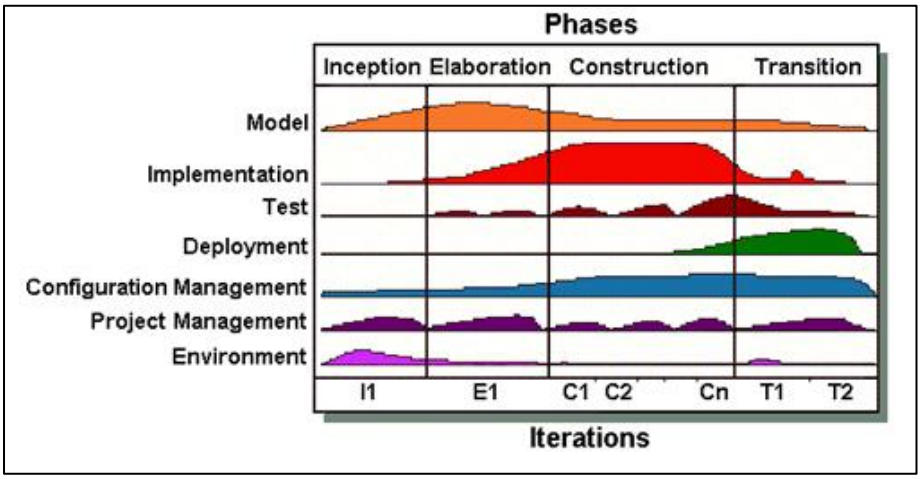


Fig. 1. Rational Unified Process Methodology
source: http://www.ambysoft.com

The researchers undertook the following phases of the methodology: Inception phase, for this phase, the researchers analyzed the existing studies and literatures, identify the opportunities, and project objectives. It was observed that existing systems has limited features in capturing important details (like raw data) and system that would keep present and future projects. Thus, these resulted to unsynchronized repository of data which means new project tend develop another new system. It is the intention of this project to address the identified problems and transform the same into opportunities to attain stakeholder's objectives. The opportunities are the situations observed in the existing studies and literatures. Guided by the objectives and deliverables stipulated in the project proposal, researchers have the clear understanding of the scope and objectives of the project. The researchers made an analysis on the survey instrument used and design the database schema. Some application programming language (API) for script and map rendering were analyzed and considered in the development process. Storyboarding was considered to pre-visualize the location of various objects such as text, pictures and other interactive media. In elaboration phase, the goal of this phase is to define and specify the baseline architecture of the system in order to provide a basis for the design and implementation in the construction phase. The architectural framework was dissected to give clear understanding of each requirement in the subsequent and development stage. The researchers used context flow diagram, data flow diagram, and use case diagram to analyze the system needs and its architectural components. The web architecture was considered including its features and sub-modules. The software/hardware specification was considered to make sure that the system accommodates the required system operation. The

construction phase, is the production process where emphasis is placed on developing and constructing the details of the system. This is where the finalized features and sub-modules worked functionally. The milestone of this phase includes the web interface modules, user management module, report generation and maintenance module. In the transition phase, this phase is focused on delivering the system into stakeholder implementation and the shift to link the system to stakeholder's web portal so that it would be available to the community. The presentation of the system at the stakeholder's meeting would help the researcher's fine tune the system and maybe ready for Alpha/Beta testing.

RESULTS AND DISCUSSION

User management and login module

This module allows the administrator of the system to control and manage user access and defined the role in the security domain. The system was broken down into sub-modules. These sub-modules comprised the user management, project assessment management, and map module. The user management consists of users and administrator who are controlled by security privilege (Fig. 2).

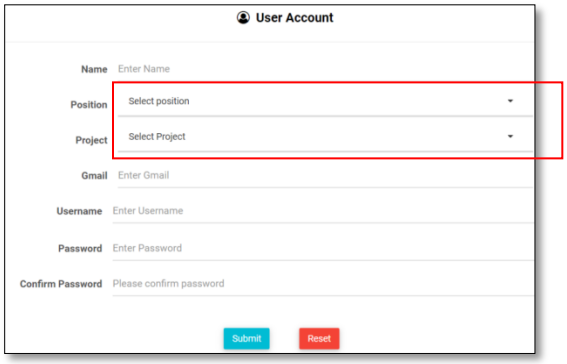


Fig. 2. User account interface

The system has provided user management which accepts details of user namely: full name, position, name of the project, email address, username, and password. The level of security privilege to the system depends on the position which shall be validated by the administrator upon registration. The user accounts are generated and managed by the administrator who controls the access and monitors the activities of the user when logged-in.

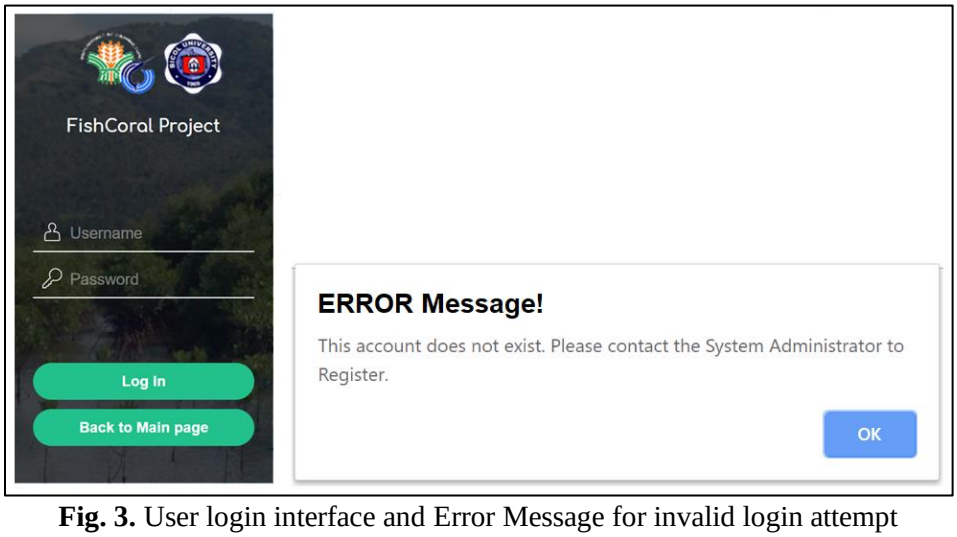


Fig. 3. User login interface and Error Message for invalid login attempt

Figure. 3 showed the user login screen, which shall prompt the user to enter the valid username and password and an invalid error message will be displayed for incorrect input. A user who has granted access shall have exclusive privilege over the information

and could perform data management. This served as a control mechanism to prevent other users from manipulating the information which may corrupt the data from improper usage (Fig. 4).

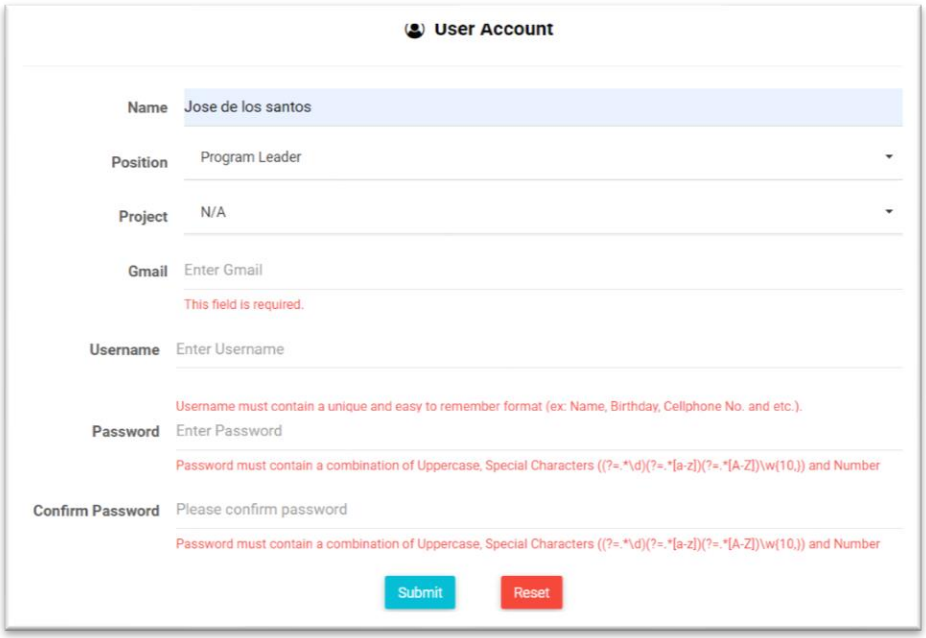


Fig. 4. Interface showing user account for valid and invalid user entries

It is important to record and monitor system status and operation. Figure 5 shows the history log interface which contains the log information of the users who accessed the system. This captures the username, date and time logged-in and the position.

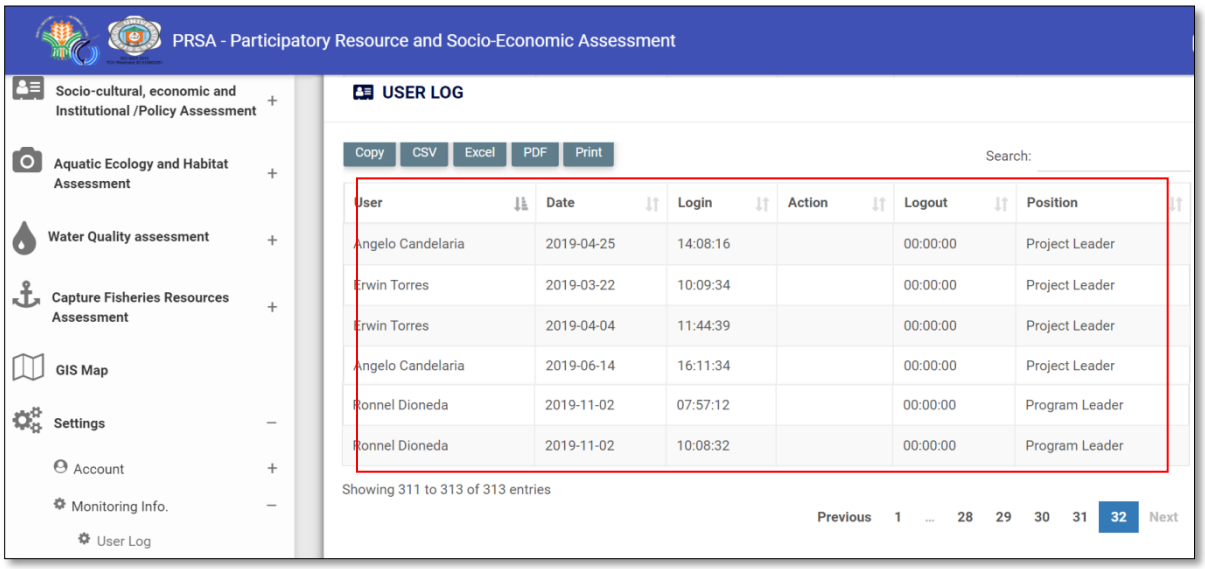


Fig. 5. History log interface

Project assessment management module

This module presents the assessment results, field activities, and infographics and factsheets. The features include socio-economic, aquatic ecology and habitat assessment, water quality, and capture fisheries assessment which has distinct interface and functionalities. Figure 6 shows a sample interface for aquatic ecology and habitat assessment. This interface has functionalities which showed the description of the project component, actual results gathered from different areas cities/municipalities along with corals, seaweed/seagrass, and mangrove.

Fig. 6. Interface of water quality showing the sample station, results and infographics

Additionally, the project management module has its feature showing pictures of the project team members. Using a light gallery plugin for jQuery, the images are fully responsive to dynamic transitions. The project management module is the user assessment sub-module which provides support to users in managing the assessment results. The user shall be allowed to perform CRUD management, view other component information and generate reports. The interface showing the user assessment sub-module was presented in Figure 7. The overall function of the module is to assist project leaders and administrators effectively managed the assessment results.

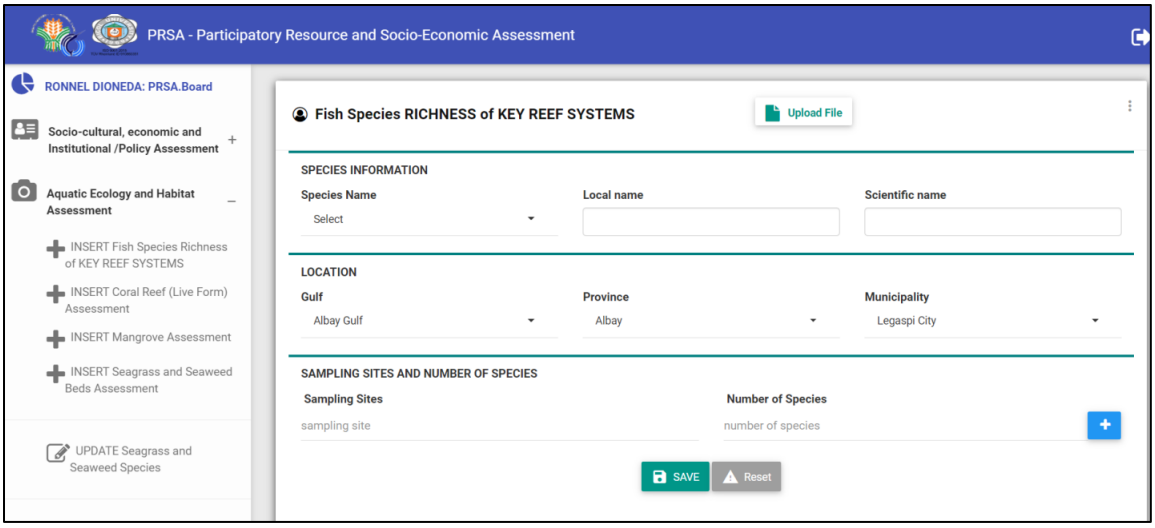


Fig. 7. Interface for adding fish species richness of key reef system in Ragay gulf

A customized feature for socio-cultural, economic and institutional policy, aquatic ecology and habitat, water quality and capture fisheries were designed to attain the objectives. Each component has its distinct features catering to the activities of the project. The management and control of assessment results are exclusive to registered users. However, information about other components shall be available for viewing only. Information shall be inputted and recorded per project component. The information displayed in the component results reflects the actual information stored in the database. The details are stored according to the summary results per Province, Municipality, and Barangay. Information shall be temporarily saved every after entry and shall be automatically saved to the master database after actual form submission. Thus, in the event of any unwarranted system occurrences, users could limit the effort in repeating their input and directly modify the saved record. This feature shall be true to all components to maximize the efforts in reducing the time for checking user entries.

In Figure 6, the interface for seagrass and seaweeds species allows the user to perform updates on existing information. Sometimes, we lose track of what we are doing and in many situations, we tend to go back where we started the process. The purpose of the update module is to keep track of the information and store the accurate details.

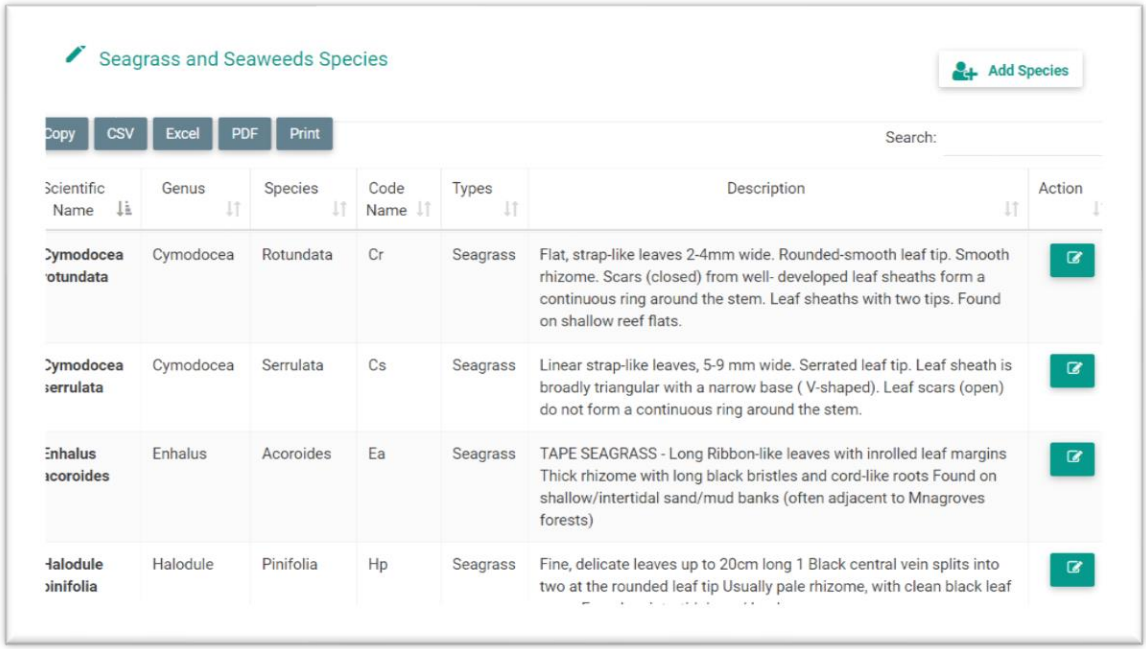


Fig. 8. Seagrass and Seaweeds species interface of Ragay gulf

It shall be observed that records on-display represents those species collected or found within Ragay gulf only. Similarly, records for water quality are arranged based on the date the records were submitted. Still, the records can be displayed in ascending or descending order (Fig. 9). The parameters recorded for water quality assessment results include pH, dissolved oxygen, temperature, conductivity, salinity, color, nitrate, phosphate, total suspended solids, and fecal coliform.

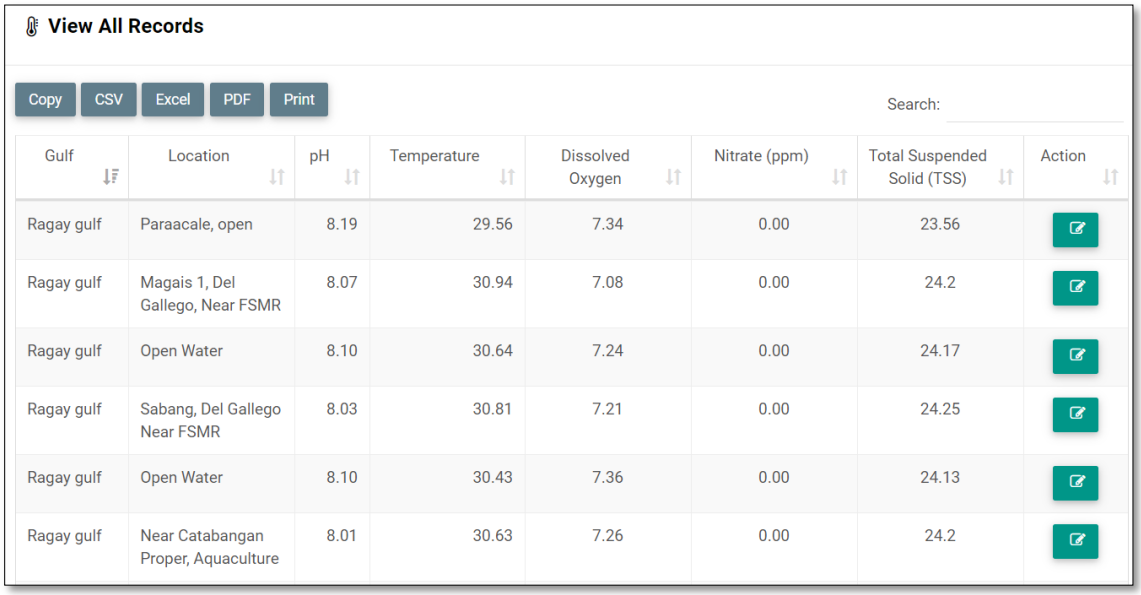


Fig. 9. Interface viewing water quality assessment

For capture fisheries and resource assessment, the system managed to record the details for catch and effort which includes gear inventory, catch rate and production. To enhance the process of recording, the researchers devised an approach which simplified the process. In the selection option, the gulf name shall be selected first which triggered the province, municipality, and barangay option to be in the automatic state. That is, this shall display the appropriate options managed by the program. The results from capture fisheries resource assessment include the fishing gear used per month and calculated catch rate. Thus, the user could navigate and provide options for the type of fishing gears used. The selections for fishing gears are in their local name (i.e. Baklad, Ispat, Kati (tina-tina), etc) (see Fig. 10). Entries should be in number values and negative values are also accepted. The system also recognizes NULL and zero entries for each parameter.

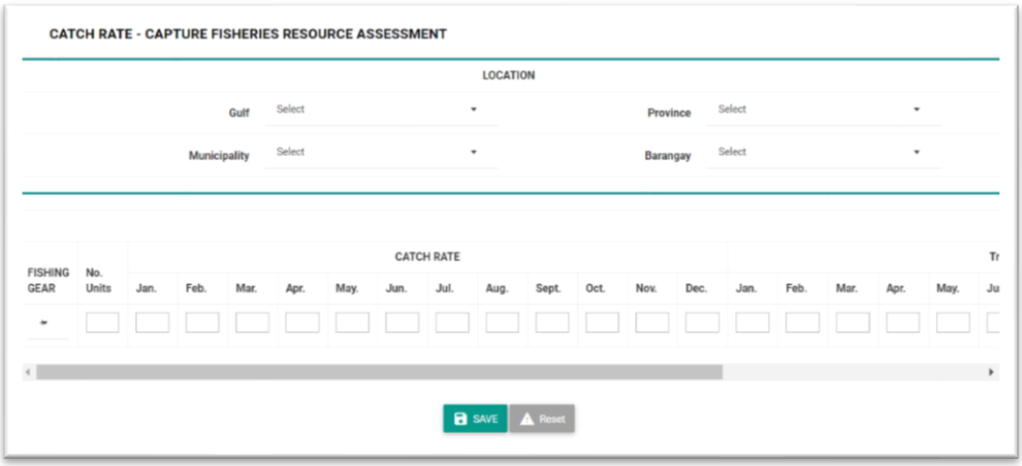


Fig. 10. Interface for adding catch rate per fishing gear per month

Report Generation

Report generation is an integral component of an information system. This improved the quality of providing accurate records, reduce errors, and minimize costs. The system makes use of the available tool to generate the reports in format with extension .xls, .pdf, .csv and direct printing. In Figure 11, a generated sample report for water quality was produced in Excel format.

Gulf	Location	pH	Temperature	Dissolved Oxygen	Total Suspended Solid (TSS)
Ragay gulf	Paraacale, open	8.19	29.56	7.34	23.56
Ragay gulf	Magais 1, Del Gallego, Near FSMR	8.07	30.94	7.08	24.2
Ragay gulf	Open Water	8.10	30.64	7.24	24.17
Ragay gulf	Sabang, Del Gallego Near FSMR	8.03	30.81	7.21	24.25
Ragay gulf	Open Water	8.10	30.43	7.36	24.13
Ragay gulf	Near Catabangan Proper, Aquaculture	8.01	30.63	7.26	24.2
Ragay gulf	Near MPA, open water	8.00	30.42	7.52	24.15
Ragay gulf	Near MPA, open water	8.03	30.53	7.43	24.09
Ragay gulf	Open Water	8.02	29.87	7.45	24.09

Fig. 11. Sample report generated in Excel format (.xls)

The values therein are the actual summary reports taken from the water quality report. In Fig. 12 shows the ready to print water quality report. The report was arranged based on the date the entries were inputted in the system and user preference. However, printing by preference shall be made before printing.

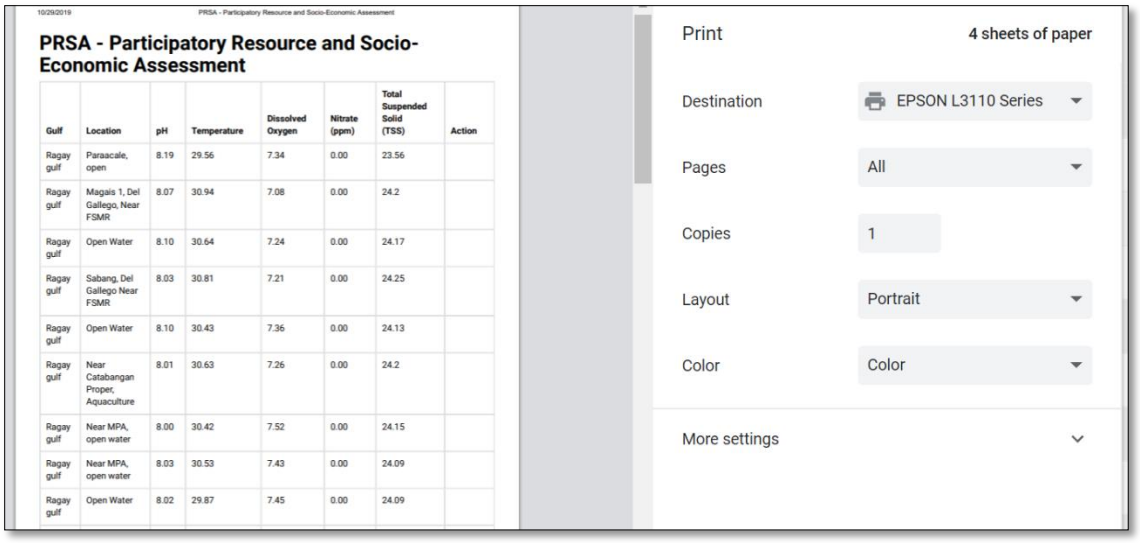


Fig. 12. Water quality print report window

An on-screen display report is another option that the system has provided. This feature is very common yet it gives prompt and direct output to the user. Fig. 13 shows the sample on-screen report generated for coral (live form). The major category percentage cover for Ragay gulf was presented. The total percentage comes from the actual values of hard coral, dead coral, soft coral, other organisms, algae, substrate, and TWB.

Fig. 13. Sample report generated for Coral (live form)

Along with other project components, this interface represents the main description which takes the overall appearance of the process. Simply means, selecting the accordion button would display the details of the target sampling site. In Fig. 14 shows an example

where details of mangrove assessment accomplished in Buyo, Legazpi City was presented. This gives the user a clear description of the mangrove species found, number of stand, density, relative density, and others. Also, the general comment was provided which gives the user updated information and opportunity for updates. A similar report interface was presented in Fig. 15 for capture fisheries resource assessment.

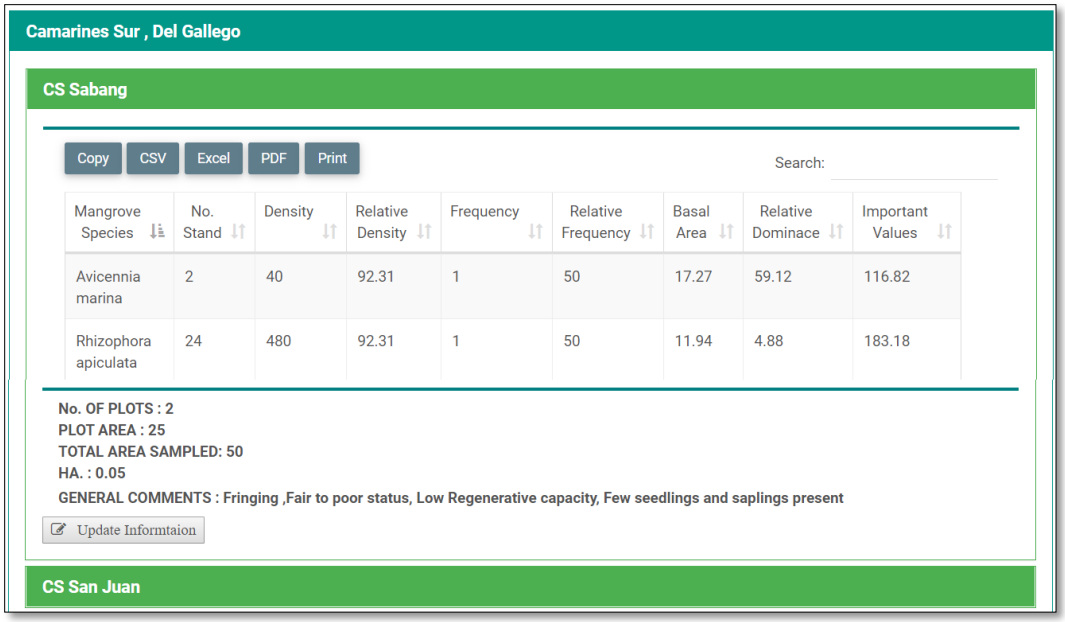


Fig. 14. Summary count, relative density, relative frequency, relative dominance and importance value

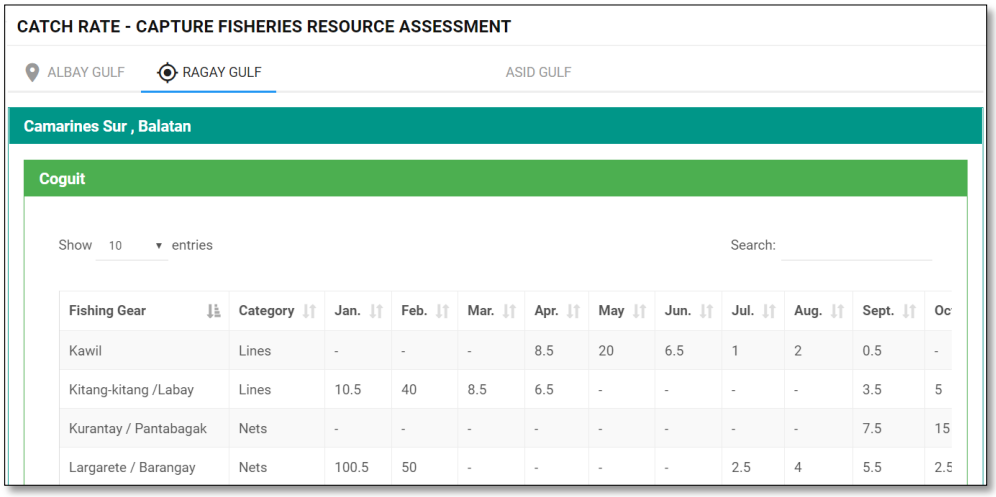


Fig. 15. Sample interface to display catch rate of fishing gear per month in Ragay gulf

Other information includes catch and fish landing statistics, catch per unit effort (CPUE) of fishing gears and fisheries production disaggregated to dominant species by Municipality and by fishing gears. Likewise, boat inventory is also included as part of the gear inventory which displays the types of fishing vessels used, gross tonnage, and

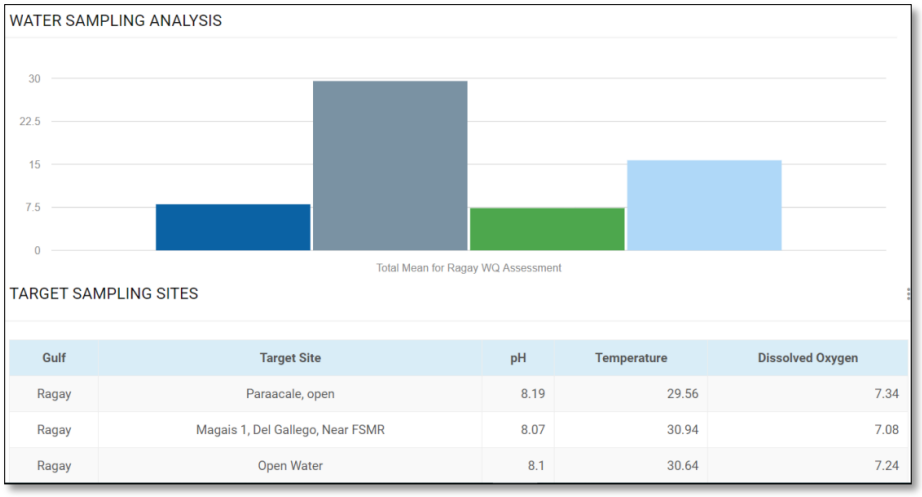
horsepower per Municipality. While, in SW/sg, the scientific name of species, percentage covered and average biomass was presented in tables (Fig. 16).

AVERAGE COVER AND BIOMAS

Scientific Name	Cover (%)	Biomas
Cymodocea rotundata	19.32	54.18
Cymodocea serrulata	5.97	13.64
Enhalus acoroides	12.89	274.55
Halodule pinifolia	16.19	160.00
Halodule uninervis	5.68	33.27
Halophila decipiens	0.28	3.64
Halophila minor	3.70	4.36
Halophila ovalis	4.12	14.73
Syringodium isoetifolium	24.29	75.82
Thalassia hemaprichii	8.67	122.91

Fig. 16. Sample results for average cover and estimated biomas (sw/sg)

In Fig. 17 shows the graph generated for water quality assessment. The parameters displayed include the color (TCU), Dissolved Oxygen (mg/L), Fecal coliform (MPN/100 ml), Nitrate as NO_3-N (mg/L), pH (range), Phosphate (mg/L), temperature (^oC) and Total Suspended Solids (TSS, mg/L). The data are collected in fifteen (15) sampling stations of Ragay Gulf with the use of geographic information system (GIS) map tool.



TARGET SAMPLING SITES

Gulf	Target Site	pH	Temperature	Dissolved Oxygen
Ragay	Paraacale, open	8.19	29.56	7.34
Ragay	Magais 1, Del Gallego, Near FSMR	8.07	30.94	7.08
Ragay	Open Water	8.1	30.64	7.24

Fig. 17. Graph showing water quality assessment in Ragay gulf

Geographical Information System (GIS)

The geographical information system (GIS) is not only a technological tool to gather, analyze, visualize spatial information and used to make intelligent decisions (Wright, 2011), but also a fully integrated environment for the management and analysis of spatial information (Caloz & Collet, 1998). It had been used as a standard tool for environmental assessment and analysis (Gonzalez, 2012), and the demand in government, industry, business and in educational settings (Learning to Think Spatially, 2006). In the system, the GIS application supports to facilitate map rendering and generated the coordinates of target sampling sites for corals, SW/sg, mangrove and water quality. Fig. 13 shows the location of some sample target sites in Ragay gulf using the Openstreetview map generated by leaflet API. The balloon marker indicates the covered areas in Ragay gulf.

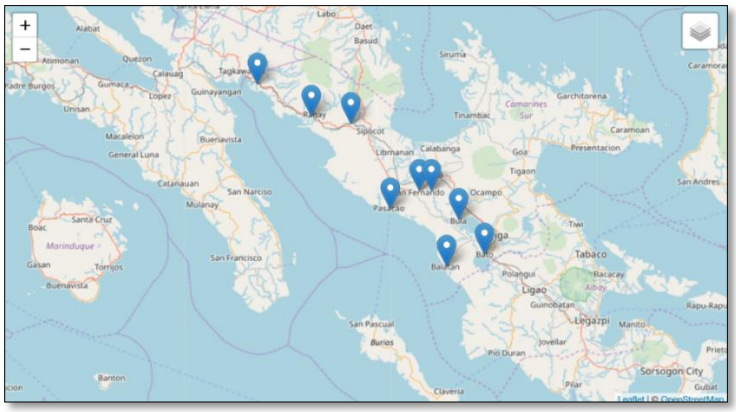
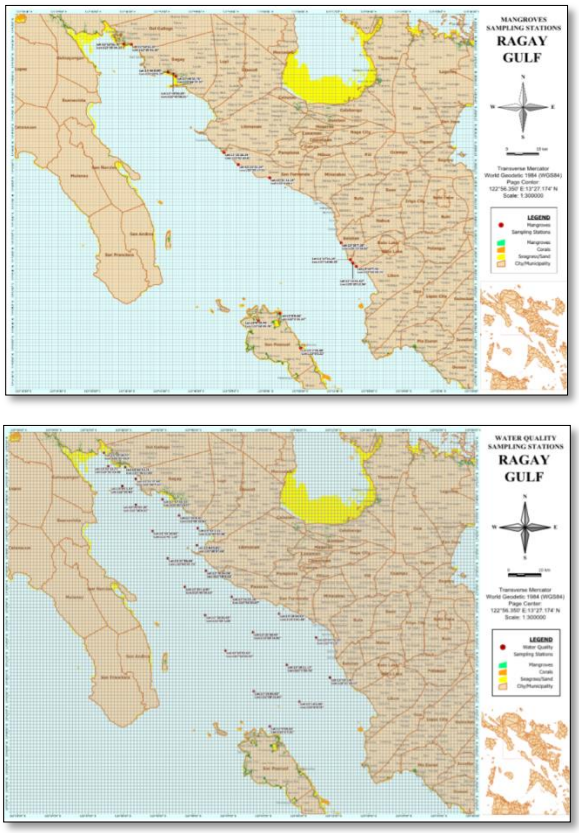


Figure 18. Generated GIS map with sample target sites

To use of GIS applications such manifold, NV, and ArcGIS to produce the map facilitated the generation of location/coordinates for corals, SW/sg, water quality, and mangrove, the researchers used some GIS applications (Fig. 19).

Fig. 19. Map showing the covered sample target sites for Ragay gulf

The generated image map produced by satellite reveals the coordinates and existence of mangrove (green color), corals (orange) and sw/sg (yellow) in Ragay gulf. These served as a baseline to identify the approximate location of the sample target sites. Project teams shall be guided and be able to come up with the best strategy to accomplish the objectives. This shall improve the planning strategy and predict possible precautionary measures before field actions (Fig. 20).



(a) mangrove sites (b) water quality sample target sites

Fig. 20. Sample GIS map displaying Mangrove target site location and coordinates

System Evaluation

The study used a software testing (white/black box testing) method to analyze and validate the internal structures and functionalities of the system components including the full visibility of the logic and code structures. Table 1 showed the results of branch testing after evaluating the test cases. The design of test cases was specific to procedures of the system.

Table 1. Results of Branch Testing with Test Cases

Test ID	Description	Actual Results
1	if not isset(var) display alert else register the variable as session	PASSED
2	read gulf if no Municipality or Barangay is active assign given area, if area is active then call a mysql query of said area then display the result	PASSED
3	execute sql query count the number of records per area do the loop assign the field variables to different parameters do the computation then divide the results by records count prepare the chart tables display the chart with values	PASSED

The study used branching and statement testing for white box testing to validate the specific requirement of the system. The local and global variables were used to determine the scope of the variables. These variables together with other parameters were used as a reference to execute the procedure. The identified test cases represent the majority of the processes involved in storing data entries, error message alert, SQL queries, collecting data values and transform these values into graphical representation.

Table 2. Results of Statement Testing with Test Cases

Test ID	Description	Actual Results
1	Assignment of labels as variables are related to project (*ie. gulf, temperature, transect, etc.*)	PASSED
2	Statement syntax and delimiters was appropriately applied	PASSED
3	Top-down coding approach was properly used	PASSED

A trial was conducted to determine the functionality of the system, specifically on the ability to determine authorized login request, assessment results, and generated map coordinates. In Black Box testing, results showed that the features of the developed system successfully attained the expected outputs (Table 3). This can be seen from the fact that upon testing, the user was able to manipulate the system and view the results of each component.

Table 3. Sample Results of Functional Testing

Test Case	Description	Expected Output	Next State	Results
Display username and password	S1	passed user level validation	S2,S3	accomplished
Invalid login attempt and display error message	S2	display error message	S1	accomplished
Display sub-module features	S3	access to features	S4, S5	accomplished
Access to use map features	S4	display target sites	S5	accomplished
User admin allowed to perform CRUD	S5	perform create, read, update and delete	S7	accomplished
Exit sub-module and return to main page	S7	confirmation window	S8	accomplished
Logout to system	S8	destroy sessions and close database	S1	accomplished

Furthermore, the results have accomplished the provision of user acceptability, interactivity, error messages and attained the expected output.

Infographics

The project aims to design infographics and factsheets based on the summary reports submitted by different project components. A total of four (4) infographics and six (6) factsheets were designed and presented before the stakeholder's meeting. It was observed that stakeholders are interested both in the system for dissemination to the community and infographics as IEC campaign materials. Some have suggested to allow them to access the system and download the materials. As feedback, the BFAR counterpart agreed to look into the possibility of linking the developed system into their existing system. Details of infographics are presented in Appendices.

CONCLUSIONS

The development of the system provided an opportunity to have a reliable and systematic information storage, archiving and management system for fisheries and coastal resource management. Test cases were tested and successfully passed the provision for user acceptability, interactivity and error messages. Also, the system successfully designed the interfaces for socio-economic, aquatic ecology, water quality, and capture fishery components. System access was successfully tested and provided security procedures for user requests. The results and findings are encouraging. Thus, there should be a more comprehensive data gathering tool that should be introduced to capture a wider range of parameters that affects coastal habitat and fisheries in different season, use data mining to analyze the reports of socio-economic trends and other components depending on given or acquired data sets, and develop a real-time collection of data through system integrated hardware devices.

REFERENCES

Babaei, M. & Beikzad, J. (2013). Management information system, challenges and solutions. European Online Journal of Natural and Social Sciences 2013. 2(3). 374-381. Retrieved from http://european-science.com

Caloz, R. & Collet, C. (1998). Geographic information system (GIS) and remote sensing in aquatic botany: methodological aspects. Aquatic Botany, 58, 3-4 (209-228). Retrieved from https://www.sciencedirect.com/science/article/pii/S0304377097000363

Information Systems (2019). *Author Information Pack*. Elsevier.

Gonzales, A. (2012, March). GIS in Environmental Assessment: A Review of Current Issues and Future Needs. Journal of Environmental Assessment Policy and Management, 14(1). Retrieved from https://www.researchgate.net/publication/254458404_GIS_in_ Environmental_Assessment_A_Review_of_Current_Issues_and_Future_Needs

Learning to Think Spatially (2006). Chapter 8. An Assessment of GIS as a System for Supporting Spatial Thinking in the K-12 Context. The National Academies of Sciences, Engineering, and Medicine, 166-314. Retrieved from https://www.nap.edu/read/11019/chapter/10.

Lozancic, A. (2016). Benefits of Software Testing. *Test & QA.* Retrieved from Gauss Development dated July 3, 2019.

Maliene, V., Grigonis, V., Palevičius, V., & Griffiths, S. (2011). Geographic information system: Old principles with new capabilities. *URBAN DESIGN International*, *16*(1), 1-6. doi: 10.1057/udi.2010.25

Strategies and Solutions. *Chapter 3.* Government Information Systems. Retrieved from http://www.neda.gov.ph

Wright, D., & Bartlett, D. (2001). *Marine and coastal geographical information systems*. London: Taylor & Francis.

Pradhan, S.K. (2013). IT Architecture Design Framework: ADMIT. Retrieved from https://www.infoq.com/articles/admit-architecture-framework/

Wright, D. (2011, January). GIS for the Oceans. ESRI. Retrieved from https://www.esri.com/library/bestpractices/oceans.pdf

APPENDIX A

Socio-cultural, Economic, Institutional and Policy Baseline, Livelihood Profile, and Coastal Resources Management (CRM) in Asid, Albay and Ragay (Bicol Side) Gulfs.

STATUS OF CORAL REEFS AND ASSOCIATED FISHES IN RAGAY GULF

Profile of MPAs in Ragay Gulf (hectares)

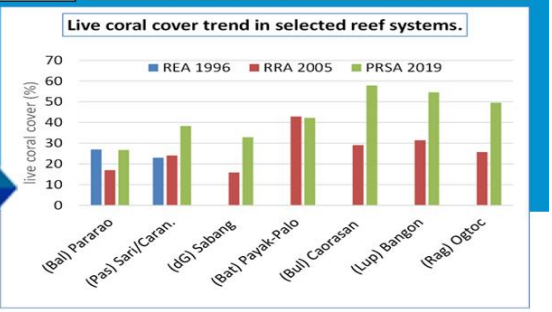
Municipality	Area in Hectares				Mun. Water Protection
	Mun. Water	Total Area	Sanctuary	Reserve	
Bato	7,779	78.79	78.79		1.01
Balatan	10,654	166.00	61.00	105.00	1.56
Bula	9,141	30.00			0.33
Minalabac	6,973	126.20	102.40	23.80	1.81
San Fernando	6,791	141.80	48.40	93.40	2.09
Pasacao	47,300	144.00	63.00	112.00	0.30
Libmanan	26,918				
Sipocot	659	140.00	40.00	100.00	21.24
Lupi	2,092	54.00	54.00		2.58
Ragay	30,460	98.55	68.48	30.07	0.32
del Gallego	7,604	526.00	18.00	508.00	6.92
San Pascual	142,982	1139.00	65.00	1074.00	0.80
Total	**299,353**	**2644.34**	**599.07**	**2046.27**	

Round-up of Live coral cover.

Municipality	MPA		non-MPA	
	min	max	min	max
Bato	42.24	43.06		
Balatan		26.24	31.76	55.28
Bula	57.88			
San Fernando	34.71			
Minalabac	38.32	54.10		
Pasacao	50.50	55.44		
Lupi	54.62	57.30		
Ragay	49.56	54.37		
del Gallego	32.90			
San Pascual	25.48	35.48	49.84	54.02
Overall	**25.48**	**57.30**	**31.76**	**54.02**

- Reef systems are in Fair to good Condition (28-50+% LCC)
- Near to half of transects in MPAs are in good condition
- MPAs do not necessarily have the best reef systems

Some baselines (REA,1996 and RRA, 2005)show coral reefs of Ragay Gulf have been covering



Diversity, abundance and biomass of reef fishes in Ragay Gulf.

MPA/Reef	Municipality	Species	Fish No.	Biomass (kg)
Pas (Sarimao)	Pasacao	31	809	30.73
Pas Tinalmod	Tinalmod	27	703	29.36
Bangon	Ragay	33	689	26.76
Caorasan	Bula	23	489	25.48
Gnaran	San Fernando	31	546	12.11
Tinalisayan (non MPA)	San Pascual	34	501	10.82
Payak	Bato	23	187	7.76
Pararao	Balatan	22	193	7.54
Sabang	Del Gallego	24	198	6.91
Busing	San Pascual	21	481	6.56

High fish biomass in most reef systems
Less diverse fish assemblage
Dense fishes in most reefs
Major group dominates but "Targets" are relatively high.
Diminishing grazer is bad to reef systems

ALBAY GULF VS. RAGAY GULF

	Albay Gulf	Ragay Gulf
Biomass (kg/250m^2)	2.5-14	6.56-31
Diversity	15-43	21-33
Fish Density (pcs/m^2)	0.64-2.6	0.7-3.2

CONCLUSION

The coral reefs of Ragay gulf are at Fair to Good condition. Some disturbances are still notable.
Some baselines (REA, 1996 and RRA, 2005) revealed improving state of Ragay gulf reef systems
Extent of coverage of MPAs is very minimal (0.8% of municipal water. There is then a need to reconfigure coverage of the MPAs.
Reef fishes is abundant, high in biomass but less diverse. The Pressence of target species is notable. Grazers are alarmingly low.
MPA networking and standardization of MPA management system could be explored.

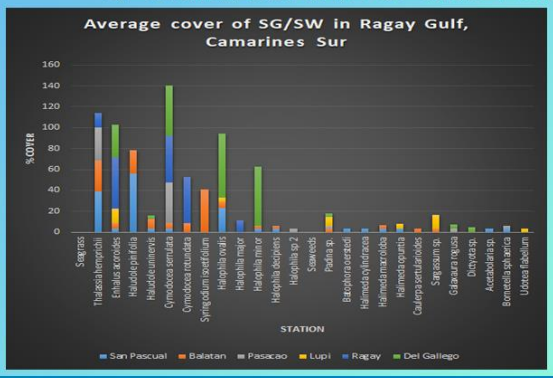
APPENDIX B

Aquatic Ecology and Habitat Assessment under BFAR Project Participatory Resource and Socio-Economic Assessment Factsheet

IFAD Investing in rural people

FishCORAL

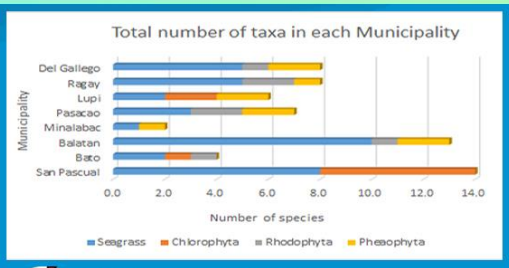
SEAGRASS AND SEAWEEDS ASSESSMENT IN RAGAY GULF



Most Abundant Seagrass (%cover)

60.80% - Halophila ovalis Del Gallego
56.25% - Haludole pinifolia San Pascual
48.87% - Enhalus acoroides –Ragay
41.00% - *Syringodium isoetifolium* – Balatan
39.10% - *Cymodocea serrulata* – Pasacao

Other recorded seagrass are *Thalassia hemprichii, Haludole uninervis, Cymodocea rotundata, Halophila major, Halophila minor, Halophila decipiens, Halophila sp 2.*



Number of species of seagrass and seaweeds in each Municipality

Municipality	Seagrass	Seaweeds
San Pascual	8	6
Bato	2	1
Balatan	10	4
Minalabac	1	1
Pasacao	3	4
Lupi	2	4
Ragay	4	0
Del Gallego	5	2

Threats to Seagrass/Seaweeds Beds in Ragay Gulf

Pollution - Plastic

Siltation

Habitat encroachment

Industrialization near coastal areas

CONCLUSION

Seagrass/seaweeds play a very important role in the marine environment.
Thallasia hemprichii and E. acoroides appeared in all stations while Sargassum sp. dominate Ragay gulf .
Cymodocea –Thalassia-Halophila mixed species were observed an indication of a productive ecosystem for both fin fishes and macro-invertebrates.
Heavy siltation was observed in the gulf which is due to erosion from road developments, conversion of coastal areas into industrialization or residential areas and dreading which caused seagrass/seaweeds beds continuous condition decline along the gulf.

APPENDIX C

Participatory Resource and Socio-Economic Assessment (PRSA)
in ALBAY, RAGAY and ASID GULFs

Mangrove Assessment

IFAD INTERNATIONAL FUND FOR AGRICULTURAL DEVELOPMENT

FishCORAL

Implementing Agency : Bicol University, Center for Policy Studies and Development
Collaborating Agencies : PSU, MIFT, CASIFMAS, and RNAFS

Mangrove Target Sampling Sites
- San Juan
- Sabang
- Halabang Baybay
- Pinamasingan
- San Rafael

STATUS of MANGROVES IN RAGAY GULF?

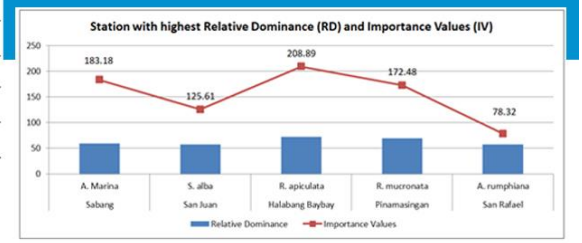
Mangrove species found in the areas of Ragay Gulf

- *Avicennia marina* (Bungalon)
- *Rhizophora apiculata* (Bakawan lalaki)
- *Sonneratia alba* (Pagatpat)
- *Ceriops ecandra* (Malatangal)
- *Osbornia octodonta*
- *Avicennia rumphiana* (Miapi)
- *Rhizophora stylosa* (Bakawan Bato)
- *Rhizophora mucronata* (Bakawan Babae)

Diversity of Mangrove in Ragay Gulf

Municipalities	Mangrove	No. of Trees
Del Gallego (DG)	Sabang (SB)	2
	San Juan (SJ)	4
San Pascual (SP)	Halabang Baybay (HB)	2
	Pinamasingan (P)	2
Ragay (Ra)	San Rafael (SR)	6

Municipality		Type	Status	Regenerative capacity	Remarks
San Pascual	Halabang Baybay	fringing	good	low	few seedlings/saplings
	Pinamasingan	fringing	good	good	enough seedlings and saplings
Del Gallego	San Juan	fringing	good	low	few seedlings/saplings present
	Sabang	fringing	fair to poor	low	few seedlings/saplings present
Ragay	San Rafael	fringing, riverine	good	high	the number of adult vs seedlings/saplings is enough



Trees Stand and Basal Area

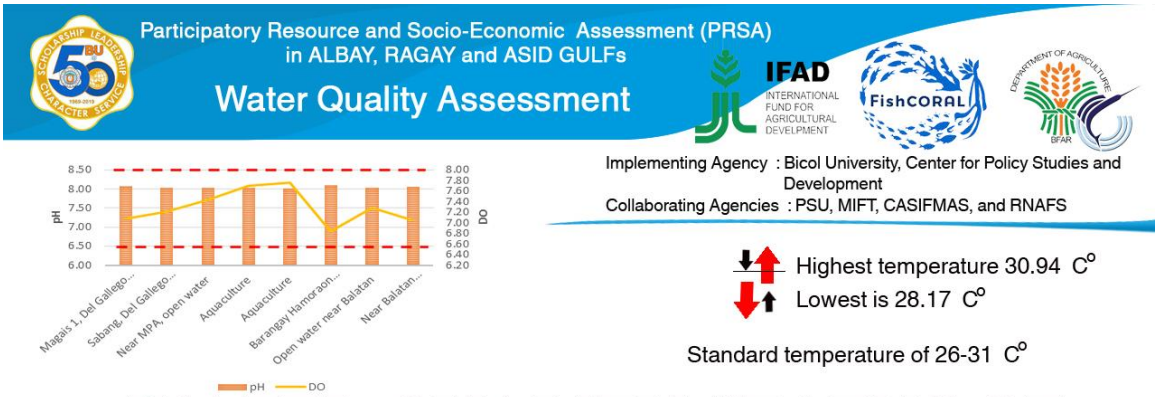
Mangrove Station	Trees	Total Basal Area (sq. ft.)
Sabang (DG)	26	29.21
San Juan (DG)	28	35.01
Halabang Baybay (SP)	47	45.32
Pinamasingan (SP)	43	32.81
San Rafael (RA)	12	4.61

San Pascual (Halabang Baybay and Pinamasingan) has the highest Relative Dominance and Importance Values with 142.1 and 381.37 respectively while San Rafael (Ragay) has the lowest.
These are mangrove areas inhabited with just Rhizopora species (3 species)

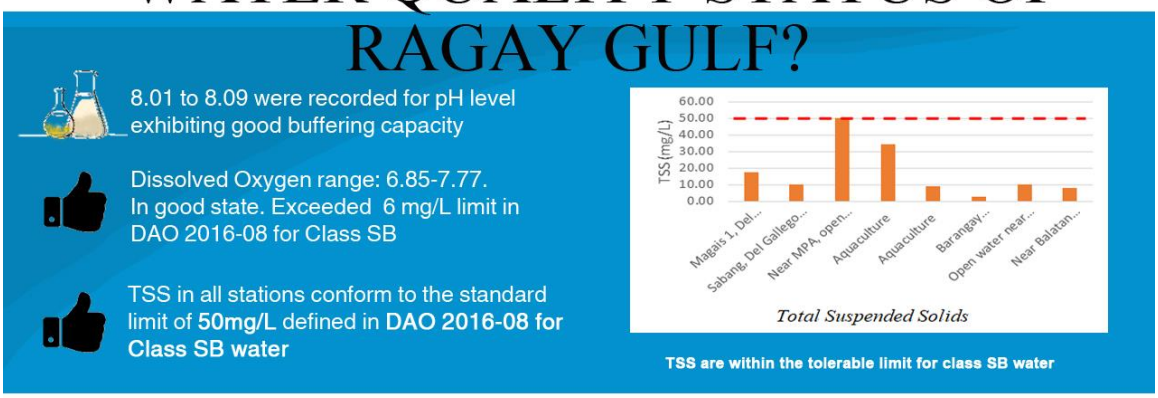
FINDINGS/CONCLUSION

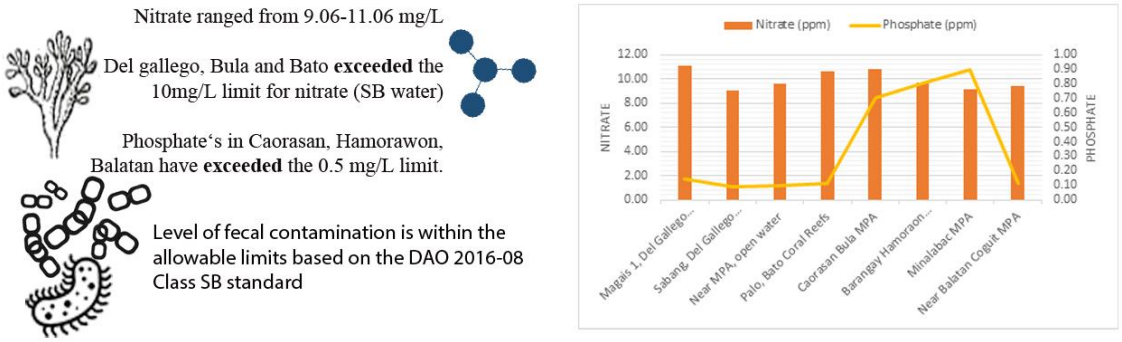
- Many mangrove areas are in poor condition so they are not covered in the full assessment.
- The five mangrove communities assessed are generally in good condition
- Presence of large mangrove areas converted into fishponds in Sabang and few in San Rafael
- San Rafael (Ragay) and Pinamasingan (SnPascual) have good-high regerative capacity. Others are poor.
- Some mangrove rehabilitation initiatives are done the wrong way. (encroaching seagrass beds)
- Low species diversity in rehab initiatives: only 1 or 2 mangrove species are used in reforestation
- Need continuous rehabilitation/restoration

APPENDIX D



WATER QUALITY STATUS OF RAGAY GULF?

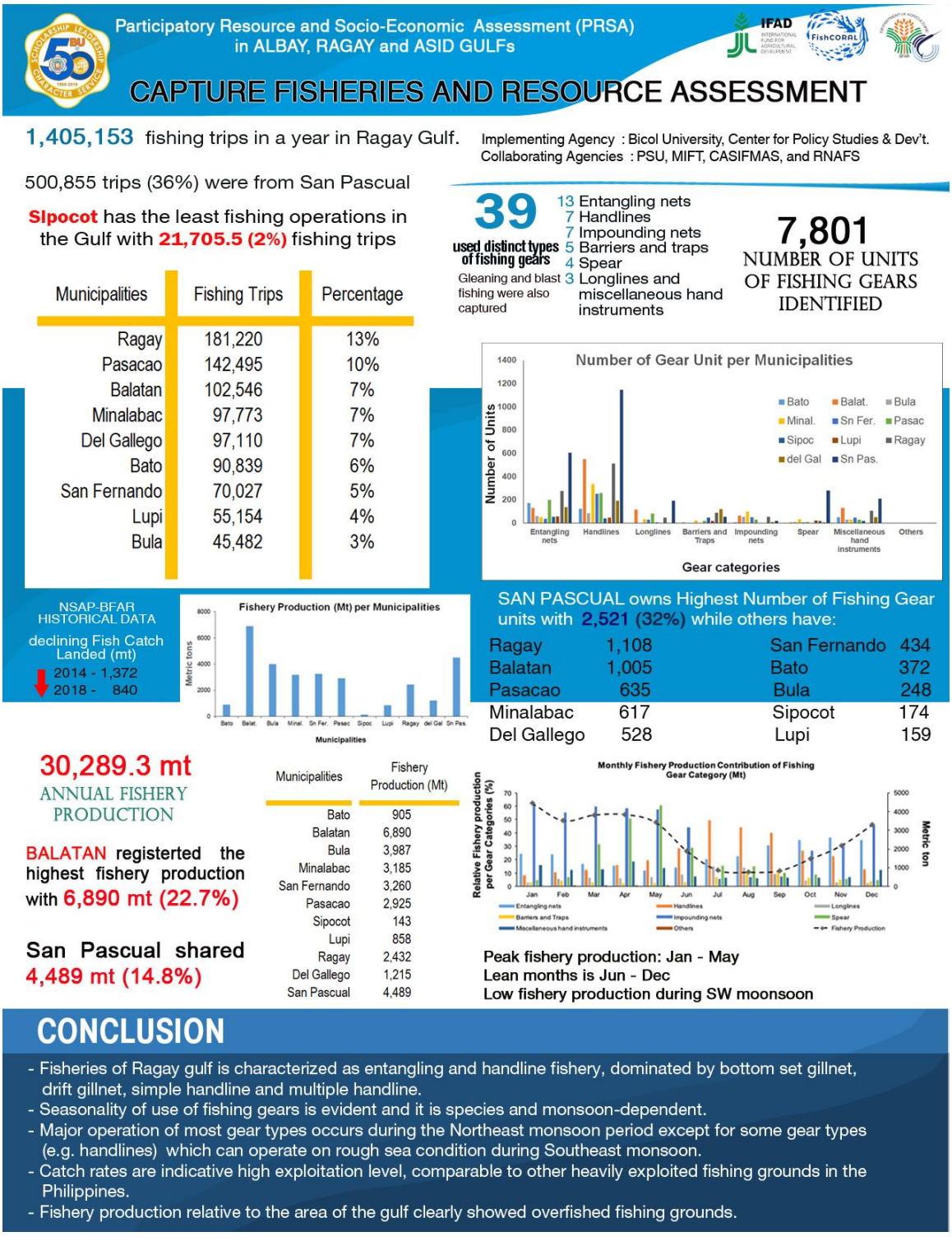




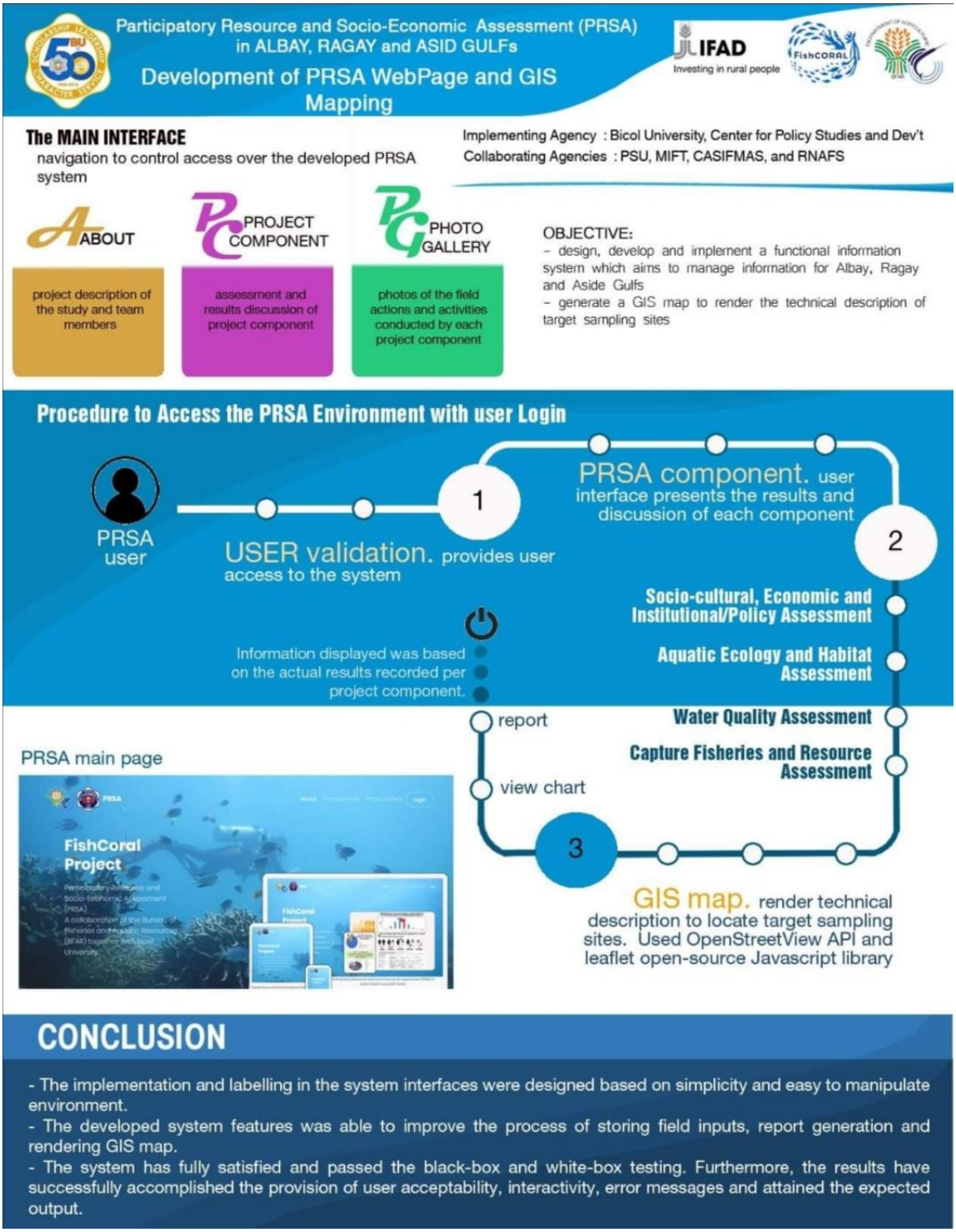
CONCLUSION

Temperature pH and Dissolved oxygen of waters of Ragay are in optimum levels and ranges
Nitrate and phosphate are within tolerable limit except to some stations which exceeded limits.
Areas with high nitrate coincided aquaculture zone (Del Gallego)
Total suspended and dissolved solids are within allowable imits
Fecal coliform were detected in all stations. Buts these are within tolerable limits for class SB water.
Generally, the water in Ragay Gulf is compliant to the standards set by DAO 2016-08 for SB classification of water.

APPENDIX E

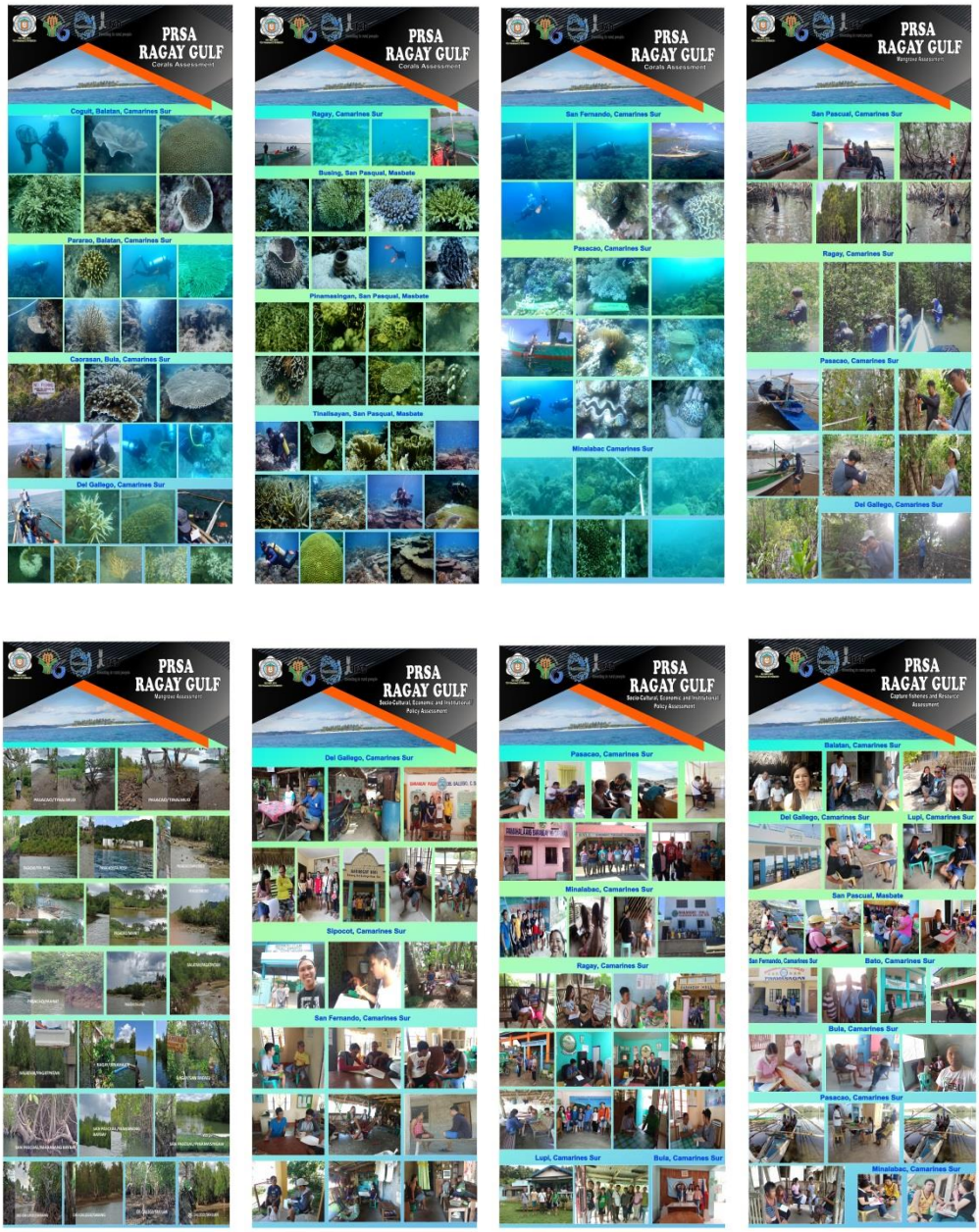

Participatory Resource and Socio-Economic Assessment (PRSA)
in ALBAY, RAGAY and ASID GULFs
IFAD
FishCORAL
CAPTURE FISHERIES AND RESOURCE ASSESSMENT
1,405,153 fishing trips in a year in Ragay Gulf.
Implementing Agency : Bicol University, Center for Policy Studies & Dev't.
Collaborating Agencies : PSU, MIFT, CASIFMAS, and RNAFS
500,855 trips (36%) were from San Pascual
Sipocot has the least fishing operations in the Gulf with 21,705.5 (2%) fishing trips
Municipalities | Fishing Trips | Percentage
Ragay 181,220 13%
Pasacao 142,495 10%
Balatan 102,546 7%
Minalabac 97,773 7%
Del Gallego 97,110 7%
Bato 90,839 6%
San Fernando 70,027 5%
Lupi 55,154 4%
Bula 45,482 3%
39
used distinct types of fishing gears
Gleaning and blast fishing were also captured
13 Entangling nets
7 Handlines
7 Impounding nets
5 Barriers and traps
4 Spear
3 Longlines and miscellaneous hand instruments
7,801
NUMBER OF UNITS OF FISHING GEARS IDENTIFIED
Number of Gear Unit per Municipalities
Number of Units
Bato Balat. Bula Minal. Sn Fer. Pasac Sipoc Lupi Ragay del Gal Sn Pas.
Entangling nets
Handlines
Longlines
Barriers and Traps
Impounding nets
Spear
Miscellaneous hand instruments
Others
Gear categories
NSAP-BFAR HISTORICAL DATA
declining Fish Catch Landed (mt)
2014 - 1,372
2018 - 840
Fishery Production (Mt) per Municipalities
Metric tons
Municipalities
SAN PASCUAL owns Highest Number of Fishing Gear units with 2,521 (32%) while others have:
Ragay 1,108
Balatan 1,005
Pasacao 635
Minalabac 617
Del Gallego 528
San Fernando 434
Bato 372
Bula 248
Sipocot 174
Lupi 159
30,289.3 mt
ANNUAL FISHERY PRODUCTION
BALATAN registerted the highest fishery production with 6,890 mt (22.7%)
San Pascual shared 4,489 mt (14.8%)
Municipalities | Fishery Production (Mt)
Bato 905
Balatan 6,890
Bula 3,987
Minalabac 3,185
San Fernando 3,260
Pasacao 2,925
Sipocot 143
Lupi 858
Ragay 2,432
Del Gallego 1,215
San Pascual 4,489
Monthly Fishery Production Contribution of Fishing Gear Category (Mt)
Relative Fishery production per Gear Categories (%)
Metric ton
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Entangling nets
Handlines
Longlines
Barriers and Traps
Impounding nets
Spear
Miscellaneous hand instruments
Others
Fishery Production
Peak fishery production: Jan - May
Lean months is Jun - Dec
Low fishery production during SW moonsoon
CONCLUSION
- Fisheries of Ragay gulf is characterized as entangling and handline fishery, dominated by bottom set gillnet, drift gillnet, simple handline and multiple handline.
- Seasonality of use of fishing gears is evident and it is species and monsoon-dependent.
- Major operation of most gear types occurs during the Northeast monsoon period except for some gear types (e.g. handlines) which can operate on rough sea condition during Southeast monsoon.
- Catch rates are indicative high exploitation level, comparable to other heavily exploited fishing grounds in the Philippines.
- Fishery production relative to the area of the gulf clearly showed overfished fishing grounds.

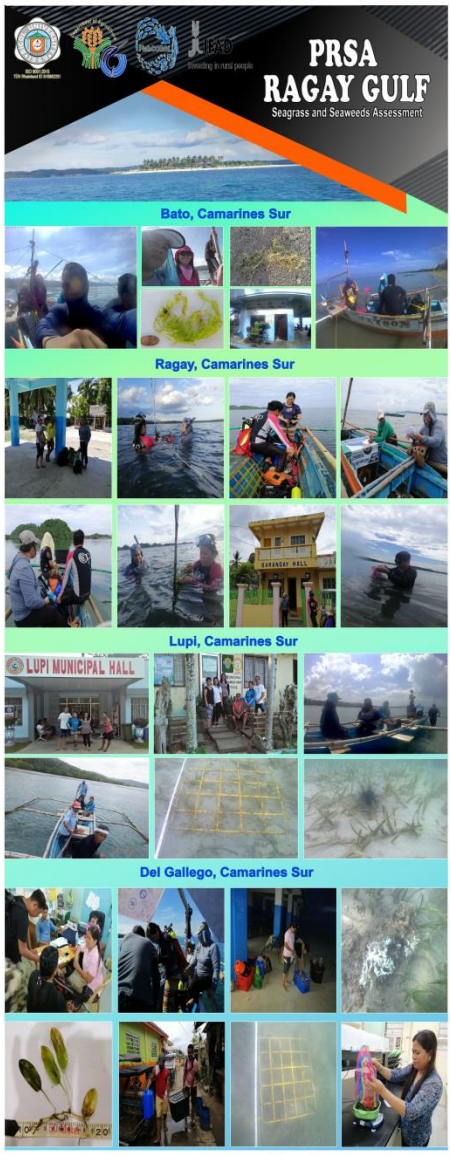
APPENDIX F


Participatory Resource and Socio-Economic Assessment (PRSA) in ALBAY, RAGAY and ASID GULFs
Development of PRSA WebPage and GIS Mapping
IFAD
Investing in rural people
FishCORAL
The MAIN INTERFACE
navigation to control access over the developed PRSA system
Implementing Agency : Bicol University, Center for Policy Studies and Dev't
Collaborating Agencies : PSU, MIFT, CASIFMAS, and RNAFS
ABOUT
project description of the study and team members
PROJECT COMPONENT
assessment and results discussion of project component
PHOTO GALLERY
photos of the field actions and activities conducted by each project component
OBJECTIVE:
- design, develop and implement a functional information system which aims to manage information for Albay, Ragay and Aside Gulfs
- generate a GIS map to render the technical description of target sampling sites
Procedure to Access the PRSA Environment with user Login
PRSA user
1
USER validation. provides user access to the system
PRSA component. user interface presents the results and discussion of each component
2
Socio-cultural, Economic and Institutional/Policy Assessment
Aquatic Ecology and Habitat Assessment
Water Quality Assessment
Capture Fisheries and Resource Assessment
Information displayed was based on the actual results recorded per project component.
report
view chart
3
GIS map. render technical description to locate target sampling sites. Used OpenStreetView API and leaflet open-source Javascript library
PRSA main page
FishCoral Project
CONCLUSION
- The implementation and labelling in the system interfaces were designed based on simplicity and easy to manipulate environment.
- The developed system features was able to improve the process of storing field inputs, report generation and rendering GIS map.
- The system has fully satisfied and passed the black-box and white-box testing. Furthermore, the results have successfully accomplished the provision of user acceptability, interactivity, error messages and attained the expected output.

APPENDIX G

Field actions of the different project components




PRSA
RAGAY GULF
Seagrass and Seaweeds Assessment
Bato, Camarines Sur
Ragay, Camarines Sur
Lupi, Camarines Sur
LUPI MUNICIPAL HALL
Del Gallego, Camarines Sur


PRSA
RAGAY GULF
Seagrass and Seaweeds Assessment
San Pascual, Masbate
Balatan, Camarines Sur
Minalabac, Camarines Sur
MINALABAC
Pasacao, Camarines Sur