SOCIO-DEMOGRAPHIC, ECONOMIC, INSTITUTIONAL AND POLICY BASELINES IN ALBAY GULF

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ABSTRACT

The study sought to provide socio-demographic, economic, institutional and policy baselines in Albay Gulf. There were 401 households randomly selected from the 83 covered barangays facing Albay Gulf. Results revealed that a majority (58%) of the fishing households were below the poverty threshold. A big percentage of households (43%) were also reported below the sustenance level, which means their income is hardly insufficient to meet at least the basic food needs. Despite that most of the households visited had access to electricity and owned a dwelling unit and tangible assets, access to safe and treated drinking water was yet to be solved. Community participation is also low in Coastal Resources Management (CRM), as reflected by the few households reported as members of people's organizations, such as fisherfolk organizations. Thus, to alleviate the standard of living of the fishing households, as well as increase their participation in CRM, efforts can be done in the form of livelihood interventions, conditional cash transfers, and capability building programs to economically, socially, and environmentally empower them.

Keywords: Albay Gulf, fishing households, socio-economic baseline, poverty threshold

INTRODUCTION

The fisheries sector plays a vital role in any economy specially in reducing hunger and poverty and achieving food and nutrition security. In particular, the fishers' contribution extends from the household level for food and livelihood to the industries who source out raw materials from them for further processing and commercialization. However, based on the 2015 estimate by the Philippine Statistics Authority (PSA), fisherfolks are among the three sectors identified with the highest poverty incidence (34%), with children and farmers as the other two sectors. This is consistent with the previous data on poverty statistics in 2006 (41%), 2009 (41%), and 2012 (38%). In 2016, the Philippines ranked 8th among the top fish producing countries in the world with its total production of 4.2 million metric tons of fish, crustaceans, mollusks, and aquatic plants (including seaweeds). This is 2% of the total world production of 202.2 million metric tons. In terms of value, this translates to P228.9 billion (Philippine Fisheries Profile, 2017). With such irony in the data and the true value of the fisheries sector, targeted development policy and programs aiming to promote sustainability, increase productivity, and improve the livelihood of small-scale fishers must be in place but by no means should jeopardize the natural resources and environment.

In any intervention made, either in a form of policy or program, it is of prime importance to establish baseline data. Following this initial step, planning will be easier and the evaluation stage of future interventions will be guided. In the fisheries sector, relevant statistics are disseminated by the Bureau of Fisheries and Aquatic Resources through the annual Philippine Fisheries Profile. Growth in fisheries in terms of production, export, and import are updated every year. However, in terms of the number of persons employed in the sector, the country's latest recorded data was last published in the 2016 Philippine Fisheries Profile and was based on National Statistics Office 2002 census for fisheries. Nationwide, there were a total of 1,614,368 fishing operators, with 16,497 from the commercial and 226,195 from the aquaculture sectors. With such outdated data, any policy decisions concerning this sector can lead to underestimation of the people or households that need intervention.

Thus, in this study, an assessment of the socio-demographic, economic, and institutional and policy of coastal fishing communities in the seven Local Government Units (LGUs) along the Albay Gulf was conducted. These LGUs were Legazpi City, Sto. Domingo, Bacacay, Manito, Bacon, Prieto Diaz, and Rapu-Rapu. This paper is divided into five parts. The first part discusses the socio-demographic characteristics of the respondents. This includes the structure and composition of study participants according to age, sex, marital status, educational attainment, and occupation status. The second part focuses on the household characteristics based on household size, age, marital status, and educational attainment of family members. Household members' engagement in fishing was also included in the discussion, as well as the illness history of family members. The third part describes the socio-economic characteristics of households based on gender roles in fishing. The fourth part gives an assessment of the economic standing of the coastal fishing communities in terms of property ownership, sources of income, expenditure items, and access to credit. Lastly, the existing laws and ordinances related to coastal resource conservation/protection in the coastal barangays

covered were analyzed in terms of the perceived enforcement level of the respondents, as well as the community involvement in coastal resource management.

OBJECTIVES

The study generally provides an assessment of the baseline data of households in the fishing sector along Albay Gulf. Specifically, the paper intended to:

1. Provide a socio-demographic, economic, institutional, and policy baseline of the households along Albay Gulf;
2. Analyze the socio-demographic characteristics of the respondents;
3. Assess the gender roles of households in fishing and other related economic activities;
4. Evaluate the economic situation of the households engaged in fishing; and
5. Assess the extent of implementation of existing policies related to coastal resource conservation and protection in the coastal barangays covered.

METHODOLOGY

This section provides the population and sample as well as the method of data collection and analysis used throughout the study.

Population and sample

The study covered 83 coastal barangays along Albay Gulf (Table 1). Of these, 22 barangays were from Sorsogon Province and 61 barangays were from Albay. Each barangay was represented by five randomly selected respondents that belonged to a fishing household. Thus, the expected total number of respondents was 415. However, there were cases when fishers already considered fishing as less of a priority in terms of source of livelihood. These barangays had one respondent (Pigcale, Legazpi City and San Francisco, Sto. Domingo), lacked one respondent (Centro Baybay and Victory Village North, Legazpi City; Del Rosario & Salvacion, Sto. Domingo; and Lupi, Prieto Diaz, Sorsogon), or lacked two respondents (San Isidro, Sto. Domingo). According to the barangay officials, most of their fishers shifted from fishing to being employed in the service and industry sectors, such as in construction. In addition, several refusals were encountered. Considering these circumstances and limitations, the study was able to consider only 401 respondents.

Table 1. Coastal Barangays Covered Along Albay Gulf, 2019

Province	City/Municipality	Coastal Barangays	Number of Respondents
Sorsogon	Bacon	Balogo, Bato, Bogña, Bon-ot, Buenavista, Caricaran, Del Rosario, Gatbo, Osiao, Poblacion, Rawis, Salvacion, San Juan, Sawanga, Sta.Lucia, Sto. Domingo, Sto. Niño, Sugod	90
	Prieto Diaz	Talisayan, Manlabong, San Ramon, Lupi	19
Albay	Bacacay	Mataas, Misibis, Sula	15
	Legazpi City	Arimbay, Bagacay, Banquerohan, Bigaa, Buenavista, Centro-Baybay, Dapdap, Homapon, Lamba, Maslog, Padang, Pigcale, Puro, Rawis, Sabang, San Francisco, San Roque, Victory Village (North), Victory Village (South)	89
	Manito	Balabagon, Buyo, Cabacongan, Cavit, Cawit, Holugan, It-ba Poblacion, Malobago, Manumbalay, Pawa, Tinapian, Cawayan	60
	Rapu-Rapu	Bagaobawan, Caracaran, Carogcog, Dap-dap, Lagundi, Liguan, Manila, Marocborocan, Pagcolbon, Poblacion, Santa Barbara, Tinocawan, Malobago, Bugtong, Batan	75
	Sto. Domingo	Buhatan, Calayucay, Lidong, San Juan Pob., Santo Domingo, San Vicente, Del Rosario, San Francisco, Salvacion, San Isidro, Pandayan Pob., Alimsog	53
		Total Respondents	**401**

Method of data collection

To facilitate the data collection, coordination with municipal and barangay officials was done prior to the activity. Then, simultaneous data collection was conducted. The questionnaire was divided into eight parts: (1) socio-demographic profile, (2) household members, (3) property ownership, (4) economic characteristics, (5) coastal resources management, and (6) community involvement.

Using the structured questionnaire approved by the FishCORAL Technical Committee of Bureau of Fisheries and Aquatic Resources Regional Office V (BFAR ROV), each field interviewer was assigned to do a face-to-face interview with the respondent which lasted for 25-30 minutes. For 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 made 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.

Method of data analysis

The data were analyzed using descriptive statistics. For the 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

I. SOCIO-DEMOGRAPHIC CHARACTERISTICS OF THE RESPONDENTS

This section provides the descriptive statistics of the socio-demographic profile of the respondents. Details on the characteristics of the study participants include the age structure, sex composition, marital status, and highest educational attainment. They are presented in Table 2 while the occupational status of the respondents are illustrated in Figure 1. For the purpose of this study, the term respondents were interchangeably used with the terms study participants and interviewees.

Age structure

A majority of the respondents (31%) interviewed were from 51 to 60 years old. This was followed by study participants who were 41-50 years old (24%), 31-40 years old (22%), and 61-70 years old (13%). There were respondents as young as 30 years old, but they only comprised 8% of the total sample. Some were 71 years old and above but they constituted the smallest percentage of the total sample (2%). The data imply that for most households visited, those members engaged in fishing activities were either nearing the age of retirement or even reached the age of 60. Thus, given the age structure of the respondents, which were mostly composed of fisherfolks, the fisheries sector in Albay Gulf might experience a shortage of labor in the next generations. Referring to the definition stated in R.A. 8550, fisherfolks are those who are directly or personally and physically engaged in taking and/or culturing and processing fishery and/or aquatic resources.

Composition of respondents according to sex

The majority of the study participants of the study were male (87%). Only 13% comprised the female respondents. The male interviewees were mostly the head of the family engaged primarily in fishing. However, in cases when the father was not available, the sons who were usually trained in fishing by their fathers served as the respondents. In times when any of the household member directly engaged in fishing was not available for interview, the housewife acted as the study participant.

Marital status of the respondents

As Table 2 shows, most of the respondents were married (87%), followed by single (10%), and those who were widowed, divorced, or annulled (3%). This suggests that most of the respondents had a family to support and sustain from their income, which they got mainly from fishing and other related economic activities.

Highest educational attainment

In terms of educational attainment, most of the respondents were elementary school graduate (40%). High school graduates composed 24% of the total sample, followed by those who reached the elementary (14%) and high school levels (14%), and by those who attained college level (2%) and graduated from college (3%). As it is a common situation among fisherfolks not to pursue higher education, it was not a surprise that there was no recorded data for post-baccalaureate degree among the households visited. On a positive note, only a small percentage of the study participants did not receive formal schooling (1%). This means that a majority of the households engaged in the fishing sector have literate members and have reached at least elementary level and graduated from college in rare cases.

Table 2. Characteristics of Respondents by Socio-demographic Profile in Albay Gulf, 2019

Socio-demographic profile	Frequency	Percentage
Age		
21-30	32	8
31-40	88	22
41-50	95	24
51-60	123	31
61-70	51	13
71-80	9	2
No response	3	1
Sex		
Male	348	87
Female	52	13
No response	1	nil
Civil Status		
Single	41	10
Married	347	87
Annulled	3	1
Divorced	4	1
Widower	5	1
No response	1	nil
Highest Educational Attainment		
No formal schooling	5	1
Elementary Level	57	14
Elementary Graduate	160	40
Highschool Level	57	14
Highschool Graduate	97	24
College Level	9	2
College Graduate	12	3
No response	4	1

Major occupation

Since the target participants of this study were residents of coastal barangays, it was anticipated that most of the respondents were full-time fishermen. Referring to Figure 1, it can be observed that a big percentage (84%) of the respondents worked as a full-time fisherman. The remaining 10%, on the other hand, were only part-time fisherman. This means that, aside

from fishing, some of the fishing household members had subsidiary occupations. They engaged in other economic activities, such as farming (3%), serving as barangay official (3%), and working as construction worker, carpenter, or laborer (3%). On the other hand, while a considerable portion of the respondents were part of the labor force, 6% of the study participants were housewives.

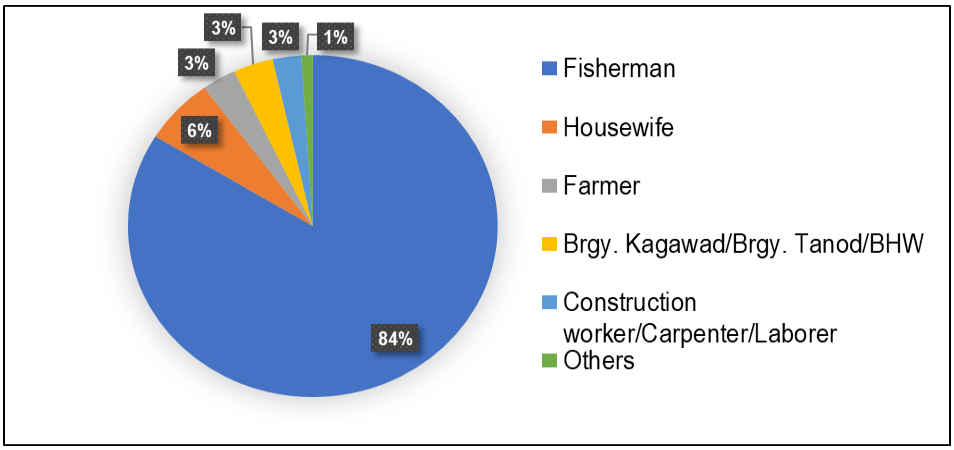

Figure 1. Major Occupation of Respondents

The occupational status of the fishing households in Albay Gulf suggests that fisherfolks still lack the to opportunities particularly in terms of employment and value-adding activities. Value-added products are food products presented in a more attractive and appetizing manner by using ingredients that will increase the quality and shelf life of the item, as well as through packaging and fortification. Seaweed, for instance, can be processed to produce crackers, pickles, and noodles (BFAR, 2017). In addition, aside from dried or smoked fish, fisherfolks can explore fish value-added products which can either be mince-based, battered or breaded, or surimi-based (Datta, 2013). Thus, programs or projects should ensure that access to alternative sources of income are being provided to them, specially that fishing is not a stable source of income.

II. HOUSEHOLD SOCIO-DEMOGRAPHIC CHARACTERISTICS

In this section, the socio-demographic characteristics of the fishing households were assessed. Similar presentation of data in the previous section were depicted for the household level. The following characteristics considered are summarized in Table 3, in order of presentation: household size, age structure, sex composition, marital status, educational attainment, household members engaged in fishing, and disease history.

Household size

A majority of the households visited had a household size between 6 to 10 (57%), followed by those with a household size of less than 5 (39%), and those with 10 and above household members (4%). This suggests that a majority of the households covered were

relatively big compared to the 2015 national average of 4 household members (PSA, 2016). This also implies that, given the meager income of the households derived from fishing, each household member gets a smaller share of the total household income.

Age structure of the household members

The households covered in the study were composed mostly of the young generation, belonging to the age bracket of 20 years old and below (41%). This implies that coastal barangays along Albay Gulf have very young populations. Household members at these ages are usually dependent on their parents and costs associated with the upbringing of children such as food, clothing, and education will increase as the number of young dependent household members also increase.

On a positive note, these young members can be a form of smart investment. Building a strong foundation through investing in programs tailored to develop cognitive and non-cognitive skills and health capabilities of children and youth advances the economic status of the household. Conditional cash-transfer programs can help achieve this objective. By doing so, costs associated with the negative outcomes (e.g., school drop-outs, teen pregnancy, child labor, and crime and violence) resulting from the absence of programs targeting the children and the youth can be prevented or at least mitigated.

Composition of household members according to sex

The household surveyed were mostly composed of males (52%). This means that in the coastal communities covered, the sex ratio is close to being "balanced" and less "male-biased" though it is evident that there are slightly more male than female members, on average, in each household. This result is closer to the national statistics on population by sex distribution. Based on the 2010 Census of Population and Housing (CPH), the household population reached 92.1 million. Of the household population, 50.4% were males while 49.6% were females (PSA, 2012).

Educational attainment of household members

A majority of the members of the households surveyed have reached elementary level (21%) or high school level (21%). Those who graduated from elementary school comprised 18% of the total members recorded while those who graduated from high school composed the 16%. Only 6% of the household members were college degree holders while 5% were able to reach at least college level. Less than a percent of the households visited had at least one member who were able to pursue postgraduate studies.

Table 3. Characteristics of household members by socio-demographic profile in Albay Gulf, 2019

Household socio-demographic characteristics	Frequency	Percentage
No. of HH Members		
less than 5	154	39
6 to10	229	57
10 and above	15	4
No response	2	
Age		
Below 20	857	41
21-30	327	16
31-40	272	13
41-50	195	9
51-60	236	11
61-70	101	5
71-80	23	1
No response	56	3
Sex		
Male	1068	52
Female	999	48
Civil Status		
Single	1168	57
Married	808	39
Annulled	1	nil
Divorced	6	nil
Widower	15	1
No response	69	3
Highest Educational Attainment		
No formal schooling	14	1
Elementary Level	440	21
Elementary Graduate	371	18
Highschool Level	435	21
Highschool Graduate	339	16
College Level	109	5
College Graduate	114	6
Post-baccalaureate	5	nil
No response	240	12
Total number of household members*	**2067**	

Note: *The total presented in Table 3 is the sum of the number of household members of the 401 households covered.

The results evoke positive implications. Those members who were able to reach at least college level or were able to graduate from college can find a more stable and higher paying job and contribute financially to their families. The problem is on sustainability and access to financial assistance. More household members could have attained higher education but the scant income from fishing was hardly enough to cover the costly fees of university education.

Number of household members engaged in fishing

As shown in Table 4, a majority of the households reported that no other members were engaged in fishing aside from the father as the household head (59%). This is because most of the households surveyed had either young dependents who were attending school or not yet capable of fishing. Almost 37% said that at least one member is involved in fishing. Usually, these are the sons of the fishers trained on fishing at an early age. Only a small percentage (4%) of households reported having at least two or more members engaged in fishing.

Table 4. Number of Household Members Engaged in Fishing

Number of household member/s engaged in fishing	Frequency	Percentage
None	235	59
At least 1	148	37
Two or more	18	4
Total	**401**	**100**

Disease/illness history of the household members

Varied responses were recorded when the respondents were asked to recall the illness history of the members of their households for the past year and where they went for consultation (Table 5). The data imply that a majority of the households visited were indisposed for the past year of diseases or illnesses caused by virus (19%). These include influenza, common cold, chicken pox, mumps, and measles. They were followed by hypertension (9%) and symptoms of some underlying disease or illness like headache, fever, back pain, stomachache, and dehydration (8%). In such cases, most of them reported to have consulted to a Barangay Health Worker. Other cases reported were bacterial infection (Urinary Tract Infection, prostate infection, tuberculosis, boil, etc.); asthma or allergy; brain-related injuries (stroke, epilepsy, convulsion, paralysis, etc.); inflammation-related illnesses (rheumatism, arthritis, tonsillitis, appendicitis, pneumonia, hepatitis, etc.); pasma and other folk illnesses; heart disease and other organ complications or disorders; diabetes; cancer, cyst, or myoma; migraine, insomnia, or fatigue; cataract or glaucoma; hyper acidity; hyperuricemia; and amoebiasis.

Overall, most of the respondents reported to have consulted a BHW (89 or 36%). This is because BHW provide primary health care services for free to the community people. The Department of Health (DOH) defines a BHW as "a person who has undergone training programs under any accredited government and non-government organization and who voluntarily renders primary health care services in the community after having been accredited to function as such by the local health board in accordance with the guidelines promulgated by the DOH" (Philippine Commission on Women, 2009). These primary services include, but are not limited to, promoting good health, as well as preventing and treating minor illnesses or diseases through immunization programs, nutrition and medical advices, free medicines, and laboratory services. However, in cases when health services are not available in the barangay

due to a lack of expertise, equipment, facilities, and technology, consulting a private physician was preferred by the respondents, which comprised 64 or 26% of the total number of consultations.

Table 5. Disease/Illness History of the Household Members

Illness/Disease	Local Hilot	BHW	RHU	Private Physician	None	Freq.	Percentage
Viral infection	11	38	7	13	7	76	19
Hypertension	3	18	6	7	4	38	9
Disease symptoms	4	11	9	4	5	33	8
Bacterial infection	0	5	3	8	0	16	4
Asthma/Allergy	2	3	2	3	2	12	3
Brain-related injuries	1	2	4	4	0	11	3
Inflammation-related illnesses	2	1	3	3	1	10	2
Pasma and other folk illnesses	1	2	3	2	1	9	2
Heart Disease and other organ complications/disorders	0	2	2	5	0	9	2
Diabetes	0	2	1	1	1	5	1
Cancer/Cyst/Myoma	0	1	0	3	1	5	1
Migraine/Insomnia/Fatigue	0	2	0	1	1	4	1
Cataract/Glaucoma	0	0	0	4	0	4	1
Hyper acidity	0	0	1	1	0	2	0
Hyperuricemia	0	0	0	0	1	1	0
Amoebiasis	0	0	1	0	0	1	0
Total	24	89	44	64	24	245	100

III. HOUSEHOLD SOCIO-ECONOMIC CHARACTERISTICS

Gender roles in income-earning activities

There was a large gender gap in terms of gender-specific tasks in fishing, farming, and other income-generating activities. Women of productive age hardly played any role in fisheries activities (Figure 2). Almost all the major fisheries activities, such as seaweed farming, aqua-silviculture, and mari-culture, were undertaken by men. Except for some income-earning activities, about 35% of women had participation in fish processing, 16% in gleaning, and only 2% in preparation and mending of fishing gears.

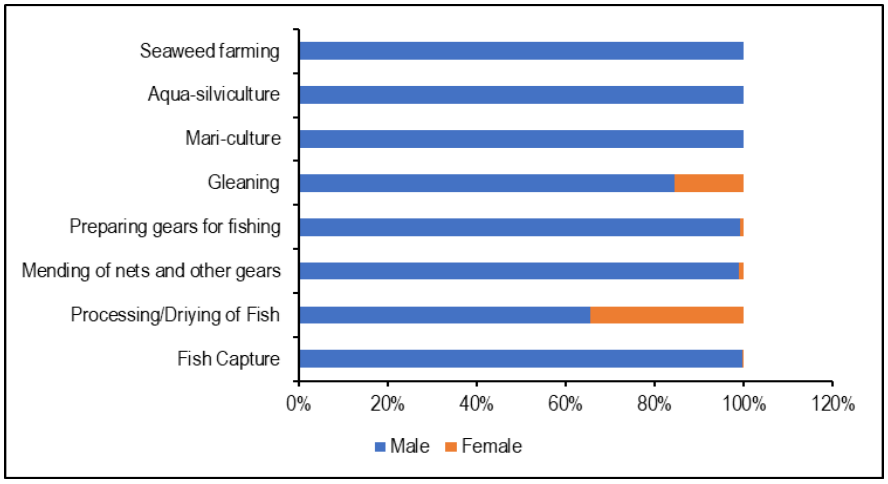

Figure 2. Gender roles in Fishing and Other Related Activities

Compared to fisheries, women played a more pronounced role in farming activities (Figure 3). In animal production for instance, about 29% were involved in ranching, 22% helped in feedlot fattening, and 13% engaged in backyard raising. Similarly, crop production (e.g., rice, corn, and vegetable production) was still dominated by male household members. This is because mechanized and technical tasks are usually performed by male members. Activities where minimum physical activities are required are performed by female members because they are usually responsible for household tasks.

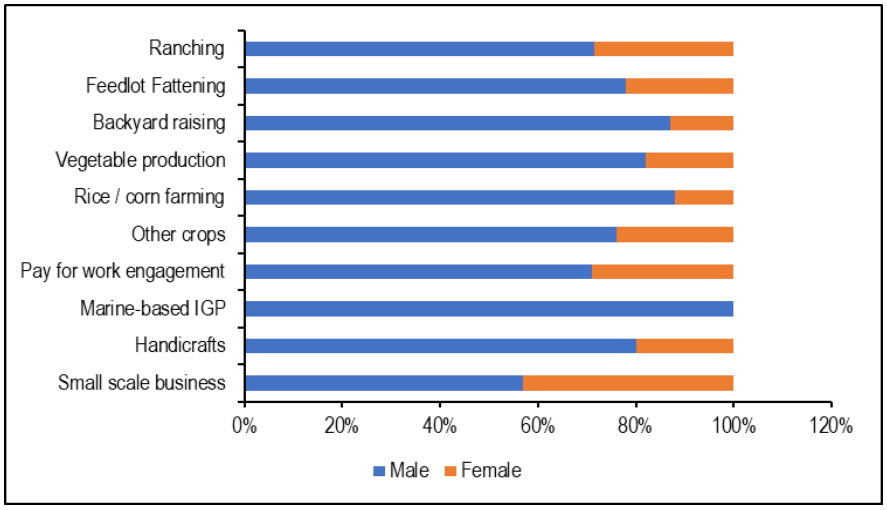

Figure 3. Gender Roles in Farming and Other Income-earning Activities

While the participation rate of women is low compared to men, it is interesting to note that gender roles between men and women in terms of engaging in small-scale business is converging. About 57% of men household members were involved in small-scale business as compared to 43% of women. Other than small-scale business, there were also reported participation of women in the handicraft industry and other market works. However, for marine-based income-generating activities, only men have reported participation.

In general, few women were involved in income earning activities, both in fishing and farming. This is because women are often engaged in "home-based" work, which are

considered as unpaid labor. This include taking care of children, cooking food, fixing nets, baiting hooks, and other tasks which demand less technical knowledge and physical strength. These findings bring forth important implications, namely (1) that in the fishing communities studied, it is more likely for male household members to work both in the fishing and farming sectors because both are unstable sources of income; and (2) it is possible through education and training to increase women participation in farming activities more than in fishing.

IV. ECONOMIC STATUS OF COASTAL FISHING COMMUNITIES

Assessing the economic conditions of small-scale fishermen plays a vital role in determining the kind of assistance programs needed to improve the living standards of fisheries-dependent households. At the very least, access to quality infrastructure and facilities, such as housing, electricity, consumer durables, and water supply, must be in place.

Table 6. Ownership of House and Type of Dwelling Unit

Ownership of house and type of dwelling unit	Frequency	Percentage
Ownership of house		
Owner, owner-like possession of house and lot	224	56
Own house, rent-free lot with owner's consent	128	32
Own house, rent-free lot without owner's consent	28	7
Rent-free/ room, including lot	2	1
Rent-free house and lot with owner's consent	14	4
Rent-free house and lot without owner's consent	2	1
No response	3	1
Type of dwelling unit		
Concrete (Coment)	180	45
Nipa/Cogon Hut	127	32
Wood/Bamboo with GI Roof	89	22
No response	5	1

Property ownership

A majority of the households owned their house and lot (56%). About 39% owned a house but did not own the lot. Of the 39%, about 32% did not pay rent but with owner’s consent and 7% did not pay the rent and without owner’s consent. About 6% lacked ownership of both their house and lot, but only 1% was reported without owner’s consent.

Most of the households surveyed had concrete dwelling units (45%), followed by those who had houses made of nipa or cogon (32%), and wood or bamboo with galvanized iron roofing (22%). According to the accounts given by some of the respondents, access to credit helped them finance their dwelling units. This included either maintenance or improvement of their houses.

As shown in Table 7, a majority (94%) had electricity as their major source of lighting. Only a small percentage reported using kerosene lamp (2%) and generator (2%). Among the

94% of households with access to electricity, 82% owned the connection while 12% shared it with other households. The remaining 5% had either no source of electricity (3%) or used generator (2%) as a source of electricity. This suggests that access to electricity is high among the households situated along Albay Gulf. However, alternative energy sources, such as solar energy, are yet to be introduced as these are cheaper and more environment friendly. In the case of coastal communities, initiatives to implement solar-powered projects can help achieve energy-security and improve the living conditions of fishing households as a result of increased savings from fuel during night fishing and electricity costs from household consumption.

Table 7. Lighting Facility and Source of Electricity

Lightning facility and source of electricity	Frequency	Percentage
Lightning Facility		
Electricity	377	94
Kerosene Lamp	10	2
Generator- Operated	7	2
No response		
Source of Electricity		
Electricity own connection	327	82
Electricity shared connection	48	12
None	11	3
Generator	9	2
No response	5	1

As illustrated in Table 8, more than half of the households owned a television set (80%), cellular phones (64%), and a radio set (55%). This suggests that fisheries programs, laws and regulations pertaining to coastal resource management, and disaster preparedness can be easily disseminated through these common modes of communication. While 61% of the households owned an electric fan, only few a households owned a refrigerator (5%), sewing machine (1%), and computer (1%) as these durables are relatively more expensive. Although, with these facilities, there can be opportunities for income-generating activities.

Table 8. Furniture/appliance Ownership

Furniture/ Appliance owned	Frequency	Percentage
Television	318	80
Cellphone	257	64
Electric fan	243	61
Radio	221	55
Bed	175	44
Sala Set	103	26
Gas Stove	91	23
Refrigerator	74	19
Sewing machine	20	5
Computer/laptop	19	5
Others	2	1

A majority of the households got their drinking water from their own water faucets (38%), followed by deep or artesian well (30%), surface water (13%), and bottled water (8%). This implies that in fishing communities, tap water is the most common source of drinking water. However, combining those households that have ground water and surface water as their source of drinking water, the data suggest that close to half of the households surveyed (43%) had no access to safe and treated drinking water. Surface water is an example of an unprotected water source (The Open University, 2016). Unless it is treated, water from this source is not safe to drink. Groundwater is preferable compared to surface water sources. If the groundwater is deep enough, the community could benefit from drinking water with good microbiological properties. This is because the bacteria and viruses found in groundwater are filtered as they pass through several layers of rock and soil. However, groundwater might contain chemicals such as calcium, magnesium, iron, and manganese. Moreover, groundwater is more likely to be contaminated by nearby pit latrines. Thus, the 43% of households covered can be exposed to microorganisms causing illnesses (such as malaria, diarrhea, and worm infections). Moreover, the result suggests improvement of water sources by investing on piped household water connection, which is at the top of the drinking water ladder designed by World Health Organization (WHO).

Access to sanitary private toilet facilities is a necessity for every household. Lack of it means transmission of many infectious diseases and higher health care costs. Along Albay Gulf, a majority of the households (79%) had water-sealed toilets. This means that proper hygiene is observed, and health risks related to waterborne diseases can be prevented. However, only a few households (3%) had flush-type toilet. About 15% of the households still practiced poor sanitation in disposing human waste through overhang latrine (12%), open field (2%), and pit toilet (1%), cases of which were reported highest in Bacon, Sorsogon (5%), Rapu-Rapu, Albay (4%), and Legazpi City (3%). With these types of toilet facilities, surface water like rivers, lakes, and the seas become polluted. This, in turn, does not only pose a threat to the environment but also contaminate the sources of drinking water of the community.

Table 9. Water and Sanitation

Water and Sanitation	Frequency	Percentage
Source of water		
Own water faucet	151	38
Deep well/ Artesian well	120	30
River,stream,lake, and other bodies of water	51	13
Bottled water	32	8
Others	47	12
Toilet Facility		
Water-sealed	315	79
Drop/overhang	50	12
Flush type	14	3
Open field	10	2
Pit toilet/ latrine	4	1
No response	8	2

In terms of ownership of transportation assets, 59% of the households owned a boat (Table 10). About 31% owned land-based transportation assets like motorcycle (19%), bicycle (7%), tricycle (4%), and car (1%). This suggests that not all households involved in the fisheries sector had their own boat for fishing. Close to half (41%) of the households surveyed shared a boat with their relatives or neighbors under some conditions. The owner usually shoulders the maintenance cost of the boat. In terms of the fish catch, the fishers and boat owner adopt a 50-50 sharing scheme. This means, 50% of the fish catch should go to the owner while the remaining 50% will be divided among the fishers. Among the households covered, about 10% reported not owning any transportation asset.

Table 10. Transportation Assets Owned

Transportation owned	Frequency	Percentage
Boat	235	59
Motorcycle	76	19
None	41	10
Bike	26	6
Tricycle	14	3
Car	2	nil
No response	7	2
Total	401	100

Aside from fishing, households along Albay Gulf also raised animals to augment their income (Table 11). Common among the households was backyard poultry. In addition to chicken, other animals such as ducks, carabaos, pigs, cattles, and goats were raised by households for food or selling them later for cash.

Table 11. Animals Owned

Description	Number of Household Reporting	Total Quantity	Mean Quantity
Chicken	157	1200	7
Ducks	86	217	2
Carabao	29	59	2
Pigs	16	96	6
Cattle	5	10	2
Goats	3	7	2

Sources of income

Income is calculated as earnings from work plus employee benefits and unearned income. Examples of unearned income are interests, dividends, and government cash transfers. Table 12 shows the sources of income of households. Fishing accounted for the highest percentage among the possible choices listed. On average, a majority of the households (94%) had a monthly income of P8,000 from fishing. Regular employment is next to fishing, with 32% of the households reported earning an average income of P8,000. On the other hand, while

it was reported that 94% of the households earned through fishing, only 16% were engaged in fish marketing or selling. This suggests that most of the households took part only in the first stage of the supply chain and depended on other players in the market to sell their catch. Further, there is an evident lack of value-adding in the household level. Only 2% of the households did fish processing as part of their economic activities after fish catch. Respondents cited lack of knowledge and support from the government in terms of trainings and facilities in fish processing. Instead, some members of the households preferred being employed as laborers (13%) with an average monthly income of P6,000. Also, a small percentage of households had income from agriculture-related activities, such as animal husbandry, rice production, and root crop production. The reason behind this small share of agriculture to household income is that most of them did crop production or animal husbandry for home consumption only. Another explanation provided by the respondents was related to food expenditure. Due to seasonality in fishing, incomes were not evenly spaced throughout the year. As an alternative, they considered planting rice or root crops and raising animals for food in times of low catch.

Table 12. Sources of Income of Households in Albay Gulf, 2019

Source	Number of Household Reporting	Monthly Household Income (Median)
Fishing/Fish processing, marketing, selling	378	8,000.00
Regular Employment	130	8,000.00
Laborer	53	6,000.00
Animal Husbandry	35	4,096.00
Business	22	2,000.00
Remittance of OFW, sibling, children, etc.	15	8,000.00
Preparation of gears	10	2,500.00
Rice Production	10	3,400.00
Handicraft Making	9	3,360.00
Pension	8	2,750.00
Root Crop Production	7	2,600.00
UCT Benefits	7	2,400.00
Vegetable Production	1	3,000.00
Tourism	1	400.00
Online Selling	1	500.00
Others:	35	2,312.00

Table 13 shows the percentage of households for each income cluster. The results suggest that a majority of fishing households in Albay Gulf are classified as poor in terms of food and income. About 43% of the households fall below the minimum income/expenditure required for a family/individual to meet the basic food needs, which satisfies the nutritional requirements for economically necessary and socially desirable physical activities (PSA, 2007). This is the food threshold, which is P1,467.40 monthly (per capita). Since fishing households depend on their fish catch for food, food availability becomes unstable for the family, as well as energy and nutrient needs insufficient for the household members. This can

decrease the productivity of household members as hunger can lead to illnesses or even chronic damage to health. In the case of schooling members, their ability to develop cognitive skills can also be impaired. On the other hand, a higher percentage (58%) of the households were unable to meet the minimum income/expenditure required for a family/individual to afford the basic food and non-food requirements. This is the poverty threshold, which is P2,096.20 monthly (per capita). Those who are classified as low-income household comprised 23% of the total respondents for food threshold and 19% for poverty threshold. About 26% are classified as middle class in terms of food threshold and 16% in terms of poverty threshold. Only 1% of the households surveyed are considered as upper class but not rich in terms of food threshold. These households are usually those engaged in commercial fishing. No household was reported and classified as rich.

With the high poverty incidence of households reported in the coastal barangays facing Albay Gulf, there is a need to expand coverage of the conditional cash transfer program in these areas. Of the 401 households visited, only 33% were beneficiaries of 4Ps or the Pantawid Pamilyang Pilipino Program. Thus, about 25% of the households below the poverty threshold are yet to be subsidized to move them out of poverty.

Table 13. Household Poverty Rate (% of the total sample) in Albay Gulf, 2019

Income cluster[a/]	Income definition[b/]	Food Threshold[c/]		Poverty Threshold[d/]	
		Frequency	Percentage	Frequency	Percentage
Poor	less than food/poverty threshold	173	43%	233	58%
Low-income class (but not poor)	between the poverty line and twice the poverty line	92	23%	76	19%
Lower middle-income	between two and four times the poverty line	53	13%	41	10%
Middle middle-income	between four and seven times the poverty line	39	10%	15	4%
Upper middle-income	between 7 and 12 times the poverty line	11	3%	8	2%
Upper-income class (but not rich)	between 12 and 20 times the poverty line	6	1%	1	0%
Rich	at least equal to 20 times the poverty line	0	0%	0	0%
No response		27		27	
Total		401		401	

**Author's calculations based on the national per capita poverty threshold for food and income poverty in 2018 (PSA, 2019).*
[a/]Income from fishing [b/] Source: Albert, Santos, & Vizmanos (2018) [c/]Php1,467.40 (per capita) [d/]Php2,096.20 (per capita)

Household expenditures

As shown in Table 14, the top three expense items in terms of the number of households reporting are food, electricity, and education. With food as a top priority, households are left with a meager income to spend on other items like durables and recreation. On a positive note, fish-dependent households put a high value on education as revealed by the number of

households allotting a portion of their income, albeit low, to support their children's education. Next to education, households also spend on gadgets with an average of P100 for cellphone load per month. Following the spending on gadgets, households also spend an average of P300 per month for clothing. Most households prefer to buy secondhand apparels such as clothes, bags, and shoes at "ukay-ukay" where these items are being sold at very cheap prices. A few also mentioned buying new and branded clothes but only on important occasions, specially during the Christmas season. While water and healthcare are basic and essential expenditure items, they only come sixth and seventh in terms of the number of household reporting, respectively. According to them, they usually get their drinking water for free with minimal spending on labor and spend on over-the-counter drugs or nonprescription medicines for minor pains and illnesses. On the other hand, recreation (including vices), loan amortization, improvement of dwelling unit, and appliance amortization are the items with the lowest number of households reporting. With low income derived from fishing, it is not surprising that these items are the least prioritized.

Table 14. Household Expenditures in Albay Gulf, 2019

Expense Items	Number of Household Reporting	Monthly Household Expenditure (Median)
Food	378	3,500.00
Electricity	373	338.00
School Expenses	263	1,000.00
Gadgets (Cellphone Load)	214	100.00
Clothing	149	300.00
Water	137	120.00
Health Care	125	500.00
Recreation/ Vices	86	290.00
Loan Amortization	74	2,000.00
Improvement of Dwelling Unit	64	3,000.00
Appliance Amortization	22	1,450.00

Investments in fishing equipment and facilities through a strong credit support can lead to an increase in production and improvement in the socio-economic condition of the fishing communities. However, as Table 15 shows, households mostly depend on non-institutional credit arrangements, such as borrowing money from relatives, neighbors, and friends. This is because formal credit providers, such as credit cooperatives, have lending procedures and requirements that usually ask borrowers' collateral.

Some households also borrow money at small convenience stores or commonly known as the "suking tindahan" or "sari sari" stores. The amount of money borrowed from these sources are limited and can only be used to finance immediate needs, such as food items and not as working capital. Loan sharks were also an option to a few households despite the unfavorable terms and conditions attached to this kind of loan. Thus, because of the constraints imposed by formal credit providers, opportunities for income-generating and value-adding activities are also hampered. There were also cases when

Table 15. Access to Credit

Source	No. of household reporting	Percentage	To be paid on specific period of time with interest rate	No specific period of time, without interest rate
Relatives	231	58	13	218
Neighbors/Friends	120	30	12	108
Credit Cooperatives	59	15	56	3
Suki	40	10	5	35
Loan Sharks (5/6)	16	4	16	0
Pawnshop	1	nil	1	0

the fishing households borrow money from middlemen. Sometimes, instead of cash, the middlemen provide the fisher rice or fuel. In exchange, the fisher sells all his catch to the middlemen at a price set by the latter. This undermines the opportunity of the fishers to seek the most optimal price had their catch been sold in an open market. As a consequence of this practice, most fishers are entrapped in lifelong debt as their debt increases in a sizeable amount impossible for them to repay.

V. INSTITUTIONAL AND POLICY BASELINE IN ALBAY GULF

A basic framework for coastal resource conservation and management is provided by the 1987 Constitution under Article II, Section 16, which declares the policy of the state in protecting and advancing the "right of the people to a balanced and healthful ecology in accord with the rhythm and harmony of nature." Under this mandate, the Philippine government, from national agencies concerned down to the LGUs, should craft and implement laws and regulations to conserve the nation's marine wealth.

Table 16. Laws/ordinances Related to Coastal Resource Conservation/Protection, Albay Gulf

Laws/ Ordinances	No. of aware	%	Enforcement Level									
			Very strong		Strong		Good		Weak		No enforcement	
			f	%	f	%	f	%	f	%	f	%
Illegal use of destructive fishing practices	239	60%	143	60%	60	25%	21	9%	14	6%	1	0
Proper waste disposal	190	47%	109	57%	40	21%	23	12%	14	7%	4	2%
Protection of rare, threatened, and endangered species	147	37%	79	54%	38	26%	15	10%	12	8%	3	2%
Illegal use of active fishing gear	125	31%	59	47%	30	24%	18	14%	12	10%	6	5%
Closed season fishing in municipal waters	52	13%	25	48%	11	21%	10	19%	4	8%	2	4%

In Albay Gulf, existing laws and ordinances related to coastal resource conservation and protection were assessed based on the perceived enforcement level of the said laws and ordinances by the resident respondents (Table 16). Out of the 401 study participants, 60% of them were aware of the laws and ordinances being implemented in their respective barangays particularly those related to illegal use of destructive fishing practices (Table 16). On the other hand, less than 50% of the respondents were aware of the laws and ordinances pertaining to proper waste disposal (48%); protection of rare, threatened, and endangered species (37%); illegal use of active fishing gear (31%); and closed fishing season in municipal waters (13%).

The lack of public awareness can be attributed to the inadequate involvement of the community in coastal resource management. To realize effective coastal resources management requires not only funding and technical support but also the active participation and trust of the people. Accounts from the study participants point to selective enforcement of laws and ordinances by some officials with some offenders easily getting away from punishments while others take stiffer penalties in the form of fines.

Table 17. Community Participation in Coastal Resources Management in Albay Gulf

Community Involvement	Frequency	Percentage
Existing Organization		
None	327	82
Fisherfolk organization	39	10
There is an organization, name identified	27	7
There is an organization, name not identified	8	2
Membership		
Yes	51	69
No	23	31
Position		
Member	19	37
President/Chief/Chairman	9	18
Others	9	18
No Response	14	27
Projects Implemented		
Capacity building	15	29
Fishing equipment and infrastructure	13	25
Not aware	12	24
Others	11	22
Status		
Not Aware	26	51
Ongoing	16	31
Completed	5	10
Pending/Discontinued	4	8

As shown in Table 17, out of the 401 respondents, about 82% said that no people's organization, NGO, or financial institution has been established in their barangay. Only 74 or 19% were able to identify an existing organization in their community. Of the 74 respondents, 51 or 69% were members of their organization. Among them, 37% were members, 18% were presidents of their respective organizations, and 18% were officials other than president. In terms of project implementation, a majority of the organizations (29%) focused on capacity-building activities, such as trainings and seminars on planting mangroves and corals, fish

processing, and culturing. This was followed by distribution of fishing equipment and construction of fishing infrastructures (25%). There is, however, 24% of the respondents who expressed lack of awareness of the projects implemented by their respective organization. Further, of the 51 members of the organizations, more than half or 51% lacked awareness of the status of their projects. About 31% reported that they had ongoing projects. On the other hand, 10% had projects completed while 8% had either pending or discontinued projects.

With the above findings on low awareness level on laws and ordinances promoting coastal resources management, coupled with low community participation, the urgent need to further educate the people on coastal resources management is just timely to help them appreciate the importance of regulating the fisheries. As the primary unit of governance of the country, any policy, project, program, and activity concerning the coastal environment should emanate from the initiative of municipalities and cities.

CONCLUSIONS

The study compiled the socio-demographic, economic, institutional, and policy baselines of households situated in coastal barangays along Albay Gulf. The data on the socio-demographic characteristics of respondents revealed that the sector clearly has an ageing labor force. The household data, on the contrary, showed that a majority of the households were composed of young members. In terms of educational attainment, there were members who were able to finish college. In rare cases, some members were able to even pursue post-baccalaureate degree. Thus, literacy is not an issue in fishing households. However, in terms of the roles performed by male and female household members in fishing and farming activities, a large disparity can be observed. The fisheries sector is still gender- biased although the data suggest that female participation in economic activities can be increased through education and training.

In addition to owning a boat, property in terms tangible assets like concrete housing and appliances, as well as access to electricity and toilet facility, were also evident. Access to safe drinking water, however, is yet to be solved as a majority of households got their drinking water from contamination-vulnerable sources, such as groundwater and surface water.

Value-adding is rarely observed in the fishing households. Also, fish marketing and selling were seldom practiced by the fishers. As a result, fisherfolks tend to receive the lowest share of the final product's price when sold in the market. Thus, it was not surprising that a majority of the fishing households visited were low-income and poor. It was further noted that income from fishing was insufficient to meet at least the basic food needs of each family member. Meanwhile, the fishing households spent most of their income on food, electricity, and education and least on recreation and amortization. This means that households earn to meet at least their basic needs. Recreation, although necessary for welfare, is not a priority among fishing households.

Access to formal credit providers is less evident among fishing households. Requirements set by these institutions usually serve as barriers to fisherfolks. As a result, they are impelled to borrow from relatives, neighbors, and friends. However, money borrowed from these non-institutional credit arrangements are only limited and can only be used to finance immediate needs such as food items and not as working capital. Thus, opportunities for income earning activities and value adding are also hampered.

Public awareness of the existing coastal resources and management laws and ordinances are yet to be intensified. This is especially important as most of the households heavily depend on the resources found in Albay Gulf. If the residents lack the knowledge of proper management and sustainable use of coastal resources, time will come that the marine ecosystem will be incapable of sustaining the food needs of the population. On top of public awareness, community participation was also low. Because of this gap, more efforts need to be done to achieve the intended ends of regulating fisheries through coastal resource management.

RECOMMENDATIONS

The matters and issues discussed in the previous sections present opportunities for LGUs to look into solutions that will address the problems confronting the fisheries sector and coastal resources. Given the socio-demographic and economic profile of the fishing households, female participation can be increased in faming activities to augment the household income. This can be done through seminars and training. In addition, value-adding of the fisheries products should be introduced to fishing households. This will not only increase the income of the household but also the quality of the fisheries products. As an incentive, access to credit must be in place for fisherfolks. Expanding of 4Ps coverage can also be a viable option in reducing the poverty incidence of households. In terms of water and sanitation, LGUs should strictly consider prioritizing rehabilitation or construction of water systems. The economic status of fisherfolks should be an important agenda, but health care should never be discounted.

Promoting and enforcing coastal resource management is not only the responsibility of the national government but also of the local communities. Hence, CRM efforts should be participatory rather than centralized. To address the policy and institutional gaps identified, LGUs must be capacitated first through technical expertise and budgetary support from the national government. In raising public awareness and participation, innovative information, education, and communication (IEC) campaigns can be used as tools in increasing environmental literacy and ethics, as well as promoting environmental advocacies. IEC can be in the form of advertisements, printed materials like comic books, or workshops. To further increase community participation, 4Ps beneficiaries can also be tapped in promoting coastal resources management as part of their Family Development Session (FDS). Also, to ensure the sustainability of CRM initiatives, memorandums of agreement signed by LGUs, NGOs, and POs in support of CRM plans should be in place. Capacity building, monitoring, and evaluation should also serve as mechanisms for sustainability.

With the baseline data provided in the paper, further study can be conducted particularly in assessing the efficiency and effectiveness of policies and programs being implemented by the LGUs. More importantly, evaluating future programs which focus on improving the sector's economic and health situation will be much easier as baseline data is already established.

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DOCUMENTATION AND EVALUATION OF THE LIVELIHOOD IN ALBAY GULF

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ABSTRACT

The documentation and evaluation of livelihood in Albay Gulf intends to present the livelihood of the residents of the coastal communities, identify the livelihood assistance related to fishing provided by different government and non-government agencies; and, assess the alternative livelihood programs provided by various agencies. The researcher used the primary data obtained from the Participatory Resource Socio-Economic Assessment (PRSA) survey interview with five households of every identified barangay. The analyzed data were presented in summary through descriptive statistics. Furthermore, evaluated livelihood projects on the basis of perception as to community effectiveness were herein provided. Generally, most of the coastal residents' livelihood involved fishing. A small number of fishermen served as barangay tanods. There were, however, a few that engaged in construction/carpentry-related work especially on lean fishing season as another source of income. The people's organization in the barangay have community-organized livelihood programs for their members but limited to only one barangay in Bacacay, six in Bacon, 11 in Legazpi City, five in Manito, one in Prieto Diaz, two in Rapu-Rapu, and three in Sto. Domingo. Livelihood assistance/alternative programs were made available to the coastal residents through government and non-government organizations, particularly the Bureau of Fishewries and Aquatic Resources, Department of Labor and Emplyment, Local Government Units, and Sunwest Corporation. The assistance provided were evaluated by the respondents as to their perception of effectiveness of such assistance like fish gears and boats freely provided to them for the improvement of their fish catching activities or the paitlogan as an alternative livelihood program. However, not all the coastal barangays or residents were beneficiaries of alternative livelihood programs nor livelihood assistance from agencies, be it government or non-government.

Keywords: Coastal community, Alternative livelihood, Albay Gulf

INTRODUCTION

The Fisheries, Coastal Resources and Livelihood (Fish CORAL) Project is a five-year endeavor (2016-2020) of the Philippine Government and the International Fund for Agricultural Development (IFAD) aiming to reduce poverty in economically-challenged coastal communities while strengthening local food and nutrition security in the target areas in the Philippines. Its executing agency is the Bureau of Fisheries and Aquatic Resources (BFAR), under the Department of Agriculture.

The project has three components: Coastal Resources Management (CRM), Livelihood Development (LD), and Project Management and Coordination. Fish CORAL is being implemented in four regions: Region 5 (Bicol), 8 (Eastern Visayas), 13 (CARAGA), and ARMM (Autonomous Region in Muslim Mindanao). One of the components that this paper emphasizes is LD augmenting the income of the coastal communities in the area through diversified livelihood enterprises. The FishCORAL project aims to support 1,098 coastal communities nationwide to sustainably manage their fishery and coastal resources generating livelihood benefits for fishing households. The coastal communities will benefit through organizational strengthening and business plan development while waiting for the spill-over effect of the CRM component to the municipal waters. Local stakeholders are encouraged to form and/or strengthen People's Organizations (POs) in the area to participate in diversified livelihood activities through fishery sub-projects, such as aquasilvi culture, seaweed farming, mud crab fattening, mussel culture, lobster culture, fish cages and fish pens farming, eco-tourism, etc.

This study presents the livelihood profile of the coastal residents in Albay Gulf. Livelihood is a means of making a living. It encompasses peoples' capabilities, assets, income and activities required to secure the necessities of life (What is a livelihood, 2019). Also, livelihoods are defined as the way people combine their capabilities, skills and knowledge with the assets at their disposal to create activities that will enable them to make a living. It is said to be sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets bo now and in the future, while not undermining the natural resource base (Chambers & Conway, 1992). The coastal areas are considered important for the numerous benefits and resources that they bring, such as fish, oil, gas, minerals, salt, and construction materials, as well as services, such as shoreline protection, sustaining biodiversity, water quality, transportation, recreation, and tourism (PEMSEA, 2003). These areas are very accessible, making them centers of human activity where people live and derive their means of livelihood. These people (poor) are the most dependent upon the environment and its resources whether there is a direct or indirect use of the said resources. There is diversity in livelihood (Carney, 2002) and is determined by the available assets in the households with respect to ownership and accessibility (Shamsuddoha, 2004). The variation on the array of livelihood activities is dependent on the peoples' household assets and their access to the asset base in order to gain income. Thus, in the coastal areas, the livelihood activities may have similarities in most areas and/or differences on the others. Ireland et al (2012), during their literature review, identified different coastal livelihood income generating activities and strategies being employed worldwide. These are enumerated below:

Environment and Natural Resource (ENR) Based Livelihood Activities	Non-ENR Livelihood Activities
Agriculture (crop and livestock)	Bicycle repairers
Aquaculture (all types)	Black smiths
Bed making	Builders
Bee keeping	Dress making
Boat building/repair	Employment (local government)
Carpentry	Employment (private sector)
Charcoal making	Guest houses
Cooking and selling food	Hair dressing
Cow dung collection	Ice sellers
Cut flowers	Labouring
Crab fattening	Mechanics
Employment (food processing factories)	Net making/repair
Fish processing	Petty trading
Fish trading	Prostitution
Fishing (all types & all gears)	Seasonal migration to towns
Fuelwood collection	Shop keepers
Gum collection	Transport (on bicycles)
Handy craft (mat making, bags, baskets etc.)	Textile factories
Harvesting and selling coconut by-products	
Hunting	
Live coral extraction	
Lime making	
Mangrove harvesting (inc. selling poles)	
Mariculture (all types)	
Palm wine making	
Poultry farming	
Post larvae collection	
Shrimp nursery	
Salt Panning	
Seaweed collection	
Shell collection	
Stone quarrying	
Thatch makers & collectors	
Tourism	
Traditional medicine	
Waste recycling	
Weaving using natural fibres	

Alternative livelihoods are implemented for two major reasons/goals: (1) protecting and preserving the marine and coastal environment by actively stopping people from using the resources and (2) using coastal and marine resources in a sustainable way that does not undermine the future potential use of these resources. Development agencies have moved into initiating alternatives selected from an expanding global list of "ideas" that may or may not have any relevance to the needs, aspirations or capacities of people concerned, which results in the common failure of adapting such alternative (Ireland et al, 2004). To achieve success in

an alternative livelihood, it is essential that wider livelihood issues (local) and influences concerning the coastal residents must be primarily considered. Livelihood interventions should be relevant to the needs and aspirations of the people in the community. There is a great need to have knowledge and better understanding of the livelihood opportunities and challenges along coastal communities to formulate a sound, appropriate, and sustainable intervention.

OBJECTIVES

The study intends to describe the livelihood of the coastal communities along Albay Gulf. Specifically, this paper aims to:

1. Document the livelihood of the residents of the coastal communities in Albay Gulf;
2. Identify the livelihood assistance related to fishing provided by different government and non-government agencies; and
3. Assess the alternative livelihood programs provided by various agencies—government or non-government.

MATERIALS AND METHODS

Research Method

The documentation and assessment of livelihood used the primary data from the result of the Participatory Resource Socio-Economic Assessment (PRSA) survey/interview on the households of the coastal municipalities in Albay Gulf.

Population and Sample

In Albay Gulf, there were seven coastal municipalities subjected to the PRSA, namely Bacacay (three barangays), Bacon (18 barangays), Legazpi City (19 barangays), Manito (12 barangays), Prieto Diaz (four barangays), Rapu-Rapu (15 barangays), and Sto. Domingo (12 barangays). Eighty-three barangays in the gulf were visited, with five households per barangay, to gather the data needed for the livelihood documentation and evaluation.

Method of Data Collection

The were five respondents in every coastal barangay in all the municipalities surrounding the gulf. The data were gathered by going gathering was made possible through coming to the identified coastal barangay and visiting the coastal residents in their houses to conduct the survey/interview.

The target barangays in various municipalities are presented in Table 1 below:

Table 1. The Target Coastal Barangays in the Selected municipalities surrounding Albay Gulf, 2019

Municipalities	**Target Barangays:**
Bacacay	Mataas, Misibis, Sula
Bacon	Balogo, Bato, Bogna, Bon-ot, Buenavista, Caricaran, Del Rosario, Gatbo, Osiao, Poblacion, Rawis, Salvacion, San Juan, Sawanga, Sta. Lucia, Sto. Domingo, Sto Nino, Sugod
Legazpi	Arimbay, Bagacay, Banquerohan, Bigaa, Buenavista, Centro-Baybay, Dapdap, Homapon, Lamba, Maslog, Padang, Pigcale, Puro, Rawis, Sabang, San Francisco, San Roque, Victory Village (North), and Victory Village (South)
Manito	Balabagon, Buyo, Cabacongan, Cavit, Cawit, Holugan, It-ba Poblacion, Malobago, Manumbalay, Pawa, Tinapian, and Cawayan; In Prieto Diaz, Talisayan, Manlabong, San Ramon, and Lupi
Prieto Diaz	Lupi, Manlabong, San Ramon, Talisayan
Rapu-rapu	Bagaobawan, Caracaran, Carogcog, Dap-dap, Lagundi, Liguan, Manila, Marocborocan, Pagcolbon, Poblacion, Santa Barbara, Tinocawan, Malobago, Bugtong, and Batan
Sto. Domingo	Buhatan, Calayucay, Lidong, San Juan Poblacion, Santo Domingo, San Vicente, Del Rosario, San Francisco, Salvacion, San Isidro, Pandayan Poblaction, and Alimsog

Method of Data Analysis

A summary of the data gathered are presented qualitatively. The responses pertaining to the livelihood activites or programs are presented through tables showing frequency count and percentages. Furthermore, in the aspect of livelihood programs provided, the respondents evaluated these projects based on perception by determining whether it is very effective, moderately effective, effective, ineffective, or ‘very ineffective.

RESULTS AND DISCUSSION

Livelihood of coastal communities

Most of the residents of the coastal communities, especially the head of the families were fishermen (336 or 84%). This is attributed to the endowments of the communities. Some of the respondents were housewives (21 or 5%) representing their husbands who were at the time of interview were either away at work and/or for fishing activities or representing their households on their own because they were already alone in raising the family. Others were fishermen and construction workers/laborers/carpenters on the lean season of fishing. Some were both fishermen and farmer. Others were fishermen and *barangay tanod.* Fish vendors also make up the list of occupations. There were other occupations in the coastal communities, such as barangay health worker, *barangay kagawad*, construction worker, vendor and barangay tanod, a fisherman and diver, a fisherman and fish vendor, a fisherman and liaison, a fisherman and miner, hog raiser, and a businesswoman engaged in agriculture. A summary of the data is presented in Table 2.

Table 2. Distribution of the Respondents Based on Occupation

Major Occupation	**f**	%
Fisherman	336	84
Fisherman/Construction worker/Carpenter/Laborer	8	2
Fisherman/Farmer	7	2
Fisherman/Fish vendor	1	.25
Housewife	21	5
Agriculture	1	.25
Barangay Kagawad	2	.50
BHW	3	1
Businesswoman	1	.25
Construction worker	2	1
Fish Vendor	5	1
Fisherman/ Diver	1	.25
Fisherman/Brgy. Tanod	7	2
Fisherman/Liaison	1	.25
Fisherman/Miner	1	.25
Vendor/Brgy. Tanod	2	.50
Piggery	1	.25

There were respondents with dual occupations during the season when fish are abundant, these people engage in fishing. During the season when the catch is scarce, they become farmers, carpenters, laborers, divers, fish vendors, liaison officers and miners. Aside from fishing, fishers are serving the community as *barangay tanod* and *kagawad.*

In terms of the number of household members engaged in fishing activities, 359 or 90.2% responded only “1”, which shows that in the coastal communities, to most of the

households, the head of the families are the sole providers in the family. Sixteen or 4.02% responded "2", one or .25% responded "3"; and, only one (1) or .25% responded "4" members are engaged in fishing. This shows that fishing activities may also involve either the wife, the brother, brother-in-law, and/or even the young male children. This practice occurs due to the limited opportunities present in the community to earn a living.

Almost all the livelihood activities in the barangays were dominated by men, particularly fishing-related activities: fish capture (360 or 99.72%), processing/drying of fish (36 or 65.45%), mending of nets and other gears (162 or 98.78%), preparing of gears for fishing (207 or 99.4%), gleaning (54 or 84.38%), mari-culture (7 or 100%), aqua-silviculture (5 or 100%), seaweed farming (6 or 100%), Lobster Culturing (1 or 100%) and Bagoong Production (1 or 100%).

Most fathers/heads of the families in the coastal communities are engaged in fishing because it is the means of obtaining an income taught to them by their fathers. In their engagement with processing/drying of fish, there was no formal training provided but simply a product of knowledge transfer from their forefathers. No formal training was provided by any agency in the fish processing activities of the fisherfolks as such skill was learned either on their own or from the fellow fishermen in the community who know fish drying. On instances when fishing gears and nets break down, the males are most likely to fix them instead of asking somebody else to repair them for a fee. Since the fisherfolks are the ones responsible for fish capture, they are also the people who prepare all the necessary materials or gears before they leave for the day's fishing activity. Gleaning, for instance, does not take place every day and consistently as such activity is made as the need arises, especially when the tide is very low (Table 3).

Similarly, livelihood activities dominated by males were: farming (animal production) such as backyard raising 47 or 87.04%, feedlot fattening (21 or 77.78%), and ranching (5 or 71.43%); farming (crop production): rice/corn farming (15 or 88.24%), vegetable production (14 or 82.35%), root crop production (13 or 76.47%) and copra production (11 or 100%); and, other income-generating activities: small scale business (13 or 56.52%), handicrafts (8 or 80 %), marine-based income generating project (3 or 100%), pay-for-work engagement (5 or 71.43%), and other activities such as boat making, bamboo stick production, repair services, rice farming rental, *palaw*, and pig selling (7 or 78.78%). These activities were observed to be male-dominated because the activities require physical effort for which men are more capable than women and in the practice of Filipino families, it is the male that is engaged in livelihood related activities as women are expected to stay at home to nurture and take good care of the children.

Although these livelihood activities are dominated by men, some women deviate from the norm and engage in such activities within their capacity. These activities include fish capture (1 or .28%), processing/drying of fish (19 or 34.55%), mending of nets and other gears (2 or 1.22%), preparing gears for fishing (2 or .96%), gleaning (10 or 15.63%), backyard raising (7 or 12.96%),

Table 3. Distribution of respondents by classification of livelihood and by sex in Albay Gulf, 2019.

Classification of livelihood	Male		Female	
	Freq.	Percent	Freq.	Percent
Fishing				
Fish Capture	360	99.72	1	0.28
Processing/Drying of Fish	36	65.45	19	34.55
Mending of nets and other gears	162	98.78	2	1.22
Preparing gears for fishing	207	99.04	2	0.96
Gleaning	54	84.38	10	15.63
Mari-culture	7	100.00		
Aqua silviculture	5	100.00		
Seaweed farming	6	100.00		
Other, Specify:				
Lobster Culturing	1	100.00		
Bagoong Production	1	100.00		
Farming (Animal production)				
Backyard raising	47	87.04	7	12.96
Feedlot Fattening	21	77.78	6	22.22
Ranching	5	71.43	2	28.57
Farming (Crop production)				
Rice / corn farming	15	88.24	2	11.76
Vegetable production	14	82.35	3	17.65
Root crops Production	13	76.47	4	23.53
Other, Specify: Coprahan	1	100.00		
Other Income-generating activities				
Small scale business	13	56.52	10	43.48
Handicrafts	8	80.00	2	20.00
Marine-based IGP	3	100.00		
Pay for work engagement	5	71.43	2	28.57
Other, Specify:	7	77.78	2	22.22

feedlot fattening (6 or 22.22%), ranching (2 or 28.57%), rice/corn farming (2 or 11.76%), vegetable production (3 or 17.65%), root crop production (4 or 23.53%), small scale business (10 or 43.48%), handicrafts (2 or 20%), pay for work engagement (2 or 28.57%) and other income generating activities such as selling/marketing and taking care of pets (2 or 22.22%).

Community organized livelihood assistance programs

Bacacay. A handicraft seminar in basket making was initiated by MWLO in the coastal community of Misibis to assist in the livelihood of the fisherfolks living in the said area.

Bacon. Fisherfolk organizations such as the Jose Deliosa Fisherfolk Organization, provided lapu-lapu in Buenavista; Barangay Rawis Fisherfolk Organization conducted a seminar on

constructing fish ponds; some unnamed fisherfolk organizations provided boats and *panke* to fishermen and conducted seminars on fish drying and seaweed planting; Sugod Fisherfolk awarded fishing gears. A fisherfolk organization in Osiao planned on putting up fish cages but was still waiting for implementation.

Legazpi City. The fisherfolks in Bigaa gave fishing nets, engines and fishing gear, as well as estabiiehed a bigasan and fishing center. All of these except the fishing center, are ongoing projects in the said barangay. The fishing center ceased its operations. In Padang, the farmers' initiatives for tilapia production was not implemented but two of the livelihood initiatives, the distribution of motor boats and providing alternative livelihood for the wives of the fishermen are in the process. The giving of motorized boat in Dapdap is also in the process. Other fisherfolk organizations have ongoing projects such as seaweed/crab cultivation (Buenavista), seaweed farming (Lamba), ice making (San Roque), and bigasang bayan (Victory Village South). The *gulayan* (San Francisco) initiated by the fisherfolk organization was a success. Other fisherfolk organizations initiated crab fattening (Homapon), giving of fishing net and boat (Lamba), giving of fishing gears (Rawis), and *palubid ng niyog* (Puro) but the respondents were not able to identify whether these projects are in the planning stage, are ongoing, or were already finished.

Manito. Several projects are currently implemented in the different coastal barangays in Manito which include trainings (Cabacongan), seminars (Cawit), and polyculture of *hanit* and bangus (It-ba Poblacion). A lending program (Holugan) was initiated but nothing happened when it took effect.

Prieto Diaz. The coastal barangays of San Ramon and Lupi were the recipients of projects implemented by Kalahi CIDDS. The projects include the distribution of free boats, *palutang* and *ikot.* A people's organization (Lupi) initiated a savings program for the community and is an ongoing project.

Rapu-Rapu. The fisherfolk organization implemented projects, such as the giving of fishing net (Bugtong) and providing of fishing assistance and seminars/training (Dap-dap).

Sto. Domingo. The Buhatan Fisherfolk and Farmers' Organization proposed a livelihood program on aqua silviculture but as to implementation, the project is still waiting for its budget. Similarly, the Lidong Fisherfolk Organization's fishpond culture has not yet commenced but a bidding in the municipality has started and awaiting approval for implementation.

Table 4 shows a summary of the community organized livelihood assistance programs.

Table 4. Community Organized Livelihood Assistance Programs, 2019

Barangay	Program
Misibis, Bacacay	Handicraft Making (basket)
Buenavista, Bacon Rawis Bacon Del Rosario, Bacon Sugod, Bacon Osiao, Bacon	Provided lapu-lapu Seminar on making fish ponds, free boats and panke, fish drying, seaweed planting Free fishing gears Plan on putting up fish cages (awaits budget)
Bigaa, Legazpi City Padang, Legazpi City Padang and Dapdap Buenavista, Legazpi city Lamba, Legazpi City San Roque, Legazpi Victory Village (South), Legazpi San Francisco, Legazpi City Homapon, Legazpi City Lamba, Legazpi City Rawis, Legazpi City Puro, Legazpi City	giving of fishing nets, motor, fishing gear, bigasan and the establishment of fishing center Tilapia production (not implemented) Alternative livelihood for the wives (on the process, meeting) Distribution of motor boats (in the process, meeting) Seaweed/ crab cultivation Seaweeds farming Ice Making Bigasan Bayan Gulayan Crab fattening (no status stated) Giving of fish net and boat (no status stated) Giving of fishing gears (no status stated) Palubid ng niyog (no status stated)
Cabacongan, Manito Cawit, Manito It-ba Poblacion, Manito Holugan, Manito	Trainings Seminar Polyculture-Hanit and Bangus Lending program (nothing happened)
San Ramon, Prieto Diaz Lupi, Prieto Diaz	Distribution of free boats Savings program, free boat, palutang and ikot
Bugtong, Rapu-Rapu Dap-dap, Rapu-Rapu	Giving of fish net Fishing assistance and seminars/training
Buhatan, Sto. Domingo Lidong, Sto. Domingo	Aquasilvi culture (awaits budget for implementation Fishpond culture (awaits approval for implementation)

Livelihood assistance programs of government and non-government agencies

Despite the efforts of the residents of the coastal communities to seek other means to survive in their day-to-day living, for some households it is still not enough. The local government unit helps the fisherfolks through projects to improve their livelihood. Some agencies also rendered assistance through projects that are directly related to improving the fishing capacity of the townsfolk, while other agencies provide alternative livelihood programs as another earning option for the coastal residents besides fishing.

According to the respondents, the programs implemented by the Bureau of Fisheries and Aquatic Resources (BFAR) in improving their fishing livelihood are provision of fishing net, *hikut-hikut, tansi and/or banwit*, and nylon; boat making; and boat releasing. BFAR also provided alternative livelihood programs in the various coastal communities. The townsfolk were given training on *paitlogan* (2006), *negosyo* (for a year), ice making (2018), *tilapiahan*, and bigasan/fish pond (2016). The Department of Labor and Employment provided the coastal residents with boat (2017), fishing net (2014 and 2017), and training on ice making. Meanwhile, the local government units (LGUs) provided lapu-lapu, recycling materials, fish processing, palaisdaan, and KALAHI CIDSS Program of helping in the school.

Non-government organizations (NGOs) also extended their assistance to the coastal communities such as the Sunwest Corporation's sandal making program in 2014, rice retailing (2012-2014), and an NGO's ongoing fishpond project. Programs were also provided by other agencies but can no longer be recalled by the coastal resident recipients except for the programs provided to them. These programs are *pagbibigay ng ikot paggawa ng pangke* (2015), seminar, boat releasing, and *gulayon*.

Table 5. Summary of the livelihood assistance programs of government and non-government agencies, 2019

Agency	Livelihood Program/Assistance
BFAR / Alternative Livelihood Assistance	Paitlogan (Osiao, Bacon) Negosyo (San Isidro, Sto. Domingo) Ice Maker (San Roque, Legazpi City) Tilapiahan (Tinapian, Manito) Bigasan/Fish Pond (Lidong, Sto. Domingo)
BFAR/Fishing Livelihood Assistance	*Nagbibigay ng net* (Banquerohan, Legazpi City) boat making (Lamba, Legazpi City) Giving of *hikut-hikot* (Del Rosario, Bacon) Releasing of boat (Sula, Bacacay) Giving of tansi and banwit (Pawa, Manito) Giving of nylon (Alimsog, Sto. Domingo)
Department of Labor and Employment (DOLE)	Giving of net (Bagacay, Legazpi & Sta. Lucia, Bacon) Giving of Boat (Marocborocan, Rapu-Rapu)
Local Government Unit (LGU)	Lapu-lapu fish cage (Buenavista, Bacon) Recyclable materials (Dapdap, Legazpi City) *Nagbibigay ng ikot paggawa ng pangke* (Victory Village N Help in school (Dap-dap, Rapu-Rapu) Palaisdaan (Manumbalay, Manito) Gulayon (Padang, Legazpi City)
NGO (unnamed) Sunwest Construction Company	Rice retailing (Bigaa, Legazpi City) Fishpond (Rawis, Bacon) Sandal Making (Lamba, Legazpi City)

In summary, the coastal barangays receiving livelihood assistance/programs are Sula in Bacacay; Sta Lucia, Buenavista, Rawis, Del Rosario, Salvacion, and Osiao in Bacon; Arimbay, Bagacay, Banquerohan, Bigaa, Dapdap, Lamba, Padang, San Francisco, San Roque, Victory Village (North and South) in Legazpi City; Cavit, It-ba Poblacion, Manumbalay, Pawa and Tinapian in Manito; San Ramon in Prieto Diaz; Dap-dap and Marocborocan in Rapu-Rapu; and Lidong, San Isidro, and Alimsog in Sto. Domingo.

Of all the barangays included in this study, results revealed that not all the coastal barangays or residents are beneficiaries of alternative livelihood programs nor livelihood assistance from agencies, be it government or non-government. When the respondents were asked if livelihood programs were extended to their barangay, they responded that there were no introduced livelihood programs because they are far from the city or agencies. Some of the respondents did not know the reason at all. Others did know about the livelihood programs but were not included in the list of livelihood intervention recipients because they are not members of the organization. Some are aware that there are livelihood projects, but it was not implemented in the barangay. It only reached the planning stage or initial meetings and no progress after that.

In fact, 21 of the respondents stated that they should be given assistance by providing them fishing gears to aid them in their fish catching activities and that such assistance like the free fishing nets and boats must be given to real fishermen. Ten of the respondents said that they should be given livelihood programs, especially the small fishermen. Four respondents stated that they wish to be provided with more seminars and training for fishing. Five respondents were calling out to the government and BFAR for assistance in providing their needs, as well as to the LGUs such that whatever help given to the municipality should also reach the fishermen. Furthermore, should there be projects proposed by the people organizations, the government would be there to approve the proposed projects and provide financial assistance.

Assessment of alternative livelihood programs

The Bureau of Fisheries and Aquatic Resources (BFAR) provided fishing net, hikut-hikut, tansi and/or banwit, nylon and boat, the agency also taught the coastal residents how to make boats. Among these, what the respondents found very effective were the: giving of fishing net (2017, 2018 and 2019) and *hikut-hikut* (2019) and boat making (2019). Moderately effective was the releasing of boat (no time frame provided). Effective was the giving out of *tansi*, *banwit*, and nylon. At one coastal community, a respondent shared that the releasing of boat was very ineffective.

Another BFAR alternative programs for the coastal residents were training on *paitlogan* (2006), *negosyo* (for a year), ice making (2018), *tilapiahan* and bigasan/fish pond (2016). The only program that was found to be very effective to the community was the *paitlogan*. The moderately effective program was the *negosyo*, which lasted only for a year and the effective program was ice making. However, there were programs such as the *tilapiahan* and bigasan/fishpond that did not meet the expected outcome as these were evaluated as ineffective and very ineffective, respectively, by the respondents. Fish landing (2019) and *pukot (1990)* were also provided to the fisherfolks but no evaluation was provided by the respondents as to their effectiveness. Likewise, the Department of Labor and Employment's livelihood assistance to the coastal residents are through giving boat, fishing net, and training on ice making. Of these programs, the responses revealed that the giving of fishing net was very effective and the giving of boat was moderately effective. On the other hand, the program on ice making was very ineffective.

The local government unit (LGU) also had programs on vegetable production, lapu-lapu fish caging, recycling materials, and giving of fishing net that were evaluated as very effective. Several BFAR projects did not meet the expected outcome. The palaisdaan (2016-2017) and fish processing (2006) were very ineffective while the KALAHI program of helping

Table 6. Alternative livelihood and assistance to the respondents by implementing agency and year of implementation in Albay Gulf

Agency	Livelihood Program/Assistance	Year	Level of effectiveness
BFAR/ Alternative Livelihood	Paitlogan	2006	Very effective
	Negosyo	1 year	Moderately effective
	Ice Maker	2018	Effective
	Tilapiahan		Ineffective
	Bigasan/Fish pond	2016	Very ineffective
BFAR / Fishing Livelihood Assistance	nagbigay ng net	2018	Very effective
	Boat making	2019	Very effective
	Bigay hikut-hikut	2018	Very effective
	Releasing of Banka		Moderately effective
	Tansi, banwit		Effective
	Nagbibigay ng nylon	2018	Effective
Government	Releasing banca		Very ineffective
DOLE	Nagbigay Net	2017	Very effective
	Lambat	2014	Very effective
	Issued banka	2017	Moderately effective
LGU / government	Lapu-lapu fish cage		Very effective
	recyclable materials	2015- ongoing	Very effective
	Nagbibigay ng ikot panggawa ng pangke	2015	Very effective
	Help in school	2016	Ineffective
Samahan ng mga Mandaragat	Fish processing	2006	Very ineffective
	Palaisdaan	2016-2017	Very ineffective
	Gulayon	2018	
	Mangrove plantation		
NGO	Rice retailing	2012-2014	
NGO	Fishpond	ongoing	
Sunwest Construction Company	Sandal Making	2014	Effective

in the school (2016) was ineffective. Other government agencies helped the coastal residents, but these agencies were no longer recalled by the respondents except for the program given to them. The program *pagbibigay ng ikot panggawa ng pangke* and seminar are considered very effective. On the contrary, the initiative of releasing boat to the respondents was very ineffective. Programs like *gulayon (2018)* and mangrove plantation were mentioned by the respondents but, no evaluation in terms of their effectiveness to the community.

Several non-government organizations (NGOs) assisted the coastal communities, namely Sunwest's sandal making program in 2014 and was assessed by the respondents as effective. Furthermore, the rice retailing livelihood program that commenced in 2012 and lasted until 2014 had no evaluation. Table 6 shows a summary of the livelihood programs categorized under the agencies providing the livelihood initiative, the year they were initiated, and the level of effectiveness of these programs to the receiving community.

CONCLUSION

Livelihood in coastal communities. Residents of the coastal communities are mostly fishermen, usually the head of the households, the father. Their line of work is attributed to the physical endowment of the land being near Albay Gulf. This is followed by residents who are fishermen when there is abundant fish supply and are also construction workers/carpenters/laborers on lean fishing months, in which carpentry or construction-related works are their source of income. Other coastal residents beside being fishermen are *barangay tanod*, as well serving the public/community. The fishing-related livelihood that fishermen engage in are fish capture, processing/drying of fish, mending of nets and other gears, gleaning, mari-culture, aquasilvi culture, seaweed farming, lobster culturing, and bagoong production. The non-fishing related activities include animal production, crop production, and other income-generating activities such as small-scale business, handicrafts, marine-based IGP, and pay-for-work engagement, all of which are dominated by men.

Livelihood assistance programs of government and non-government agencies. Both government and non-government agencies help to improve the livelihood of the residents either to increase and improve the fishing capacity of the residents or provide additional livelihood opportunities to them. The agencies that helped were the Bureau of Fisheries and Aquatic Resources, Department of Labor and Employment, local government units, and Sunwest Corporation. The livelihood assistance provided includes the provision of fishing gears, boat making, boat releasing, training on paitlogan, negosyo, ice making, tilapiahan, bigasan, fishpond, lapu-lapu fish caging, recycling of materials, fish processing, pagbibigay ng ikot paggawa ng pangke, gulayon, mangrove plantation, sandal making, rice retailing, and fishpond project.

Assessment of alternative livelihood programs. The alternative livelihood programs provided to the coastal residents were evaluated based on effectiveness. The alternative livelihood programs and fishing livelihood assistance of the Bureau of Fisheries and Aquatic Resources (BFAR) that were considered as very effective include the paitlogan, giving of fish net and hikut-hikot, and boat making. Moderately effective were the negosyo and boat releasing; effective were the ice making program, giving of banwit, tansi, and nylon; ineffective was the tilapiahan; and very ineffective was the bigasan/fishpond. Other livelihood programs or assistance provided by other agencies evaluated as very effective were giving of nets, lapu-lapu fish cage, recyclable materials, and assistance in making pangke; moderately effective was the giving of boats; effective was sandal making; and very ineffective were the palaisdaan and fish processing.

RECOMMENDATIONS

Based on the above conclusion, the recommendations are as follows:

1. The identified livelihood assistance and interventions (effective to very effective) must be continued in the community that identified it as such, so that good projects that provide income to the fisherfolks can be sustained.
2. The alternative livelihood projects proposed should be anchored on the availability and accessibility to the resources. A coastal barangay is not the same as other barangays, so it is better that a livelihood project will not be considered as applicable to all coastal barangays with respect to their resources. Before any livelihood program can be proposed, an assessment must be conducted first in the coastal barangays to determine the capability of the fisherfolks in doing other livelihood activities beside fishing to prevent the ineffective evaluation of the livelihood programs and to optimize the financial resources for the project implementation.
3. In the planning stage where a proposal for a livelihood project is made by a leader of the PO of the community, the MAO and other offices concerned should also be involved right there and then and as such, their undertaking must be fully supported by the local government unit of the community so that the plan and effort become worthwhile. During the implementation stage, the involvement of the fisherfolks on the livelihood projects must not be limited to those who were selected on the basis of membership to the people organization but may also consider the willingness to participate by other fisherfolks who are non-members so that it becomes a community effort in sustaining the livelihood project. Otherwise, in the proposal stage per se, there is already a participation of the coastal residents through participatory planning in the community level, supported by the LGU/government through approval and financial support/assistance.
4. A strengthened monitoring system should be implemented to ensure that the leaders of the people's organization in the community, the Municipal Agricultrual Officer, and other officers who attended the livelihood sessions followed the plan and conducted the activities through the development intervention so that a livelihood program shall be visible in every coastal barangay. Furthermore, in monitoring the progress, each coastal barangay or the municipality must ensure the presence of the project representative who shall oversee the livelihood intervention capable of acting in behalf of the providing agency and in providing action measures to mitigate unwanted circumstances in the projects. The identified ineffective livelihood programs, should be evaluated immediately, and countermeasures be applied to ensure that the fisherfolks shall have a sustainable alternative livelihood income source.
5. More involvement of women must be observed in the livelihood projects of the coastal communities to empower them and aid in the increase of income generation for every household especially on the land-based activities. These include fish drying or activities that are more appropriate to the women residents and the coastal endowments. Women are also assets of the coastal community apart from their roles at home. Their participation in the livelihood will boost the living standards of the coastal barangays.

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STATUS OF CORALS AND CORAL REEF FISHES OF ALBAY GULF

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ABSTRACT

This assessment is a pioneering, first comprehensive gulf-wide assessment of coral reefs and the associated reef fishes in Albay gulf. Generally, reef systems of the gulf are in different state of health, mostly in fair condition, with some in poor and others in good status. Interestingly, reef systems outside MPAs are in better condition than those inside. This may not necessarily be reflective of management inadequacy for MPA site but may indicate the vulnerability of the MPA reefs to major disturbances such as storms, siltation from the nearby rivers and the damage inflicted to the reef system prior to its establishment as MPA. The artificial reefs of the gulf such as the coral rosary in Santo Domingo is in not so good condition. Meanwhile, the coral restoration in Legazpi City reef systems is claiming success, which likewise needs ecological verification. The LGU-bordering municipalities just protect 0.88% of the total gulf area through these MPAs. The diversity, density and biomass of coral reef fishes are very comparable to many baselines in the region. Biomass estimates which can be treated as potential yield are reflective of the potential of the coral reef areas in providing near shore fisheries production. On the negative note, the reef fishes are now dominated by less economically important fishes coming from major group (85%) with very low percentage of fisheries-target species (12%) and indicators (3%). This research also detected an imbalance between carnivore and herbivore fishes, with the former outnumbering the later by three times. The very low count of herbivore fishes will directly connect to the significant elimination of grazers, which partly could have caused the macro algal growth along reef systems. Indicators of disturbances such as presence of crown of thorns, Drupella, ghost nets and siltation in the reef systems have been documented. Revalidation of the location and expanse of the MPAs and their networking verification and more careful conduct coral rehabilitation initiatives are hereby recommended.

Keywords: Albay Gulf, Coral reefs, reef fishes

INTRODUCTION

Albay Gulf can be considered as ecologically threatened and disregarded fishing grounds of the Bicol Region. Despite of being considered by NEDA V as one of the top ten fishing grounds of Bicol (NEDA, 2005), it has been deprived of formal research and monitoring activities due to a rich fishing ground. With the past major fisheries management programs in the country (The fishery Sector Program and the Fishery Resource Management Program), Albay Gulf has not been a beneficiary of any monitoring activity afforded to its neighbouring fishing grounds like the nearby Lagonoy Gulf, Sorsogon Bay, San Miguel Bay of Camarines provinces, Ragay Gulf and Asid Gulf of Masbate. This has resulted to lack of technical information needed for the management of the critical ecological habitats and the rich resources therein. If there is any technical information to describe the gulf, they are minimal and sporadic and shall not suffice for a gulf-wide management.

The need for gulf-wide management intervention, emanating from sound technical information is urgent in the face of recent developments posing direct threat to the resilience of the rich but fragile resources of Albay Gulf. It is also hard to assess the ecological impacts of any disturbance that may happen in the gulf for there are no available baselines to compare from. This is alarming since many non-fishing uses have been emerging in the gulf which is potential to disrupt its ecological integrity. Poorly planned ecotourism projects have been one of these uses (Lash et al, 2003). To mention a few, the emergence of resorts integrating many land and sea-based activities to promote tourism, mining activities in both Bataan and Rapu-Rapu Islands, the geothermal energy-harnessing project of Manito and Bacon areas and the emerging industries are enough reasons to cast doubts to the productivity and carrying capacity of the gulf. Likewise, the increasing load of potential pollutants from ballooning households, the reported trend of overfishing and the continued denudation of the surrounding vegetation are adding burden to hundreds of families that are dependent to the bounty of the gulf.

Technical information to guide future development and management initiatives are scant and elusive in Alay Gulf. There were sporadic research and development engagements done in the gulf though. In 1990s, some NGOs (i.e. Tambuyog Development Center in 1997) and the then Bacon LGU had a spot monitoring of the status of the ecological habitats of certain sectors for marine protected area establishment, In 2002, the Sustainable Management of Coastal Resources (SUMACOR) was also implemented which resulted into the establishment of the Marine Protected Areas in Polique Bay of Legazpi City and Santo Domingo. The Coastal Core (2008) through its project on participatory community profiling and development planning for selected Barangays of Bacon District, captured concerns along fisheries productivity and sustainability. In 2010, BU and Sorsogon City partnered in a rapid resource and social assessment of the Bacon District. The Department of Environment and Natural Resources V (DENRV) through its coastal resources management programs had a productive partnership with Prieto Diaz in early 1990s resulting to establishment of its Marine Protected Area (MPA). With good partnership with community, protection not only of coral reefs but to sea grass and mangrove communities are materialized. Fisheries management, banning some destructive practices was also enforced. All these have resulted to the preservation of the coastal habitats of the town as well as the emergence of eco-tourism projects that are community-managed.

Except for the two MPAs of Rapu-rapu which is just on its 5th year of operation, the more than decade existence of the remaining marine reserve and sanctuary in these areas, including those that are found in Santo. Domingo, Bacon, Legazpi City, Manito and Prieto Diaz area is worth evaluating, 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. The present Participatory Resource and Social Assessment (PRSA) offers the first gulf-wide comprehensive assessment in Albay Gulf. This paper focuses on the assessment of the status of coral reef systems and the resident and associated ref fishes. 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; and

5. Provide notes on associated macro invertebrates and seaweed/algal colonization.

METHODOLOGY

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, expanse of coral systems. The preparation of base maps indicating the location and extent coral reefs was generated under Project 5.

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 ID and intercept reading. This is undertaken in all MPAs situated inside the gulf. In addition, some stations were also surveyed at a 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 were evaluated based on criteria set by Gomez (1982, Table 1). Ecological indices such as Shanon-Weiner index of Diversity, Dominance index and Equitability/evenness were computed using the following formulae:

Table 1. Coral cover condition

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

- 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

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

Dominance = 1/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. This is 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 are identified, counted and their lengths estimated. These length estimates are 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.

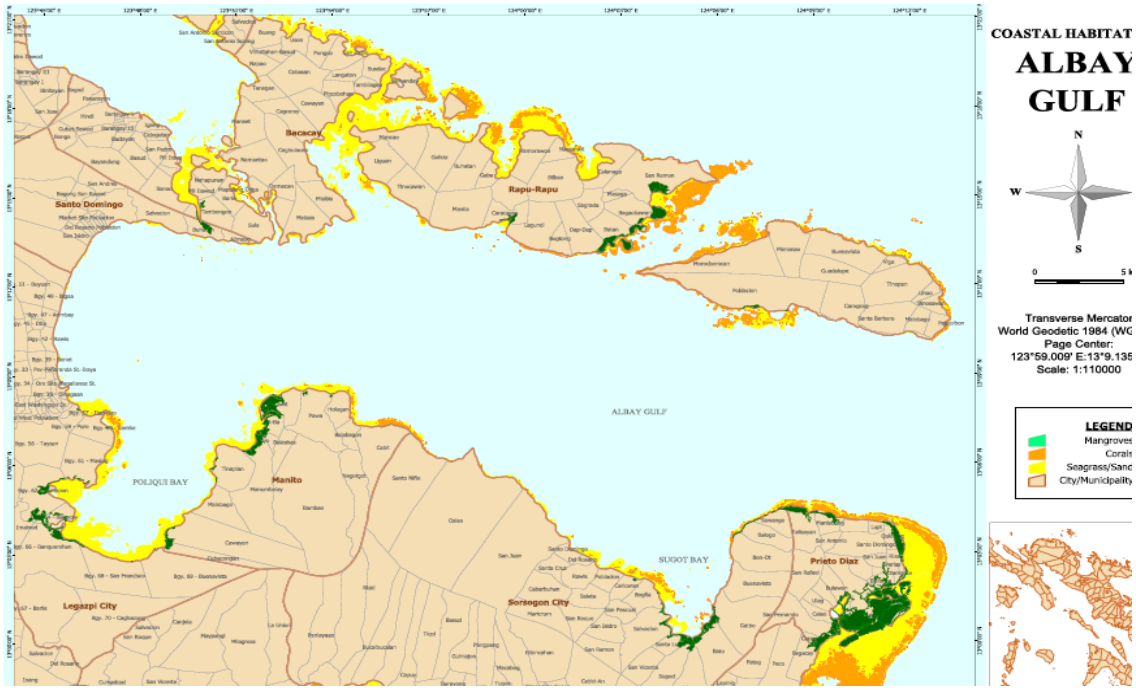
Observable perturbations such as presence of garbage, crown of thorns, ghost nets, and bleaching were documented together with macro algal colonization, and presence of macro invertebrates. All diving activities used SCUBA equipment and with the knowledge and/or participation of barangay officials, designated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

RESULTS AND DISCUSSION

Extent/Area covered by the coral reefs

Figure 1 shows the map of Albay gulf showing the concentration of coastal habitats Corals are mostly concentrated either within the narrow passages of Rapu-Rapu, Batan and Cagraray Islands or form a narrow reef systems fringing near the coastal zones. Some offshore reef systems are however identifiable such as the Denson Reef of Legazpi City and those in Polique Bay and Rapu-rapu. The coral reef systems of the gulf is estimated at 1713.64 hectares, representing 2.22% of the entire statistical area of the gulf (770 km^2). The reef system of Rapu-rapu and Prieto Diaz, Sorsogon have the highest reef coverage with 966 and 526 hectares respectively. Sto domingo have the smallest reef system with just 1.7 hectares, followed by Bacacay (24), Legazpi (33), Manito (62) and Bacon District (100).

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



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

Table 2. Area of marine protected areas of Albay Gulf.

Name of MPA	Sanctuary (has.)	Reserve (has.)	Total (has.)
1. Leg. City (Kabunturan MPA)	9.23	37.24	46.47
2. Sto. Domingo MPA	10.00	48.00	58.00
3. Caracaran, Rapu-rapu MPA	56.80	56.20	103.00
4. Poblacion Rapu-rapu MPA	68.80	105.20	174.00
5. Manito MPA	4.00	4.00	8.00
6. Bacon District MPA	--	--	120.00
7. Prieto Diaz MPA	48.00	120.00	168.00
		Total	677.47

There were a total of 677.5 hectares of MPA in Albay Gulf. This translate to protection to just 0.88% protection of the 770 square kilometer gulf area, way below the prescribed coastal areas protection by the law (Republic Act 8550). Rapu-rapu protects an aggregate of 277 hectares, representing 40% of the entire protected area in Albay Gulf (Table 2). Except for Prieto Diaz (168 hectares) and Bacon

District (120 hectares), the rest of MPAs in Manito, Legazpi and Sto. Domingo are very small (i.e., less than 100 hectares).

This section presents 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. All in all, there were 17 high resolution transects made in the major reef systems of the gulf.

Status of Coral Reefs of Legazpi City

Table 3 shows the result of the coral reef assessment undertaken in major reef systems of Legazpi City. Four major reef systems were assessed namely the reef system of its MPA in Kabunturan and the three non-MPA reef systems namely Denson and Pasig reef systems and the one fronting Maslog. The two transects inside the MPA yielded fair coral health condition (40-47% live coral cover or LCC). Hard coral component is high in the MPA (32-45%), unfortunately dead corals are also very high (32-49%). Despite its predisposition to high silt input, being right in front of discharge area of a big River, Kabunturan reef system harbors diverse benthic lifeforms with remarkable rugotsity.

Table 3. Percent cover of major coral lifeforms in Legazpi City.

Lifeforms or Substrates	Percentage Cover				
	Pasig Reef	Denzon Reef	Kabunturan T1	Kabunturan T2	Maslog T1
Hard Corals (HC)	38.88	51.12	33.08	45.56	50.58
Sort Corals (SC)	4.14		7.18	1.86	
Dead corals (DC)	35.44	43.1	49.5	32.36	31.78
Other organisms (OT)	1.46	0.96	0.86	0.96	2.44
Algae (ALG)	6.04	4.38	0.46	6.58	7.54
Substrate	14.04	0.44	8.92	12.68	7.66
LCC* (HC+SC)	43.02	51.12	40.26	47.42	50.58
Reef Health	Fair	Good	Fair	Fair	Good
Total	100	100	100	100	100
** Live Coral Cover*					

Except to Pasig reef which have fair coral health (43% LCC), the two other Non-MPA reef systems are in good condition. Maslog reef is in good coral condition (50.9% LCC). Dead corals is lowest here (32%) as compared to the other reef systems assessed in Legazpi City. Denson, an offshore reef system with several cases of ship grounding already was seen to be in good state (51% LCC). It is important to emphasize that the transects were set at the reef slope as the top area of the reef system is in bad shape. Cases of ship grounding, natural stresses inherent to shallow area (<10 meters during low tide), anchorage and decades of fishing activities may have jointly denuded its top. This is one of the sites of the rehabilitation efforts through coral transplantation aggressively done by the Integrated Coastal Resources Management Unit (ICRMU) of the city. As seen in Denson and in another two sites (Pasig reef and Nursery area), the ICRMU is succeeding in propagating stag horns and other branching corals. Full details of the assessment result for Legazpi City is in Appendix A.

Status of Reef Systems of Santo Domingo, Albay

The MPA of Santo Domingo Albay was established through Municipal Ordinance No. 07-2006, covering the reef and non-reef areas. The reef system of Santo Domingo is the narrowest and smallest in area coverage in the gulf. Three transects were assessed inside the MPA of the municipality. Live coral cover in this MPA ranged from 36-43% of purely hard corals, sufficient for a fair coral health status (Table 4). Unlike Legazpi city with lots of dead corals,

its algae here that dominates the lifeforms. Substrates of these huge microalgae assemblage are previously dead corals. The proliferation of microalgae to previously coral area is not unique to Sto. Domingo. This is a prevalent trend in the country and globally wherein, corals are 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 overfishing (Stamoulis et al, 2017 and Edward et al, 2014) are some documented causes that results to failure of reef recovery and continued coral degradation. Full detail of the coral assessment for Sto. Domingo is in Appendix B.

Table 4. Percent cover of major coral lifeforms in Sto. Domingo.

Lifeforms or Substrates	Percentage Cover		
	StoDom T1	StoDom T2	StoDom T3
Hard Corals (HC)	35.66	40.24	41.78
Sort Corals (SC)	0	0.2	1.14
Deac corals (DC)	7.3	1.74	7.04
Other organisms (OT)	1.58	3.08	1.5
Algae (ALG)	48.64	47.34	25.6
Substrate	6.82	7.4	22.94
LCC* (HC+SC)	35.66	40.44	42.92
Reef Health	Fair	Fair	Fair
Total	100	100	100
* *Live Coral Cover*			

In 2013, a civic group in partnership with a religious group and the local government of Sto. Domingo initiated the deployment of rosary-themed artificial reef (AR). Initially, it was fitted with solar energy-fed electrodes intended to alter water electrochemistry and cause precipitation of available ions in the water and thereby create coral-like mass. Shortly, and in succeeding years, powerful typhoons destroyed the underwater AR. In 2016, it was restored by deploying hundreds concrete domes measuring half a meter both in height and base diameter at the shallow sand flat of Barangay Salvacion (Figure 2) . As of this time, most of the modules which is also called "rosary beads" are already buried into sand with only dozens still visible. Three years of immersion showed colonization of some macroalgae, sponges and some corals. Some Pomacentrids, puffers and lionfishes were seen associated with the artificial habitat.

Figure 2. Underwater shot of the coral rosary bead of Santo Domingo, Albay

Status of Reef Systems of Rapu-Rapu, Albay

Rapu-rapu borders Albay gulf through the South-Western sides of its major islands Rapu-rapu and Batan. Corals here are concentrated in the straits between these islands and with Cargaray Island of Bacacay and Malilipot. Fronting Rapu-Rapu main island are shallow reef systems one is locally Minuro and the other near Pagol islet, here we call Poblacion reef. Poblacion reef is immediately fronting Poblacion. It was declared as MPA by virtue of Municipal Ordinance no. 2015-02. Minuro is nearer to the shoreline shallower than Poblacion reef and is not covered by the MPA protection. The same Municipal Ordinance established

another MPA in Caracaran, at the west side of Batan Island. Similarly, a shallow reef is found near shore and harbors good coral assemblage.

Table 5 presents the result of coral assessment in the two MPAs and in another two non-MPA sites of Rapu-rapu. Glaring is the huge disparity of coral health of the stations, with non-MPA stations interestingly showing good health condition (LCC=56.6-66.58%) while the four MPA stations/transects just ranged from poor to fair (18.26-37.54% LCC). The result seem ironical since MPA reef systems are assumed protected while non-MPA sites are not. Account of local fishers revealed that the reef systems in the MPAs were long been subjected to unsustainable fishing before they were covered by protection in 2016. Notable are the proliferation of algae, mostly macro algal assemblage that have colonized dead corals. This is very visible in one transect in Poblacion MPA which showed vast macro algal growth over dead coral as their substrate. The cause of this phenomenon as mentioned above can be nutrification from land-sourced materials and significant reduction of grazers. This could potentially result to loss of reef system and the cascading impacts to fisheries and its ecological functions. Appendix C shows the complete details of the assessment.

Table 5. Percent cover of major coral lifeforms in Rapu-rapu, Albay.

Lifeforms or Substrates	Caracaran MPA T1	Caracaran MPA T2	Caracaran non-MPA	Poblacion MPA T1	Poblacion MPA T2	Poblacion non-MPA
Hard Corals (HC)	36.22	37.14	56.6	18.06	27.44	66.58
Sort Corals (SC)	1.32	0	0	0.2	0.18	0
Dead corals (DC)	0.64	0.34	5.42	2.32	3.7	11.98
Other organisms (OT)	4.42	3.66	0.38	1.74	0.7	1.04
Algae (ALG)	40.74	36.92	32.72	74.94	64.5	17.5
Substrate	16.66	21.94	4.88	2.74	3.48	2.9
LCC* (HC+SC)	37.54	37.14	56.6	18.26	27.62	66.58
Reef Health	Fair	Fair	Good	Poor	Fair	Good
Total	100	100	100	100		100

Status of Reef Systems of Manito, Albay

Manito shares its coastal zone with Legazpi City, principally along Polique bay, and with Bacon District of Sorsogon City on its South. Its 62 hectares reef area are mostly concentrated on shallow reef flat. The near-shore formations are patchy and generally associated with seagrasses. Two transects right at the core area were assessed and revealed live coral cover ranging from 38-61.2% (Table 6). Transect 1 that yielded lower live coral cover is situated at the shallower periphery of the core area. It is characterized by patchy occurrence of massive and submassive lifeforms with occasional presence of branching types too. The very high substrate (24% cover) confirms the patchy coral assemblage here. Transect 2 is right at the ground zero of the core zone. Just like the nearby MPA of Legazpi City at Kabunturan, the MPA's reef system is vulnerable to high silt discharge from nearby river. But despite of this, the reef system harbors high living coral components. This can be attributed partly to obvious high silt dissipation potential of the location. Dead corals are smaller in coverage for both transects (14-16% cover). Likewise, algal growth that uses dead corals as

Table 6. Percent cover of major coral lifeforms

Lifeforms or Substrates	Percentage Cover	
	Transect 1	Transect 2
Hard Corals (HC)	38.24	60.48
Sort Corals (SC)		0.72
Dead corals (DC)	16.38	13.88
Other organisms (OT)	1.04	0.42
Algae (ALG)	20.6	17.38
Substrate	23.74	7.12
LCC* (HC+SC)	38.24	61.2
Reef Health	Fair	Good
Total	100	100
* *Live Coral Cover*		

substrate is considerable (17-20.6%). The complete result of coral assessment for Manito is in Appendix D.

Status of Reef Systems of Bacon District, Sorsogon City and Prieto Diaz, Sorsogon.

The 120-hectare marine protected area in Bacon district of Sorsogon City was established in 2006, fronting Barangay San Juan. The MPA covers the core of reef formation and some sand flats. In 2009, the reef system here was found to be in good condition (59.9% LCC, de Jesus et al, 2010). The adjoining Osiao reef system was also seen to be in good shape (51% LCC) although threatened by many disturbances including siltation and sediment discharge from land erosion. The remaining unprotected reef systems located in Pagol, Sta Lucia and Paguriran are in poor to fair states (15.7-34% LCC).

Nine years after this assessment, the reef system of the MPA in San Juan was seen to have deteriorated from 59.9% to just 42.3% live coral cover (Table 7). Notable was the spike of cover of algae (47%) that thrive over dead corals. Macro algal component of the reef system in 2009 was just 18% while dead corals was 21%, as reported by de Jesus et al (2010). Progressive deterioration of the reef system is happening, which could be attributed to host of factors. As hinted above, recovery of corals that suffered mortalities becomes difficult as they are easily inhabited by microalgae, partly, this becomes prevalent especially when population of grazers and coral cleaners like parrotfishes and wrasses are significantly reduced by fishing.

Table 7. Percent cover of major lifeforms in Bacon and Pto Diaz, Sor.

Lifeforms or Substrates	Percentage Cover	
	Bacon MPA	PtoDiaz
Hard Corals (HC)	40.6	30.68
Sort Corals (SC)	1.68	0
Dead corals (DC)	9.76	2.18
Other organisms (OT	0.3	0.06
Algae (ALG)	46.78	67.04
Substrate	0.88	0.04
LCC* (HC+SC)	42.28	30.68
Reef Health	Fair	Fair
Total	100	100
** Live Coral Cover*		

From records of the Bureau of Fisheries and Aquatic Resources, three marine protected areas are present in Prieto Diaz, fronting Barangay Diamante. The 168-hectare aggregate MPA is called MARILAG Marine Reserve, with 48 hectares core area and the rest is the reserve. It was established in 1994 upon the recommendation of the Ecosystem Research and Development Section of the Department of Environment and Natural Resources Region V (ERDS-DENRV). There is a 300 hectare mangrove reserve declared nearby under separate legislation. The marine protected areas of Prieto Diaz is unique. It encompass the mangrove, sea grass and coral reef habitats. Its establishment has a very rich history spanning from early 1990s. It was awarded as one of the Best Coastal Management Program of 1998

Corals in Marilag MPA is in fair condition (30.68% LCC). This is comparable to the 33% LCC measured in 2017 (Soliman et al, 2018). Still massive and encrusting corals are the predominant life forms. Assessment earlier by ERDS-DENR V has reported coral cover here to be at 33.95%. While the live coral cover just slightly changed from 33 to 30% in recent assessment, shift to other lifeforms have drastically happened. Dead corals here were 29.3% in 2017 while algae covered just 6.2%. Overwhelming colonization of macroalgae had happened in the present time, now, covering 67% of the reef system. Brown algae, represented by Sargasum and Padina species and Halimeda are the dominant species seen flourishing in the reef system, colonizing previously dead corals and other abiotic substrates. The same mechanism discussed above have driven macro algal growth in the reef systems. In addition,

nutrient input coming from neighboring mangrove and sea grass habitats and from land runoff could also be a factor.

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

Of the six MPA reef systems surveyed, Sto. Domingo MPA registered the biggest biomass of 56.12 mt/km^2 followed by Bacon District with 41.04 mt/km^2 and Caracaran, Rapu-rapu with 33.8 mt/km^2. The remaining have lower reef fish biomass just ranging from 9.84 to 33 mt/k m^2.

Table 8. Biomass, diversity and abundance of reef fishes in Albay

MPA/ Reef area	Biomass kg/250m^2	Biomass MT/km^2	Species Number	Total No. of Fishes
Sto. Dom MPA2	14.03	56.12	43	647
Caracaran MPA	8.45	33.8	34	407
Rapu Pob MPA	2.46	9.84	22	181
Pto. Diaz MPA	5.12	20.48	23	161
Kabunturan MPA	4.9	19.6	15	166
Bacon District MPA	10.26	41.04	38	428

Biomass of coral reefs are conventionally used to imply 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). Biomass of Bacon district is significantly higher (41 mt/km^2) than the estimate ten years ago (31 mt/km^2, de Jesus et al, 2010). Biomass 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 biggest biomass estimate was from the Itiw-itiw reefs of Monreal, Masbate (125.8 mt/km^2, Dioneda et al, 2014).

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

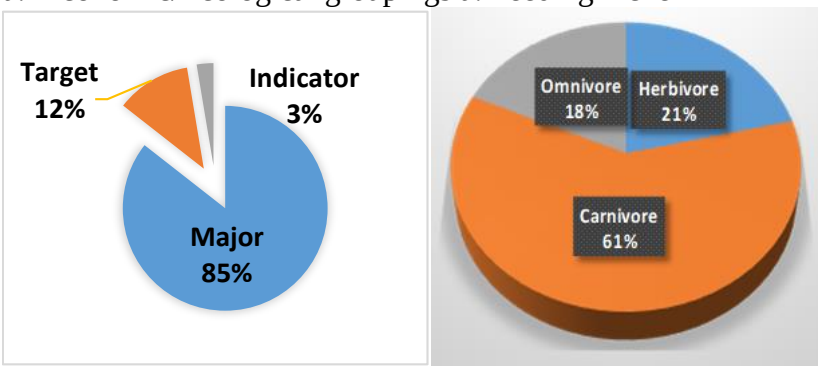


Figure 3a shows that target species in Albay gulf is very minimal, representing 12% only (112 fishes). Target species are essentially the targets of fishing operation because of their inherent economic value. Similarly, indicators species are also very inimal in fish count. Mostly represented by perturbation-sensitive species from Family Chaetodontidae (butterfly fishes) and some from Family Labridae (cleaner wrase), indicator species are represented by only 25 fishes or 3% of total number of fishes encountered in all the transects in Albay Gulf. Bulk (812 or 85%) of the fishes encountered are belonging to major group. Fish assemblage dominated by major group have less to offer for fisheries as these fishes are of less economically important and are not 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 classifies the reef fishes of Albay Gulf according to their feeding habits. Most of the fishes encountered are carnivores (61%). There seem to be an imbalance now as these groups outnumber those that are at the lower trophic level, such as herbivores and omnivores which just represent 21 and 19% respectively. The very low count of herbivore fishes will directly connect to the significant elimination of grazers, which partly could have been caused the macro algal growth along reef systems of the gulf.

Coral reefs in the MPA of Sto. Domingo harbors the densest reef fishes with 2, 58 fishes/m^2. This is followed by Bacon district with 1.71 fishes/m^2 and Caracaran MPA with 1.63 fishes/m^2. The rest of the sites have barely 1 fish/m^2.

Table 9 shows the computed values of the ecological indices computed for the coral reef fishes in the MPA reefs surveyed. Bacon district, Santo Domingo and Caracaran yielded the highest diversity indices computed (H=2.77 to 3.06). The equitability values for these locations are also high, indicative of more similar representation of fish count per species. The dominance values of these locations are lowest, consistent to the general inverse relationship between diversity and dominance.

Table 9. Ecological indices of reef fishes of Albay Gulf

MPA/ Reef area	Shannon's Diversity (H)	Equitability	Simpson's Index of Dominance ((D)
Sto. Dom MPA2	2.80	0.74	7.24
Caracaran MPA	2.77	0.82	9.13
Rapu Pob MPA	2.39	0.77	15.25
Pto. Diaz MPA	2.05	0.65	17.04
Kabunturan MPA	2.29	0.84	13.54
Bacon District MPA	3.06	0.84	3.67

In contrast, Prieto Diaz, Kabunturan in Legazpi City and Rapu-Rapu Poblacion registered the lowest (H=2.05 to 2.39). This means that there are species that tend to dominate in terms of fish count. This is clearly manifested by the high dominance (D) values computed for the three stations.

Coral reefs status and reef fish abundance and biomass between inside and outside sanctuaries

Some of the reef systems inside and outside MPAs were assessed for Legazpi City and Rapu-rapu, Albay. The assessment was designed to glean some impacts of management to the habitat status, one (inside) afforded with protection while the other (outside MPA) are unprotected. As seen from Table 3, the three non-MPA reef systems of Legazpi (Pasig, Denson and Maslog reefs) were assessed and yielded fair to good coral cover (40-51.22% LCC). In contrast, the MPA reef system (Kabunturan reef) which are just in fair condition (40.3-47.4% LCC). The same was found out in the reefs of the two MPAs of Rapu-rapu with live coral cover range of 18.26 to 37.54% as compared to unprotected reef areas with superior live coral cover of 56.6-66.6%.

Some realities are visible from this data. There are reef systems in Legazpi City and in Rapu-rapu (and intuitively in the entire gulf), that are in good shape that despite of lack of protection (i.e., not part of the MPA). These areas deserve protective management as well. The inferior coral condition inside MPAs may not necessarily be reflective of inadequacy of management but could be inherent to its vulnerability to disturbances like storms (for both MPAs) and siltation (as in the case of Kabunturan MPA of Legazpi). The MPAs of Rap-rapu is just four years old. Prior to its declaration as protected area, they were subjected to fishing

activities of varied forms, involving even the destructive practices. The developing new coral recruits over dead coral substrates observed along Caracaran may indicate that the reef systems are just recovering. This recovery stage is not much visible in Poblacion Rapu-rapu MPA as macroalgae, which cover 64-75% of the transects, have successfully overtaken the corals in colonizing baren and dead corals substrates.

Associated Macro Invertebrates and Observable Perturbation

Crown of thorns were ubiquitous in Albay gulf. They are however seen more frequently in the Legazpi, Bacon district and Manito reef systems (Figure 2). Ghost (abandoned) fishing gears such as entangled fish nets and bottom set long line are seen in all reef systems except in Prieto Diaz. Some bleached corals are seen in Sto Domingo, Rapu-rapu and Denson Reef of Legazpi City. Although some of them have recovered, some bleached coral recruits in Caracaran and the shallow part of Maslog reef have failed to recover. The highlighted overgrowth of macroalgae is also everywhere but more pronounced in Rapu-rapu, Bacon District and Prieto Diaz. The once reported Drupella infestation in the reef systems of Legazpi City is not seen during the recent summertime assessment. But the same population bloom could happen anytime as they are still there and the bio-ecological triggers for this event are obviously still prevailing.

Figure 4. Observable disturbances

CONCLUSION AND RECCOMENDATIONS

This assessment is a pioneering, first comprehensive gulf-wide assessment of coral reefs and the associate reef fishes in Albay gulf. The reef systems of six out of seven municipalities bordering Albay Gulf were assessed for the purpose of determining the condition of the reef systems and the reef fishes inhabiting therein. Bulk of these reef systems are inside MPAs while non-MPA reefs were also assessed in Legazpi City and Rapu-rapu, Albay for comparison purposes. These reef systems comprise to around 2.22% of total gulf area. No coral reefs for Bacacay was assessed as the MPA of this municipality is located on the other side (Lagonoy gulf). Overall, the MPAs provide protection to just 0.88% of the entire gulf area, way below what's prescribed by the law.

Generally, reef systems of Albay gulf are in different state of health, mostly in fair condition. Some are however in poor and good conditions. From the stations surveyed in Legazpi and Rapu-Rapu, non-MPA reefs are interestingly in better condition than those reefs inside the MPA. The inferior coral condition inside MPAs may not necessarily be reflective of inadequacy of management. The vulnerability of the MPA sites to natural disturbances such as

storm and massive siltation due to its proximity to rivers and the intense fishing activity expended to the reefs prior to their protection may have contributed to this. Macro algal growth over dead corals have been commonly observed in all reefs surveyed. This will have some serious implication to the recovery of corals. The artificial reef installed in Sto. Domingo Albay in in bad state. The concrete dome-like "coral beads" were mostly buried now in sand flat and colonized with macroalhgae and some recruits of branching corals. Some fishes (puffers, pomacentrids and scorpionfish) were observed in the AR modules.

The reef fishes in Albay Gulf manifested a very variable diversity (15-43 species) in at least 11 major reef areas. Of the six MPA reef systems surveyed, Sto. Domingo MPA registered the biggest biomass of 56.12 mt/km^2 followed by Bacon District with 41.04 mt/km^2 and Caracaran, Rapu-rapu with 33.8 mt/km^2. The remaining have poor reef fish biomass just ranging from 9.84 to 33 mt/k m^2. These biomass rates are comparable to many reef areas in Bicol. Likewise, the reef fishes are now dominated by fishes coming from major group (85%) with very low percentage of fisheries target species (12%) and indicators (3%).

In terms of feeding habit, most of the fishes encountered are carnivores (61%). There seem to be an imbalance now as these groups outnumbering those that are at the lower trophic level, such as herbivores and omnivores which just represent 21 and 19% respectively. The very low count of herbivore fishes will directly connect to the significant elimination of grazers by fisheries, which partly could have been caused the macro algal growth along reef systems of the gulf.

Presence of crown of thorns were seen in all reef areas surveyed, but are more frequently encountered in the Legazpi, Bacon district and Manito reef systems (Figure 2). Ghost (abandoned) fishing gears such as entangled fish nets and bottom set long line are seen in all reef systems except in Prieto Diaz. Evidences of coral bleaching are seen in Sto Domingo, Rapu-rapu and Denson Reef of Legazpi City. Although some of them have recovered, some bleached coral recruits in Caracaran and the shallow part of Maslog reef have failed to recover. The highlighted overgrowth of microalgae is also everywhere but more pronounced in Rapu-rapu, Bacon District and Prieto Diaz. The opportunistic coral eating gastropod called Drupella were still in Legazpi reef systems but they are not in the infestation level. But the same population bloom and eventually massive coral predation could happen anytime as they are still there and the bio-ecological triggers for this event are obviously still prevailing

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 Albay gulf is entirely a 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 Albay 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 verify the recent on-going coral transplantation in Legazpi City and the coral rosary AR project off Sto. Domingo. These and other similar interventions should be carefully studied prior to its implementation in other areas.

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. They were observed to be rampant in almost all reef systems in the gulf except in Prieto Diaz. Managers should always be on the watch for crown of thorn and Drupella infestation.

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APPENDICES

Appendix A. Percent cover of coral benthic lifeforms of Legazpi City reef systems.

Gulf				Albay Gulf				
Municipality				Legazpi City				
Reefs				Pasig Reef	Denzon Reef	Kabuntu ran T1	Kabuntu ran T2	Maslog T1
Depth (meters)				7	11	8	10	12
Direction								
Live Coral	Hard Coral	Acropora	Acropora branching (ACB)	20.66	0.52		3.88	2.58
			Acropora digitate (ACD)	0.68				0
			Acropora encrusting (ACE)	0.48		1.9		0.54
			Acropora submassive (ACS)	0.6	0.52			
			Acropora tabulate (ACT)					0.6
			Acropora Total	22.42	1.04	1.9	3.88	3.72
		Non Acropora	Heliopora (CHL)					
			Millepora (CME)	0.06		0.52		2.44
			Mushroom coral (CMR)		1.06	6.44	6.48	0.56
			Branching corals (CB)	2.68	37.1	6.02	2.92	24.56
			Encrusting corals (CE)	4.46	1.46	2.5	7.98	1.46
			Foliose corals (CF)	0.32	0.18	10	6.96	0
			Massive corals (CM)	8.94	10.18	4.52	14.92	16.66
			Submassive corals (CS)		0.1	1.18	2.42	1.18
			Non Acropora Total	16.46	50.08	31.18	41.68	46.86
		Hard Coral Total		38.88	51.12	33.08	45.56	50.58
			Soft coral (SC)	4.14	0	7.18	1.86	
	Live coral Total			43.02	51.12	40.26	47.42	50.58
Percent cover category				FAIR	GOOD	FAIR	FAIR	GOOD
Dead corals			Dead Coral (DC)	0.3	0.04	2.74		
			Dead coral with algae (DCA)	35.14	43.06	46.76	32.36	31.78
			Dead Coral Total	35.44	43.1	49.5	32.36	31.78
Other Organism			Other animals (OT)	0.1	0.3	0.7	0.78	0.64
			Sponge (SP)	0.98	0.66	0.16	0.18	1.64
			Zoanthids (ZO)	0.38				0.16
			Other Organism Total	1.46	0.96	0.86	0.96	2.44
Algae			Algal assemblages (AA)	4.12	0.54		4.68	0.32
			Coralline algae (CA)	0.1			0.68	3.08
			Halimeda (HA)					
			Macroalgae (MA)	1.82	3.84	0.46	1.22	4.14
			Turf Algae (TA)					
			Algae Total	6.04	4.38	0.46	6.58	7.54
Abiotic			Rock (RO)				0.44	2.46
			Rubble (R)	2.3		4.04	3.6	3.98
			Sand (S)	11.74	0.44			
			Silt (SI)			4.88	8.64	1.22
			Total	14.04	0.44	8.92	12.68	7.66
TWB								
Total				100	100	100	100	100

Appendix B. Percent cover of coral benthic lifeforms of Sto. Domingo, Albay

Gulf				Albay Gulf		
Municipality				Sto Domingo		
Reefs				MPA T1	MPA T2	MPA T3
Depth (meters)				8	10	14
Direction						
Live Coral	Hard Coral	Acropora	Acropora branching (ACB)	1.26	3.24	1.02
			Acropora digitate (ACD)	0.1		
			Acropora encrusting (ACE)			
			Acropora submassive (ACS)	0.3	1.48	
			Acropora tabulate (ACT)	1.9	4.16	1.34
			Acropora Total	3.56	8.88	2.36
		Non Acropora	Heliopora (CHL)			
			Millepora (CME)			1.58
			Mushroom coral (CMR)	0.44	0.64	0
			Branching corals (CB)	11.64	7.02	6.84
			Encrusting corals (CE)	8.3	6.62	2.68
			Foliose corals (CF)	1.92		
			Massive corals (CM)	9.1	13.74	20.74
			Submassive corals (CS)	0.7	3.34	7.58
			Non Acropora Total	32.1	31.36	39.42
		Hard Coral Total		35.66	40.24	41.78
			Soft coral (SC)		0.2	1.14
	Live coral Total			35.66	40.44	42.92
Percent cover category				FAIR	FAIR	FAIR
Dead corals			Dead Coral (DC)	0.24	0.1	1.12
			Dead coral with algae (DCA)	7.06	1.64	5.92
			Dead Coral Total	7.3	1.74	7.04
Other Organism			Other animals (OT)	0.52	0.22	0.36
			Sponge (SP)	1.06	2.68	1.14
			Zoanthids (ZO)		0.18	
			Other Organism Total	1.58	3.08	1.5
Algae			Algal assemblages (AA)	29.96	31.26	5.48
			Coralline algae (CA)	2.66	2.98	0.36
			Halimeda (HA)	5.86	2.22	0.86
			Macroalgae (MA)	10.1	10.88	3.52
			Turf Algae (TA)	0.06		15.38
			Algae Total	48.64	47.34	25.6
Abiotic			Rock (RO)	2.08		
			Rubble (R)	0.34	1.22	
			Sand (S)	1.2	2.18	
			Silt (SI)	3.2	4	22.6
			Total	6.82	7.4	22.6
TWB						0.34
Total				100	100	100

Appendix C. Percent cover of coral benthic lifeforms of Rapu-rapu, Albay.

Municipality				Batan, Rapu-rapu			Rapu-rapu Poblacion		
Reefs				Caracaran MPA T1	Caracaran MPA T2	Caracaran non-MPA	Poblacion MPA T1	Poblacion MPA T2	Poblacion non-MPA
Depth (meters)				9	7	3	15	15	
Direction				SE 330°	NE 205°	W 90°	SW	SW	
Live Coral	Hard Coral	Acropora	Acropora branching (ACB)	2.32	3.02	9.74		0.14	
			Acropora digitate (ACD)	0.3	0.48	3.36	0.06		0.38
			Acropora encrusting (ACE)		0.18	2.92			
			Acropora submassive (ACS)		0.72	1.2			0.3
			Acropora tabulate (ACT)	12.46	12.42	9.12		0.64	0.88
			Acropora Total	15.08	16.82	26.34	0.06	0.78	1.56
		Non Acropora	Heliopora (CHL)						
			Millepora (CME)						
			Mushroom coral (CMR)		0.34		1.04	0.28	0.52
			Branching corals (CB)	1.14	1.54	4.52	1.84	15.98	29.62
			Encrusting corals (CE)	6.82	6.16	8.36	5.98	4.02	2.34
			Foliose corals (CF)	0.18	0.4	0.88			
			Massive corals (CM)	11.7	11.06	12.18	8.08	5.92	32
			Submassive corals (CS)	1.3	0.82	4.32	1.06	0.46	0.54
			Non Acropora Total	21.14	20.32	30.26	18	26.66	65.02
		Hard Coral Total		36.22	37.14	56.6	18.06	27.44	66.58
			Soft coral (SC)	1.32			0.2	0.18	
	Live coral Total			37.54	37.14	56.6	18.26	27.62	66.58
Percent cover category				FAIR	FAIR	GOOD	POOR	FAIR	GOOD
Dead corals			Dead Coral (DC)	0.08	0.2		1.26	0.3	
			Dead coral with algae (DC	0.56	0.14	5.42	1.06	3.4	11.98
			Dead Coral Total	0.64	0.34	5.42	2.32	3.7	11.98
Other Organism			Other animals (OT)	1.82	0.58		0.14	0.34	0.22
			Sponge (SP)	2.5	2.9	0.38	1.56	0.36	0.82
			Zoanthids (ZO)	0.1	0.18		0.04		
			Other Organism Total	4.42	3.66	0.38	1.74	0.7	1.04
Algae			Algal assemblages (AA)	16.4	16.16	12.72	25.58	24.2	7.26
			Coralline algae (CA)	0.86	2.44	3.18	1.22	0.9	0.96
			Halimeda (HA)			0.32	2.86	1.52	7.18
			Macroalgae (MA)	23.42	17.72	15	45.04	36.18	2.06
			Turf Algae (TA)	0.06	0.6	1.5	0.24	1.7	0.04
			Algae Total	40.74	36.92	32.72	74.94	64.5	17.5
Abiotic			Rock (RO)	6.6	0.98				
			Rubble (R)	0.28	3.94	0.26			2.28
			Sand (S)	6.98	9.62	0.3	0.94	2.72	0.46
			Silt (SI)	2.8	6.78	3.98	1.62	0.36	0.04
			Total	16.66	21.32	4.54	2.56	3.08	2.78
TWB					0.62	0.34	0.18	0.4	0.12
Total				100	100	100	100	100	100

Appendix D. Percent cover of coral benthic lifeforms of Sto. Domingo, Albay

Gulf				Albay Gulf		
Municipality				Sto Domingo		
Reefs				MPA T1	MPA T2	MPA T3
Depth (meters)				8	10	14
Direction						
Live Coral	Hard Coral	Acropora	Acropora branching (ACB)	1.26	3.24	1.02
			Acropora digitate (ACD)	0.1		
			Acropora encrusting (ACE)			
			Acropora submassive (ACS)	0.3	1.48	
			Acropora tabulate (ACT)	1.9	4.16	1.34
			Acropora Total	3.56	8.88	2.36
		Non Acropora	Heliopora (CHL)			
			Millepora (CME)			1.58
			Mushroom coral (CMR)	0.44	0.64	0
			Branching corals (CB)	11.64	7.02	6.84
			Encrusting corals (CE)	8.3	6.62	2.68
			Foliose corals (CF)	1.92		
			Massive corals (CM)	9.1	13.74	20.74
			Submassive corals (CS)	0.7	3.34	7.58
			Non Acropora Total	32.1	31.36	39.42
		Hard Coral Total		35.66	40.24	41.78
			Soft coral (SC)		0.2	1.14
	Live coral Total			35.66	40.44	42.92
Percent cover category				FAIR	FAIR	FAIR
Dead corals			Dead Coral (DC)	0.24	0.1	1.12
			Dead coral with algae (DCA)	7.06	1.64	5.92
			Dead Coral Total	7.3	1.74	7.04
Other Organism			Other animals (OT)	0.52	0.22	0.36
			Sponge (SP)	1.06	2.68	1.14
			Zoanthids (ZO)		0.18	
			Other Organism Total	1.58	3.08	1.5
Algae			Algal assemblages (AA)	29.96	31.26	5.48
			Coralline algae (CA)	2.66	2.98	0.36
			Halimeda (HA)	5.86	2.22	0.86
			Macroalgae (MA)	10.1	10.88	3.52
			Turf Algae (TA)	0.06		15.38
			Algae Total	48.64	47.34	25.6
Abiotic			Rock (RO)	2.08		
			Rubble (R)	0.34	1.22	
			Sand (S)	1.2	2.18	
			Silt (SI)	3.2	4	22.6
			Total	6.82	7.4	22.6
TWB						0.34
Total				100	100	100

Appendix E. Percent cover of coral benthic Bacon district and Pto. Diaz, Sorsog

Gulf				Albay Guf		
Municipality				Bacon, Sor.	Prieto Diaz MPA	
Reefs				MPA T1	MPA T1	MPA T2
Depth (meters)				22	3	12
Direction					SW 88°	NE 210°
Live Coral	Hard Coral	Acropora	Acropora branching (ACB)	21.42	0.18	
			Acropora digitate (ACD)			
			Acropora encrusting (ACE)		18.24	0.48
			Acropora submassive (ACS)		0.06	
			Acropora tabulate (ACT)	3.58	2.42	
			Acropora Total	25	20.9	0.48
		Non Acropora	Heliopora (CHL)			
			Millepora (CME)			
			Mushroom coral (CMR)	0.98		0.42
			Branching corals (CB)	4.42	0.26	0
			Encrusting corals (CE)	6.36	4.72	7.9
			Foliose corals (CF)		0.76	
			Massive corals (CM)	3.4	3.36	0.88
			Submassive corals (CS)	0.44	0.68	0.38
			Non Acropora Total	15.6	9.78	9.58
		Hard Coral Total		40.6	30.68	10.06
			Soft coral (SC)	1.68		
	Live coral Total			42.28	30.68	10.06
Percent cover category				FAIR	FAIR	POOR
Dead corals			Dead Coral (DC)	0.06		
			Dead coral with algae (DCA)	9.7	2.18	0.1
			Dead Coral Total	9.76	2.18	0.1
Other Organism			Other animals (OT)	0.3		
			Sponge (SP)		0.06	0.3
			Zoanthids (ZO)			
			Other Organism Total	0.3	0.06	0.3
Algae			Algal assemblages (AA)	17.9	6.64	13.6
			Coralline algae (CA)	9.06	1.3	2.84
			Halimeda (HA)	6.06	23.04	15.36
			Macroalgae (MA)	13.68	29.98	21.54
			Turf Algae (TA)	0.08	6.08	21.98
			Algae Total	46.78	67.04	75.32
Abiotic			Rock (RO)		0.04	
			Rubble (R)	0.76		
			Sand (S)			13.84
			Silt (SI)	0.12		
			Total	0.88	0.04	13.84
TWB						0.38
Total				100	100	100

SEAGRASS AND SEAWEED HABITAT ASSESSMENT IN ALBAY GULF

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ABSTRACT

A habitat assessment of seagrass and seaweed beds in six municipalities bordering Albay Gulf noted 10 seagrass species and 36 seaweeds species. *Cymodocea rotundata*, *Cymodocea serrulata*, *Halodule pinifolia*, *Halodule uninervis* and *Syringodium isoetifolium* from Family Cymodoceaceae and *Enhalus acoroides*, *Halophila ovalis*, *Halophila minor*, *Halophila decipiens*, and *Thalassia hemprichii* under Family Hydrocharitaceae were taxonomically identified. All these species were noted in Manito, Sto. Domingo and Prieto Diaz. Among the seaweeds, 11 genera were noted under Chlorophyceae, five from Phaeophyceae, and seven in Rhodophyceae. *Acetabularia, Halicoryne, Halimeda, Neomeris, Padina* and *Sargassum* were commonly found in most of the stations with *Padina* as the most abundant. Manito takes the highest number of 17 seaweeds species noted. *Thalassia hemprichii* was the most abundant in Prieto Diaz and across all stations visited. *Syringodium isoetifolium* followed being the most abundant species in Bacon District and Sto. Domingo. *Halodule uninervis* and *Cymodocea rotundata* were abundant in Rapu-Rapu and Manito, respectively. *Enhalus acoroides* has the least percentage cover although it was most abundant in Legazpi City and harbor highest biomass. *Halimeda* spp. had high biomass. Few associated macroinvertebrates were noted such as sponges, sea cucumbers, univalves, bivalves, sea urchins and starfishes. The habitat status of seagrass and seaweed beds in Sto. Domingo was excellent. Prieto Diaz was next with good bed condition, as well as Manito and Bacon District. Rapu-Rapu and Legazpi had fair habitat condition. Generally, the beds near human settlements showed physical disturbance.

Keywords: Seagrasses, Seaweeds, Albay Gulf, habitat assessment, biomass

Introduction

The seagrass and seaweed habitat is one of the marine ecosystems that play environmentally and economically vital ecosystem services. As autotrophs, the benefits of seagrasses and seaweeds encompass wide areas. They are the primary producers in the marine ecosystem and serve as habitat and breeding ground of marine organisms. Seagrasses are sensitive to both biological and physical fluctuations, making them useful indicators of changes not easily observable in either coral reef or mangrove forest (Fortes, 2013). Goldman and Daniels (2014) stated that there are several seaweed species that play vital roles in the development of coral reefs or as essential habitats for other animals. Seagrass and seaweeds also aid in minimizing the effects of climate change. Although seagrasses represent only a small area (0.2% of the oceans' surface), it is estimated that they store 20% of oceanic blue carbon (Short, et.al., 2016). Seagrasses sequester and store carbon in their roots and sediments. Dewi and Sukandar (2017) stated that seagrass stores carbon in the form of biomass in its body and classified it into above the substrate and below the substrate. UNEP/IUCN (2009) stated that, "…when healthy, mangrove forests, saltwater marshlands and seagrass meadows are extremely effective at storing atmospheric carbon, thereby mitigating climate change."

Humans benefit from seagrass and seaweeds as good sources of materials, food, medicine and livelihood activities. Seagrasses have a long history of use in the Philippines, such as woven into baskets, roof thatch, stuffing for mattresses, and compost for fertilizer (White, 2003). As stated in the Department of Agriculture-Bureau of Fisheries and Aquatic Resources (DA-BFAR) presentation on the Status of the Philippine Seaweed Industry, seaweeds are good source of phycocolloid (i.e. algin, agar and carrageenan) that has varied uses/application in food preparation, as microbiological media, and in pharmaceutical and industrial settings. There are also *Kappaphycus* and *Caulerpa* farmers, as well as *Gracilaria* and *Sargassum* gatherers for livelihood activities. Chanda et.al. (2010) stated that seaweeds are considered as a source of bioactive compounds as they are able to produce a great variety of secondary metabolites characterized by a broad spectrum of biological activities. Compounds with antioxidant, antiviral, antifungal, and antimicrobial activities have been detected in brown, red, and green algae.

However, the threat to seagrass and seaweed meadows is apparent. In spite of the ecological and economic value of seagrasses, between 30-50 percent of Philippine seagrass beds have been lost due to industrial development, ports, and recreation in the last 50 years (Philippine Biodiversity Strategy and Action Plan 2015-2028). Higher demands for resources by the growing population lead to rapid production and consumption. Human activities posing threat include reclamation of coastal areas to expand development and clearance of beaches for tourism purposes. Brodie and N'Yeurt (2018) identified two groups of anthropogenic threats to seagrass resources: those linked clearly to climate change, such as increased storm strength, sea level rise, increased temperature and CO_2 levels, ocean acidification and exposure to increased wave energy, and those not directly related to climate change such, as water quality and poor catchment management practices (includes pollution, land runoff and nutrient loads), and urban expansion and poorly planned coastal infrastructure. Human impacts on seagrass beds were prominent in terms of improper waste disposal and sewage discharge due to its proximity to human settlements and infrastructures for recreational purposes of this habitat (Meode, et.al. 2014). Short (2016) stated that seagrasses are among the world's most threatened ecosystems and yet are little known because they are usually submerged and not easily seen. Duarte et al. stated that the seagrass shallow coastal environment is also particularly prone to physical disturbance, whether by waves or turbulence associated with strong storms. In

addition, very little is known about seagrass pathogens and related diseases, aside from the seagrass wasting caused by the marine slime mold, *Labyrinthula*. Few reports on seagrass diseases, however, may not reflect a high resistance of seagrasses to infections but the difficulty to detect them.

Managing seagrass for fisheries is complex, and many fisheries agencies embrace ecosystem-based management, but do not have direct responsibility for seagrass habitat (Hyndes, et.al., 2018).The concept of Ecosystem-Based Management, where humans are seen as an integral part of the ecosystems they manage, is crucial if seagrass habitats are to be effectively managed and conserved in a way that is sustainable to both the marine habitats and the human populations that depend on them (Brodie et.al., 2018). Both these studies recommended the conduct of further research, such as to identify what seagrass resources exist and identify specific threats and vulnerable habitats/regions.

Several studies on seagrasses were conducted in the different parts of the Philippines. Some research works were of Calumpong et al. (1983) in Davao; Paz-Alberto et al. (2015) in Zambales; and Tanduyan et al. (2011) in Camotes Island. Another research was of Nacorda, which presented, a seagrass community assessment in North Palawan and Bolinao, Pangasinan in 2005. Reviews and studies showed only a few studies on seagrasses and seaweeds in the Bicol Region, particularly in Albay Gulf. Hence, this study aimed to assess the seagrass and seaweed habitat in Albay Gulf in the Bicol Region, specifically in terms of species composition and distribution, percentage cover, and wet biomass. Account of associated macroinvertebrates in the given area was also noted. Habitat assessment of the seagrass and seaweed beds is one way to provide baseline data, which can be used by all stakeholders to inform the value and ecosystem services of seagrass and seaweed beds, as well as guide for coastal resource management.

Methodology

Study Area

The assessment of seagrass and seaweed beds in Albay Gulf, eastern part of the Philippines, covered a total of six municipalities in the provinces of Albay and Sorsogon (Appendix A). From Albay, there were nine stations surveyed in the different barangays of Legazpi City, Sto. Domingo, Manito and Rapu-Rapu. In Sorsogon, a total of five stations were visited in Prieto Diaz and Bacon District.

Field Sampling and Species Identification

A Line Transect-Quadrat Method (described by English et al., 1994) was used to assess the seagrass and seaweed beds in Albay Gulf from March to April 2019. Along the 100-meter transect line, 0.5 m^2 quadrats were laid at intervals of 10 m from the starting point of transect perpendicular to the shoreline. Sampling station locations were recorded using global positioning system at the start of every transect where seagrass and seaweed beds can be found (Appendix B).

Identification of species in every quadrat was based on taxonomic guides from the published studies “Seagrasses from the Philippines” (Menez, Phillips, & Calumpong, 1983), “A Review: Biodiversity, Distribution and Conservation of Philippine Seagrasses” (Fortes,

2013); and from the Field Guide and Atlas of the Seaweed Resources of the Philippines developed by Trono, (2004, 2017).

Data Analysis

The percentage cover of each species was estimated visually and determined using the formula and the table below by Saito & Atobe (1970).

Table 1. Sea grass meadows coverage percentage category (Saito and Atobe, 1970)

Class Area	*Coverage*	*% Cover Area*	*Midpoint*
5	½ to full	(50-100)	75
4	¼ 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

$C = \sum (M_i \times f_i) / \sum f.$, where: M_i = midpoint percentage of class i and f = frequency (number of sectors with the same class of dominance).

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

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

The weight of each species harvested from the quadrats of every transect was measured without the roots/holdfasts using a digital top loading balance. Wet biomass was estimated by dividing the total weight of each species by the total area (gm/m^2) assessed.

Result and Discussion

The Seagrass and Seaweed Species

The Philippines belongs to the Tropical Indo-Pacific region with a total of 19 known seagrass species out of 21 species in Southeast Asia (Fortes, 2018). The study of Calumpong (1983) on the taxonomy and distribution of seagrasses in the western coast of the Gulf of Davao, Mindanao, recorded nine seagrass species. A study in Bondoc, Southern Leyte, Visayas had identified seven seagrasses. Other studies in Luzon noted eight species from Bongsanglay Natural Park of Masbate, seven species in North Palawan, and five species from Zambales (Masinloc and Candelaria).

There were 10 species in six genera of seagrass recorded in Albay Gulf, which comprised 53.15% of the total number found in the Philippines. Under Family Cymodoceaceae, there were five species, namely *Cymodocea rotundata, Cymodocea serrulata, Halodule pinifolia, Halodule uninervis* and *Syringodium isoetifolium*. Family Hydrocharitaceae also has five identified species of which the biggest seagrass was *Enhalus acoroides,* and the small ones were *Halophila ovalis, Halophila minor* and *Halophila decipiens,* and *Thalassia hemprichii*. Pictures of the samples of the seagrass species from different stations in Albay Gulf were taken (Appendix C).

Many studies on the Philippine seaweeds, particularly of Trono (2004) showed the wide diversity of seaweed species. A total of 1,062 seaweeds species were recorded in the Philippines as stated in the Philippine Biodiversity Strategy and Action Plan 2015-2028. There were also 12 species of seaweeds identified in Bongsanglay Natural Park, Masbate.

In this study, a total of 36 species of seaweeds in 23 genera were recorded from the sampling stations in Albay Gulf, representing 3.39% of the seaweed species in the Philippines (Appendix D). There were 21 species of seaweed in 11 genera under Class Chlorophyceae or Green Algae, namely *Acetabularia* sp., *Bornetella nitida, Bornetella sphaerica, Bornetella* sp., *Caulerpa lentillifera, Caulerpa microphysa, Caulerpa racemosa, Caulerpa sertularioides, Caulerpa* sp., *Chaetomorpha* sp., *Cladophora* sp., *Dictyosphaeria cavernosa, Dictyosphaeria* sp., *Halicoryne* sp., Halimeda *cylindracea, Halimeda macroloba, Halimeda opuntia, Neomeris* sp., and two species of *Valonia*. Five species were brown algae or Class Phaeophyceae namely, *Dictyota* sp., *Hydroclathrus clathratus, Padina* sp., *Sargassum* sp., and *Turbinaria* species. The 10 species in seven genera under Class Rhodophyceae or Red Algae identified were *Eucheuma* sp., *Galaxuara* sp., four *Gracilaria* spp., *Hypnea* sp., *Jania* sp., *Kappaphycus* sp. and *Laurencia* species. Samples of these species are shown in Appendix D1.

The Seagrass and Seaweed Distribution

Seagrass and seaweed species occurrence varies in the different municipalities bordering Albay Gulf.All the 10 seagrass species identified can be found in Manito, Sto. Domingo, and Prieto Diaz with *Halophila decipiens* being the distinct species that was not recorded in other three municipalities. Nine seagrass species were identified in Legazpi, Rapu-Rapu, and Bacon District. Among the 36 seaweed species, Manito, Rapu-Rapu and Prieto Diaz harbored high number of seaweeds identified ranging from 15-17 species. Sto. Domingo and Bacon District has 10 seaweed species while Legazpi had nine seaweeds. *Padina* sp. was common in all municipalities.

Among the different stations surveyed, both Station 1 of Sto. Domingo and Manito had 10 seagrasses noted (Figure 1). Species richness was observed from these areas, including a

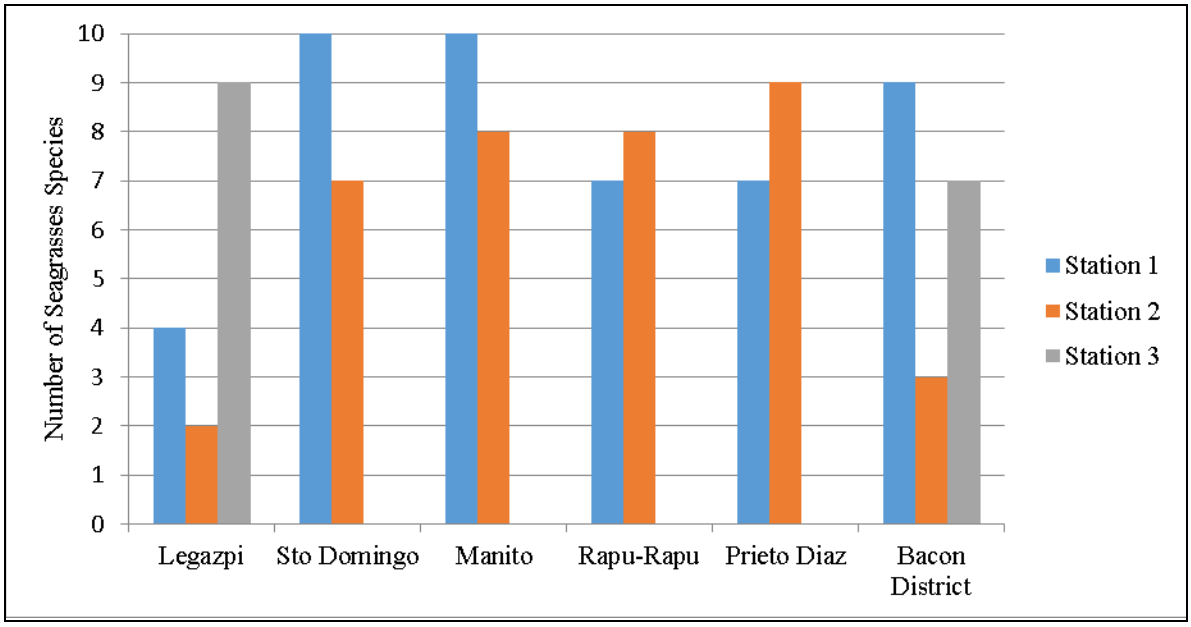

Figure 1. Number of Seagrasses Per Station in the Municipalities of Albay Gulf

station from Prieto Diaz and Bacon District. Station 3 in Legazpi City had nine seagrass species noted. However, occurrence of four species in Station 1 and only two seagrass species in Station 2 of this city was observed. Rapu-Rapu had seven and eight species identified in Station 1 and 2, respectively. Seven seagrass species were found in Station 1 and nine in Station 2 of Prieto Diaz. The distinct presence of *Cymodocea serrulata* in Station 1 and *Halophila decipiens* in Station 2 made a total count of 10 seagrass species in Prieto Diaz. In Bacon District, Station 1 had nine identified seagrass species, Station 2 had three, and Station 3 had seven. This number was higher than the assessment conducted by Dioneda et al. (2009) in Bacon District.

Manito area had the highest number of seaweeds (17) recorded with 15 from Station 1 in Holugan and another two different species from Station 2 (Figure 2). Extreme difference was observed in the stations of Manito in terms of the number of seaweeds noted. Station 1 was near a rocky cliff, has clear water, and sand with coarse sediment and few coral rubble substrate. Station 2 was adjacent to mangrove areas with sandy muddy substrate near the shoreline.

Second to the highest number of seaweed occurrence was Rapu-Rapu with 16 species noted. There were nine and 13 seaweeds identified in Station 1 and 2, respectively. Station 1 was near a mangrove area having sandy muddy substrate and part of it was exposed during low tide. Station 2 was located near a seaport with an adjacent mangrove area and vulnerable to disturbance from human activities.

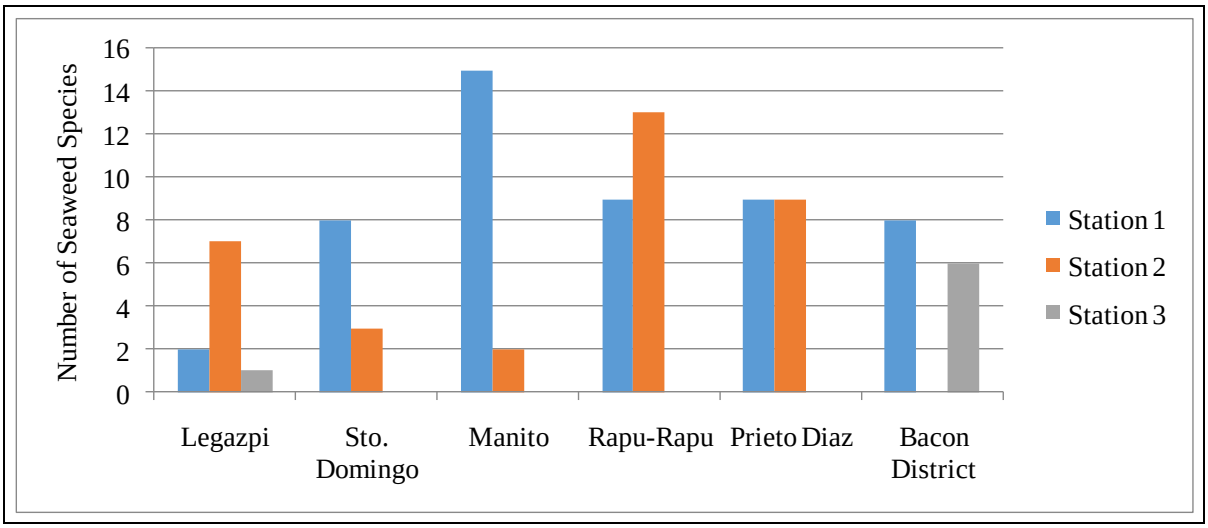

Figure 2. Number of Seaweeds Per Station in the Municipalities of Albay Gulf

Third was Prieto Diaz with 15 seaweeds named. In the wide shallow seagrass bed, both stations had nine varied seaweed species thriving in the clear waters. From Bacon District, there were 10 seaweeds, of which Station 1 had the largest number with eight species while Station 3 had six. Station 2 had no recorded seaweeds. This station near mangroves had a murky water with muddy sandy substrate. Water turbidity affects algal growth. The study of Wang (1974) on the effect of water turbidity on algal growth showed that high turbidity conditions retard algal growth, a light-inhibition effect.

Both the Legazpi and Sto. Domingo areas recorded nine seaweed species. Seven seaweed species were noted in Station 2 of Legazpi, two species in Station 1, and only one in Station 3. Murky water with muddy substrate was observed in the last two stations. Station 1 in Sto. Domingo had eight seaweed species while Station 2 only had three. The marked difference in the number of seaweed species between these stations can be attributed to the nutrient loading from the settlement nearby.

The difference in seagrass and seaweed species distribution in every municipality was evident. This difference can be attributed to the physical factors including substrate, location, and distance from human settlements and activities, as well as land development in the area. There were stations with a high number of seagrasses and seaweeds while some stations observed a low number of species occurrence and distribution. According to Duarte (2011), most seagrass species are confined to sandy to muddy sediments, although some species can grow over rock. In this study, a majority of the stations had sandy to muddy type of substrate except a station in Rizal, Prieto Diaz where the presence of corraline substrate was observed. Species richness of seagrass was observed in Prieto Diaz, Manito, and Sto. Domingo. A station in Caricaran, Bacon District showed nine species growing together in the seagrass bed but the other two stations, Banao and Del Rosario, had minimal species occurrence. Differences in species occurrence could also be attributed to the substratum. The substratum is a very important regulator of seagrass, according to Greve and Binzer (2004). Barangay Puro, Station 2 in Legazpi was near a reclamation site for access road development. Disturbance of the seagrass and seaweed bed in this area was evident and a fisherman that the small seagrasses,

Halophila species, were gone near the shoreline due to the heavy sedimentation load from the reclamation activity. Although there was occurrence of patches of *Halophila* species noted meters away from the sampling site, this was not included in the data. According to Short et al. (2016), seagrass beds alter their distribution and biomass in response to changing water quality, nutrient inputs, and light levels. The stations near human settlements and activities, such as Legazpi City and Rapu-Rapu showed fewer species occurrence.

Many epiphytes were seen in the seagrass beds of Station 2 in Diamante, Prieto Diaz, Sorsogon (Appendix E). From a compilation of seagrass studies, Borowitzka et al. (2006) stated that the seagrass epiphytes are an integral, complex, and dynamic component of seagrass ecosystems. They can make up a significant proportion of the total primary production of these ecosystems and are generally the primary food source for the associated fauna, as well as contributing to detrital food webs. He further stated that if under certain conditions that lead to a "bloom" in the epiphytic algae, they may contribute to the decline of the seagrass. Generally, the decomposition of seagrass is one feature in the seagrass beds. They are usually caused by the physical and chemical breakdown of dead organisms evolving other organisms notably bacteria, fungi, and animals (Tanduyan, 2011). A station in Diamante, Prieto Diaz have lesser species distribution than in in Rizal. A portion of the bed located in the shallow waters of Diamante facing the southeastern part of the municipal waters was observed to have some leaf reddening of the seagrasses, specifically *Cymodocea rotundata*. In Manito, sample of *Halophila ovalis* was also observed to exhibit leaf reddening (Appendix F). Novak and Short (2010) stated that leaf reddening was most commonly seen in *Cymodocea serrulata*, *Thalassodendron ciliatum*, *Halophila ovalis*, and *Cymodocea rotundata*. The phenomenon of leaf reddening in seagrasses was first seen in Australia and has since been shown to be prevalent in seagrasses growing in clear, shallow waters with high light intensities. The red coloration is caused by the accumulation of anthocyanin, which acts as a sunscreen during periods of strong light (Short, et.al., 2016 in Novak and Short, 2010).

The Seagrass and Seaweed Percentage Cover

The percentage cover of seagrass and seaweed showed the status of its habitat. Abundance of seagrass and seaweed species varies in the different municipalities studied. Using the criteria set by Fortes (1989), Sto. Domingo (79.24%) had an excellent habitat condition (Table 3). Prieto Diaz was next (56.65%) with good condition of its seagrass and seaweed beds as well as Manito

Table 3. Habitat Status of Seagrass Bed in Municipalities Bordering Albay Gulf

Municipality	Total Cover (%)	Condition
Legazpi	34.51	Fair
Sto. Domingo	79.24	Excellent
Manito	55.89	Good
Rapu-Rapu	36.51	Fair
Prieto Diaz	56.65	Good
Bacon District	53.58	Good

and Bacon District. Rapu-Rapu and Legazpi had fair habitat condition. Apparently, these two areas were considered vulnerable to daily disturbance from human activities as both had large seaports and more human settlements nearby than the other municipalities.

In Legazpi City, *Enhalus acoroides* and *Cymodocea serrulata* were present in all stations with the former taking the largest cover of 47.66% in Station 1 (Table 4). *Enhalus acoroides* had the highest mean of 20.33% making it the most abundant seagrass in Legazpi.

Table 4. Seagrasses and Seaweeds Cover (%) in Legazpi City

Seagrasses/Seaweeds	Station 1	Station 2	Station 3	Mean	Seagrasses/Seaweeds	Station 1	Station 2	Station 3	Mean
Seagrasses					Seaweeds				
Cymodocea rotundata	1.04	-	17.19	6.08	*Acetabularia sp.*	-	-	1.04	0.35
Cymodocea serrulata	1.04	7.27	1.30	3.20	*Padina sp.*	-	1.02		0.34
Halodule uninervis	8.59	-	16.06	8.22	*Sargassum sp.*	1.04	0.74	-	0.59
Halodule pinifolia	-	-	41.67	13.89	*Turbinaria sp.*	1.04	-	-	0.35
Syringodium isoetifolium	-	-	28.13	9.38	*Eucheuma sp.*	-	1.02	-	0.34
Enhalus acoroides	47.66	2.56	10.77	20.33	*Gracilaria sp.1*	-	1.59	-	0.53
Halophila ovalis	-	-	0.52	0.17	*Gracilaria sp.2*	-	0.74	-	0.25
Halophila minor	-	-	1.56	0.52	*Gracilaria sp.3*	-	0.74	-	0.25
Thalassia hemprichii	-	-	11.89	3.96	*Hypnea sp.*	-	0.74	-	0.25

Halophila ovalis had the least cover (0.52%) and was found only in Station 3. *Halodule pinifolia* (41.67%), *Syringodium isoetifolium* (28.13%), *Halophila minor* (1.56%) and *Thalassia hemprichii* (11.89%) were found in Station 3 only. *Cymodocea rotundata* and *Cymodocea serrulata* had 1.04% cover in Station 1 but the former had a high cover (17.19%) in Station 3. Station 3 in Barangay Maslog had the largest number of seagrass species noted being in a rural area and observed to have clear waters that *Enhalus acoroides* could be seen above (Appendix G).

Minimal percentage cover was observed among the seaweed species. *Acetabularia* sp., *Padina* sp., *Sargassum* sp., and *Turbinaria* sp. recorded more than 1.00% cover. A species in *Gracilaria* genera had 1.59% cover. The other two *Gracilaria* spp. and *Hypnea* sp. had the same cover of 0.74% in Station 2. *Sargassum* sp. was the most abundant seaweeds with a total mean of 0.59% across stations.

Station 2, Barangay Puro, in Legazpi City was an urban barangay near a busy seaport and commercial establishments. It only had two identified seagrasses, *Enhalus acoroides* and *Cymodocea serrulata*, and had seven identified seaweeds. A reclamation activity was observed near this station as part of the development in the city (Appendix H). The occurrence of only two seagrasses can also be attributed to this activity. A report published by the United Nations (2016) stated that degradation of wetlands, seagrass beds, and coastal water quality is commonly associated with large-scale reclamation projects. The impact of sediments has been recognized by both global reviews and the United Nations Environment Programme (UNEP/GEMS, 2008). These impacts include smothering of marine communities and, in severe cases, complete burial leading to suffocation of corals, mangrove stands, and seagrass beds. Duarte (2011) stated that high sediment mobility by currents and waves, causing successive burial and erosion, may cause seagrass mortality.

Another study supported the above-statement that sediment loading is one cause reported for the 67% loss per year (2003-2005) of seagrasses in Sabah, Malaysia while sedimentation contributed to 90% and 85% decline of seagrasses in Tauranga, New Zealand and Westernport, Australia, respectively (Short et al., 2016).

In Sto. Domingo area, *Syringodium isoetifolium* (56.77%) had the largest percentage cover in Station 2 and an average mean of 39.20% across all stations (Table 5). *Cymodocea*

serrulata (50.52%) was followed by *Cymodocea rotundata* (45.31%). The former species had low percentage cover in Station 1 (3.73%) compared to the latter. *Halodule uninervis* dominated the percentage cover in Station 1 with 33.68% cover followed by *Halodule pinifolia* (26.48%) with the former having only a small cover of 1.57% in Station 2. *Enhalus acoroides* and *Halophila ovalis* also contributed to the cover in both stations. *Thalassia hemprichii* and two species of *Halophila* were distinct in Station 1 having percentage cover below 6.00%. *Halophila decipiens* (0.26%) had the least mean cover.

Table 5. Seagrasses and Seaweeds Cover (%) in Sto. Domingo

Seagrasses/Seaweeds	Station 1	Station 2	Mean	Seagrasses/Seaweeds	Station 1	Station 2	Mean
Seagrasses				Seaweeds			
Cymodocea rotundata	31.69	45.31	38.50	*Acetabularia sp.*	0.35	-	0.18
Cymodocea serrulata	3.73	50.52	27.13	*Caulerpa sertularioides*	-	0.52	0.26
Halodule uninervis	33.68	1.57	17.63	*Cladophora sp.*	2.09	0.52	1.31
Halodule pinifolia	26.48	12.50	19.49	*Halicoryne sp.*	1.48	-	0.74
Syringodium isoetifolium	21.62	56.77	39.20	*Halimeda macroloba*	4.69	-	2.35
Enhalus acoroides	13.54	7.29	10.42	*Halimeda opuntia*	0.52	-	0.26
Halophila ovalis	2.78	2.09	2.44	*Neomeris sp.*	0.35	-	0.18
Halophila minor	1.04	-	0.52	*Padina sp.*	12.50	0.52	6.51
Halophila decipiens	0.52	-	0.26	*Sargassum sp.*	6.25	-	3.13
Thalassia hemprichii	5.82	-	2.91				

Padina sp. (12.50%) had the largest percentage cover in this municipality, although in Station 2 this species had low percentage cover (0.52%). *Acetabularia* sp. had the least cover which was noted in Station 1 only. Low cover of 0.52% was also observed among *Caulerpa sertularioides, Cladophora* sp., and *Halimeda opuntia*.

Manito stations harbored high percentage cover of seagrass and seaweeds (Table 6). *Cymodocea rotundata* had the largest percentage cover at 45.95% in Station 2 and across all station with a mean of 32.64%, followed by *Halodule uninervis* (25.90%), then *Syringodium isoetifolium* (24.29%). Both *S. isoetifolium* and *Halophila decipiens* were recorded only in Station 1, with the latter having the least cover of 0.28%. It was observed that *Syringodium isoetifolium* was in its flowering stage (Appendix I). *Halodule pinifolia* (16.19%) and *Enhalus acoroides* (12.89%) also contributed to the percentage cover. *Cymodocea serrulata* had a higher percentage cover of 20.93% in Station 2 than the 5.97% cover Station 1. The same difference was also observed in *H. uninervis*, with only a 5.68% cover in Station 1. *Halophila* spp. and *Thalassia hemprichii* had only less than 4.00% cover in Station 2. This can be attributed to the differences in location and substrate of the stations.

Seaweed species vary in the Manito stations in terms of percentage cover. *Acetabularia* sp. (2.36%) had the largest percentage cover. Seven species had the same estimated percentage cover of 0.28%, namely *Caulerpa* sp., *Chaetomorpha* sp., *Halicorynes*p., *Halimeda opuntia*, *Padina* sp., *Jania* sp., and *Kappaphycus* species. *Cladophora* sp. and *Sargassum* sp. had only more than 2.00% cover while *Dictyosphaeria cavernosa*, *Halimeda* spp., and *Neomeris* sp. had less than 1.00% cover. *Dictyota* and *Dictyosphaeria* species were only observed in Station 2 in Cawit–It-ba boundary.

Table 6. Seagrasses and Seaweeds Cover (%) in Manito, Albay

Seagrasses/Seaweeds	Station 1	Station 2	Mean	Seagrasses/Seaweeds	Station 1	Station 2	Mean
Seagrasses				Seaweeds			
Cymodocea rotundata	19.32	45.95	32.64	*Chaetomorpha sp.*	0.28	-	0.14
Cymodocea serrulata	5.97	20.93	13.45	*Cladophora sp.*	1.99	-	1.00
Halodule uninervis	5.68	25.90	15.79	*Dictyosphaeria cavernosa*	0.57	-	0.29
Halodule pinifolia	16.19	14.92	15.56	*Dictyosphaeria sp.*	-	1.04	0.52
Syringodium isoetifolium	24.29	-	12.15	*Halicoryne sp.*	0.28	-	0.14
Enhalus acoroides	12.89	8.34	10.62	*Halimeda cylindracea*	0.57	-	0.29
Halophila ovalis	4.12	2.04	3.08	*Halimeda macroloba*	0.85	-	0.43
Halophila minor	3.70	3.41	3.56	*Halimeda opuntia*	0.28	-	0.14
Halophila decipiens	0.28	-	0.14	*Neomeris sp.*	0.43	-	0.22
Thalassia hemprichii	8.67	0.95	4.81	*Dictyota sp.*	-	0.52	0.26
Seaweeds				*Padina sp.*	0.28	-	0.14
Acetabularia sp.	2.36	-	1.18	*Sargassum sp.*	1.05	-	0.53
Caulerpa racemosa	0.28	-	0.14	*Jania sp.*	0.28	-	0.14
Caulerpa sp.	0.28	-	0.14	*Kappaphycus sp.*	0.28	-	0.14

Seaweed species were most abundant during March to May and sparse from July to December in Mararison Island, Culasi, Antique (Ponce, et al. as cited by Dioneda, 2010). The present study conducted the survey from March to April during the dry months. It could be seen that the high percentage cover of seaweed species in Manito station was favored by this weather condition in summer where the trade winds prevail. The northeast (November-February) and southwest monsoon (June-October) also affect the occurrence and distribution of species. Station 1 in Holugan had a higher number of seaweed species noted than Station 2. The former station was observed to have clear water and substrate of sandy with few coral rubble, while the latter had sandy muddy substrate near mangrove areas.

The Rapu-Rapu stations showed *Halodule uninervis* (39.35%) with the largest percentage cover (Table 7). Its abundance recorded a mean of 25.15% across stations. *Halophila ovalis* and *Halodule pinifolia* followed with 15.63% and 13.64% cover, respectively. *Halophila decipiens* had the least mean cover of 0.43% and was observed only in Station 1 of Caracaran. *Syringodium isoetifolium* (8.38%) and *Cymodocea rotundata* (2.56%) were distinct in Poblacion Station 2 only. *Cymodocea serrulata*, *Enhalus acoroides* and *Thalassia hemprichii* had cover below 9.00%. It was noted that part of Station 1 had an exposed seagrass bed during low tide. The substrate was sandy muddy with murky water near mangrove areas, which explained the absence of *Syringodium isoetifolium* in this station. *S. isoetifolium* inhabits clear waters and prefers sandy substrates and is usually found in shallow waters in the lower inter- and subtidal areas up to 15 m depth (IUCN).

Table 7. Seagrasses and Seaweeds Cover (%) in Rapu-Rapu, Albay

Seagrasses/Seaweeds	Station 1	Station 2	Mean	Seagrasses/Seaweeds	Station 1	Station 2	Mean
Seagrasses				Seaweeds			
Cymodocea rotundata	-	2.56	1.28	*Caulerpa racemosa*	-	0.57	0.29
Cymodocea serrulata	7.67	6.96	7.32	*Halicoryne sp.*	0.28	0.81	0.55
Halodule uninervis	39.35	10.94	25.15	*Halimeda cylindracea*	-	0.57	0.29
Halodule pinifolia	13.64	11.36	12.50	*Halimeda macroloba*	0.43	1.99	1.21
Syringodium isoetifolium	-	8.38	4.19	*Halimeda opuntia*	-	0.28	0.14
Enhalus acoroides	1.57	6.40	3.99	*Neomeris sp.*	1.14	-	0.57
Halophila ovalis	15.63	8.67	12.15	*Udotea sp.*	-	0.28	0.14
Halophila decipiens	0.85	-	0.43	*Valonia sp.*	0.28	-	0.14
Thalassia hemprichii	4.26	7.81	6.04	*Dictyota sp.*	0.85	-	0.43
Seaweeds				*Padina sp.*	1.42	1.42	1.42
Acetabularia sp.	1.14	1.00	1.07	*Sargassum sp.*	-	0.85	0.43
Bornetella sphaerica	-	0.28	0.14	*Galaxuara sp.*	0.28	0.81	0.55
Caulerpa lentillifera	-	0.85	0.43	*Gracilaria sp.*	1.14	0.28	0.71

Among the seaweeds, *Halimeda macroloba* (1.99%) was abundant in Station 2 as seen in one of the quadrats (Appendix J). *Padina sp.* (1.42%) had equal cover in both stations. *Acetabularia sp.*, *Neomeris sp.*, and *Gracilaria sp.* had the same cover of 1.14% in Station 1. Other seaweeds identified had less than one percentage cover, namely *Bornetella* sp., *Caulerpa* spp., *Halicoryne* sp., *Udotea* sp., *Valonia* sp., *Dictyota* sp., *Sargassum* sp., and *Galaxaura* species. *Halimeda macroloba* occured in the two stations and had 1.99% cover in Station 2. The presence of *H. cylindracea* and *H. opuntia* was also noted in Station 2. The least abundant was *Bornetella sphaerica* (0.14%).

In the Prieto Diaz area, *Thalassia hemprichii* had the highest percentage cover of 65.20% in Station 2, Barangay Diamante, with a mean cover of 63.78% across stations. *Syringodium isoetifolium* followed with 21.59 % mean cover (Table 8). *Cymodocea serrulata* had the least mean cover (0.14%), which could only be found in Station 1 in Barangay Rizal, Prieto Diaz. *Cymodocea rotundata, Enhalus acoroides,* and *Halophila ovalis* had larger cover in Station 2 than Station 1. *Halodule pinifolia* and two species of *Halophila* (*H. minor* and *H. decipiens*) were distinct in Station 2 having percentage cover below 3.00%. Less abundance of *C. serrulata*, *H. uninervis,* and species of *Halophila* in Prieto Diaz resulted in a value within the range of good condition in the habitat status statistically. Abundance of *Thalassia hemprichii* and *Syringodium isoetifolium* was evidently high in Barangay Diamante, which made the seagrass meadow dense and productive in terms of its contribution to the different ecosystem

Table 8. Seagrasses and Seaweeds Cover (%) in Prieto Diaz, Sorsogon

Seagrasses/Seaweeds	Station 1	Station 2	Mean	Seagrasses/Seaweeds	Station 1	Station 2	Mean
Seagrasses				Seaweeds			
Cymodocea rotundata	6.40	21.74	14.07	*Caulerpa microphysa*	-	0.28	0.14
Cymodocea serrulata	0.28	-	0.14	*Caulerpa serrulata*	-	0.28	0.14
Halodule uninervis	1.71	2.56	2.14	*Caulerpa sertularioides*	0.28	-	0.14
Halodule pinifolia	-	3.98	1.99	*Dictyosphaeria cavernosa*	0.28	0.28	0.28
Syringodium isoetifolium	42.61	0.57	21.59	*Halicoryne sp.*	1.42	-	0.71
Enhalus acoroides	2.28	5.83	4.06	*Halimeda cylindracea*	-	0.85	0.43
Halophila ovalis	0.28	7.53	3.91	*Halimeda macroloba*	-	0.71	0.36
Halophila minor	-	1.42	0.71	*Halimeda opuntia*	-	0.28	0.14
Halophila decipiens	-	1.85	0.93	*Neomeris sp.*	1.14	0.28	0.71
Thalassia hemprichii	62.36	65.20	63.78	*Valonia sp.1*	0.28	-	0.14
Seaweeds				*Hydroclathrus clathratus*	0.28	-	0.14
Bornetella nitida	0.43	-	0.22	*Padina sp.*	0.28	-	0.14
Bornetella sphaerica	0.57	0.57	0.57	*Laurencia sp.*	-	1.00	0.50

services this kind of habitat provides. In addition, clear shallow waters were observed in these stations with sandy and coral rubble substrate (Appendix K). Sigua et al. (2015) stated that *T. hemprichii* forms dense, monospecific meadows and is the dominant seagrass species on dead reef platforms and in bottom sediments composed of coral sand and coral rubble. It was also observed growing on muddy sand and soft mud bottoms as well as covered coral banks. Station 2 of this study was located near mangrove areas where a part of the sampling areas had soft muddy sand.

A majority of the identified seaweeds in Prieto Diaz had minimal percentage cover of less than 1.00%, except *Halicoryne* sp. (1.42%), *Neomeris* sp. (1.14%), and *Laurencia* sp. (1.00%). Low cover of 0.28% was observed among *Caulerpa* spp., *Dictyosphaeria cavernosa*, *Halimeda opuntia*, *Valonia* sp., *Hydroclathrus clathratus*, and *Padina* sp. Two species of *Halimeda* and *Bornetella* contributed minimal cover.

Station 1 in Barangay Caricaran, Bacon District held the highest percentage cover of *Syringodium isoetifolium* (62.87%) across the three stations with mean cover of 39.23% (Table 9). A majority of seagrasses washed ashore in this area were *S. isoetifolium* (Appendix L). The study of Dioneda et al. (2009) confirmed the abundance of *S. isoetifolium* in this municipality. *Halodule uninervis* (35.23%) was second, followed by *Cymodocea rotundata* (24.43%). *Halophila ovalis* got the least cover of 1.10% in Station 2 but found in all station, which made *Halophila minor* the least abundant, having a mean cover of 0.63%. *H. minor* was only noted in Station 1. *Thalassia hemprichii* and *Halodule pinifolia* were recorded in two stations only with the former having higher a percentage cover. *Cymodocea serrulata* have higher percentage cover in Station 1 than Station 2. *Enhalus acoroides* was noted both in Stations 1 and 2 having a higher percentage cover in the latter station.

Table 9. Seagrasses and Seaweeds Cover (%) in Bacon District, Sorsogon

Seagrasses/Seaweeds	Station 1	Station 2	Station 3	Mean	Seagrasses/Seaweeds	Station 1	Station 2	Station 3	Mean
Seagrasses					Seaweeds				
Cymodocea rotundata	17.92	-	24.43	14.12	*Acetabularia sp.*	0.74	-	0.57	0.44
Cymodocea serrulata	15.46	1.40	2.27	6.38	*Bornetella sphaerica*	0.63	-	-	0.21
Halodule uninervis	22.09	-	35.23	19.11	*Halicoryne sp.*	1.02	-	-	0.34
Halodule pinifolia	9.47	-	5.11	4.86	*Halimeda cylindracea*	0.49	-	0.57	0.35
Syringodium isoetifolium	62.87	-	54.83	39.23	*Halimeda macroloba*	0.57	-	0.28	0.28
Enhalus acoroides	1.05	11.10	-	4.05	*Halimeda opuntia*	0.63	-		0.21
Halophila ovalis	9.43	1.10	12.50	7.68	*Neomeris sp.*	-	-	0.57	0.19
Halophila minor	1.88	-	-	0.63	*Udotea sp.*	0.31	-	-	0.1
Thalassia hemprichii	17.76	-	1.99	6.58	*Padina sp.*	0.75	-	1.14	0.63
					Jania sp.	-	-	0.28	0.09

However, human activities disturbed the seagrass meadow in this area, being a local sea port where fisherfolks anchor their boats and the gill netting as the common fishing method. Some parts of the seagrass bed had been destroyed by boat anchors scraping part of the bed. Seagrasses including some seaweed species were observed washed ashore in the area could be the result of this activity (Appendix M).

Station 2 in Barangay Banao, Bacon District, however, had only three seagrass species noted. The location of this station was adjacent to some mangrove areas. The water was observed to be muddy, which made it difficult to see the bottom. According to Short et al. (2016) turbidity reduces water clarity, thereby limiting the light reaching seagrass plants and reducing seagrass photosynthesis and growth. He added that turbidity results from sediment loading of coastal waters contributed by agriculture, creating impervious surfaces and rapid runoff. Sigua et al. (2015) stated that mariculture activity, local fishing boats, and run-offs from non-point sources like households and agriculture could affect coastal resources. In this study, Station 2 in Barangay Banao was observed to have fishponds nearby, household community, and a dike or a concrete barrier from tides (Appendix N). These activities could have caused the presence of only three seagrasses which can adapt to this kind of environment specifically the *Enhalus acoroides*, *Halophila ovalis,* and *Cymodocea serrulata* which can grow in muddy sand.

Minimal percentage cover of seaweeds in Bacon District stations was observed. Only *Halicoryne* sp. and *Padina* sp. had more than 1.00% cover. *Jania* sp. has the least cover (0.28%), which can be found in Station 3 Barangay del Rosario only. Three *Halimeda* species and *Acetabularia* sp. also contributed to the abundance of seaweeds in Stations 1 and 3.

The Seagrass and Seaweed Wet Biomass

The seagrass biomass is essential to determine the amount of seagrass species and to study the effects of environmental changes toward seagrass species (Hashim et al., 2013). Seagrasses have a relatively high productivity and biomass compared to other oceanic habitats and most terrestrial ecosystems (Short et al., 2016).

In Legazpi City, the wet biomass of *Enhalus acoroides* (267.27 g/m^2*)* dominated the weight of other seagrasses in all stations with a mean of 145.30 g/m^2 (Table 10). This species was found in the subtidal zone and is slow to produce new shoots but produces high biomass, being a very large seagrass. The siltier the water, the longer the leaves grow in order to capture

more light (IUCN Redlist). A sample of *Enhalus acoroides* taken from Station 2 of Barangay Puro reached more than 60 cm-long leaves (Appendix O).

Next to *E. acoroides* was *Halodule uninervis*, with a mean weight of 80.37 g/m^2 wet biomass. Big difference was observed in the weight of *Cymodocea rotundata* in Station 1 and Station 3. *Cymodocea serrulata* had the largest wet biomass estimate in Station 2 compared to the other stations. The seagrass species with at least more than 10 g/m^2 weight were *Halodule pinifolia* (34.67 g/m^2), *Thalassia hemprichii* (25.56g/m^2) and *Syringodium isoetifolium* (14.67g/m^2). *Halophila minor* and *Halophila ovalis* accounted for the least wet biomass of 0.33 g/m^2 and 0.67g/m^2, respectively, being one of the small species of seagrasses.

Table 10. Seagrasses and Seaweeds Biomass (g/m²) in Legazpi City

Seagrass/Seaweeds	Station 1	Station 2	Station 3	Mean	Seagrass/Seaweeds	Station 1	Station 2	Station 3	Mean
Seagrasses					Seaweeds				
Cymodocea rotundata	0.67	-	30.11	10.26	*Acetabularia sp.*	-	-	nil	-
Cymodocea serrulata	5.00	36.36	5.33	15.56	*Padina sp.*	-	29.10	-	9.70
Halodule uninervis	231.67	-	9.44	80.37	*Sargassum sp.*	20.00	5.45	-	8.48
Halodule pinifolia	-	-	34.67	11.56	*Turbinaria sp.*	10.67	-	-	3.56
Syringodium isoetifolium	-	-	14.67	4.89	*Eucheuma sp.*	-	9.10	-	3.03
Enhalus acoroides	125.83	267.27	42.67	145.3	*Gracilaria sp.1*	-	15.27	-	5.09
Halophila ovalis	-	-	0.67	0.22	*Gracilaria sp.2*	-	5.45	-	1.82
Halophila minor	-	-	0.33	0.11	*Gracilaria sp.3*	-	20.00	-	6.67
Thalassia hemprichii	-	-	26.56	8.85	*Hypnea sp.*	-	4.00	-	1.33

Padina sp. (29.10 g/m^2) got the largest biomass among the collected seaweeds although it was noted only in Station 2. With a mean of 9.70 g/m^2, it dominated the mean weight of *Sargassum* species (8.48g/m^2). It was noted that there were many *Sargassum* species near the sampling area. The presence of *Acetabularia* sp. in Station 3 was noted. However, samples were not enough to measure its weight significantly.

The wet biomass of seagrasses in Sto. Domingo, Albay revealed that *Cymodocea rotundata* (216.00 g/m^2) had the highest wet biomass measure, while *Enhalus acoroides* (139.33 g/m^2) followed next, particularly in Station 2 in Barangay Calayucay (Table 11).

Table 11. Seagrasses and Seaweeds Biomass (g/m²) in Sto. Domingo, Albay

Seagrasses/Seaweeds	Station 1	Station 2	Mean	Seagrasses/Seaweeds	Station 1	Station 2	Mean
Seagrasses				Seaweeds			
Cymodocea rotundata	24.00	216.00	120.00	*Acetabularia sp.*	1.33	-	0.67
Cymodocea serrulata	10.44	66.67	38.56	*Caulerpa sertularioides*	-	1.33	0.67
Halodule uninervis	19.33	66.67	43.00	*Cladophora sp.*	nil	nil	
Halodule pinifolia	11.44	116.67	64.06	*Halicoryne sp.*	3.33	-	1.67
Syringodium isoetifolium	17.22	116.67	66.95	*Halimeda macroloba*	5.33	-	2.67
Enhalus acoroides	27.11	139.33	83.22	*Halimeda opuntia*	4.00	-	2.00
Halophila ovalis	4.44	16.00	10.22	*Neomeris sp.*	0.89	-	0.45
Halophila minor	4.00	-	2.00	*Padina sp.*	9.33	4.00	6.67
Halophila decipiens	2.00	-	1.00	*Sargassum sp.*	12.00	-	6.00
Thalassia hemprichii	15.22	-	7.61				

The mean weight of *C. rotundata* (120.00g/m^2) had the highest wet biomass measure. Station 1 in Barangay Alimsog had seagrasses with a smaller value of wet biomass than the other station. *Halophila decipiens* had the least biomass of 2.00 g/m^2, while *H. minor* and *H.*

ovalis gained 4.00g/m^2 and 4.44g/m^2, respectively. Station 2 had a higher wet biomass measured than Station 1. However, the latter had more numbers of recorded seagrass species.

Sargassum sp. (12.00 g/m^2) had the highest weight in Station 2 but its mean weight (6.00 g/m^2) was less than *Padina* sp. (6.67g/m^2) which made the latter species having higher biomass. The wet biomass of *Cladophora* sp. was not measured due to the insignificant amount of sample. The rest of the seaweeds measured lower than 6.00g/m^2 biomass with *Neomeris* sp. having the smallest biomass of 0.89 g/m^2.

In the Manito stations, *Enhalus acoroides* appeared to have the highest biomass at 274.55g/m^2 and 248.00g/m^2 in Stations 1 and 2, respectively (Table 12). Its mean weight was

Table 12. Seagrasses and Seaweeds Biomass (g/m^2) in Manito, Albay

Seagrasses/Seaweeds	Station 1	Station 2	Mean	Seagrasses/Seaweeds	Station 1	Station 2	Mean
Seagrasses				Seaweeds			
Cymodocea rotundata	54.18	201.76	127.97	*Chaetomorpha sp.*	0.73	-	0.37
Cymodocea serrulata	13.64	98.03	55.84	*Cladophora sp.*	nil	-	
Halodule uninervis	33.27	84.94	59.11	*Dictyosphaeria cavernosa*	1.33	-	0.67
Halodule pinifolia	160.00	15.58	87.79	*Dictyosphaeria sp.*	-	1.33	0.67
Syringodium isoetifolium	75.82	-	37.91	*Halicoryne sp.*	0.36	-	0.18
Enhalus acoroides	274.55	248.00	261.28	*Halimeda cylindracea*	43.64	-	21.82
Halophila ovalis	14.73	9.48	12.11	*Halimeda macroloba*	12.73	-	6.37
Halophila minor	4.36	5.45	4.91	*Halimeda opuntia*	2.91	-	1.46
Halophila decipiens	3.64	-	1.82	*Neomeris sp.*	0.02	-	0.01
Thalassia hemprichii	122.91	17.88	70.40	*Dictyota sp.*	-	0.67	0.34
Seaweeds				*Padina sp.*	1.82	-	0.91
Acetabularia sp.	1.27	-	0.64	*Sargassum sp.*	2.00	-	1
Caulerpa racemosa	1.82	-	0.91	*Jania sp.*	1.82	-	0.91
Caulerpa sp.	1.45	-	0.73	*Kappaphycus spp.*	1.09	-	0.55

267.28g/m^2 which was followed by *Cymodocea rotundata* with 127.97 g/m^2. The wet biomass in Station 1 of *Halodule pinifolia* (160g/m^2) and *Thalassia hemprichii* (122.91 g/m^2) measured higher than Station 2. This observation was also true with *Halophila ovalis*. In Station 1, *Syringodium isoetifolium* weighed 75.82 g/m^2, which was higher compared to *Halodule uninervis* and *Cymodocea* species. *Halophila decipiens* had the least biomass at 3.64g/m^2, while *H. minor's* was below 6.00g/m^2.

Among the seaweeds, *Halimeda cylindracea* had the highest biomass at 43.64g/m^2 in Station 1 or 21.82g/m^2 mean weight. *Halimeda macroloba* had 12.73g/m^2. *Halimeda opuntia* and *Sargassum* sp. had 2.91g/m^2 and 2.00g/m^2, respectively. Low biomass measure less than 2.00g/m^2 was noted for the rest of the seaweeds with *Neomeris* sp. having the least biomass estimate of 0.02g/m^2. The sample of *Cladophora* sp. was not enough to measure its biomass. A large difference in the biomass was noted in this municipality with Station 2 in Cawit-It-Ba boundary having only two seaweed species noted.

In Rapu-Rapu, the wet biomass of *Enhalus acoroides* (95.82 g/m^2) had the highest weight among other seagrasses (Table 13). *Thalassia hemprichii* had 63.09 g/m^2 in Station 2 followed by *Halodule uninervis* with 49.09g/m^2 in Station 1 located at Barangay Caracaran. *Cymodocea serrulata* had a higher biomass estimate in Station 1 than Station 2. *Cymodocea rotundata* had 8.00g/m^2 while *Halodule pinifolia*, *Syringodium isoetifolium* and *Halophila*

ovalis in Station 2 in Poblacion, Rapu-Rapu measured only less than 5.00g/m^2 weight. *H. decipiens* had the least biomass measurement of 0.73g/m^2.

Table 13. Seagrasses and Seaweeds Biomass (g/m²) in Rapu-Rapu, Albay

Seagrasses/Seaweeds	Station 1	Station 2	Mean	Seagrasses/Seaweeds	Station 1	Station 2	Mean
Seagrasses				Seaweeds			
Cymodocea rotundata	-	8.00	4.00	*Caulerpa racemosa*	-	0.29	0.15
Cymodocea serrulata	33.45	20.73	27.09	*Halicoryne sp.*	0.15	1.46	0.81
Halodule uninervis	49.09	16.55	32.82	*Halimeda cylindracea*	-	1.82	0.91
Halodule pinifolia	1.82	3.64	2.73	*Halimeda macroloba*	9.45	13.09	11.27
Syringodium isoetifolium	-	3.64	1.82	*Halimeda opuntia*	-	7.45	3.73
Enhalus acoroides	95.82	85.09	90.46	*Neomeris sp.*	0.18	-	0.09
Halophila ovalis	1.09	2.73	1.91	*Udotea sp.*	-	0.33	0.17
Halophila decipiens	0.73	-	0.37	*Valonia sp.*	nil	-	
Thalassia hemprichii	21.82	63.09	42.46	*Dictyota sp.*	2.91	-	1.46
Seaweeds				*Padina sp.*	0.55	2.18	1.37
Acetabularia sp.	0.18	0.24	0.21	*Sargassum sp.*	-	4.73	2.37
Bornetella sphaerica	-	0.25	0.13	*Galaxuara sp.*	0.73	0.87	0.80
Caulerpa lentillifera	-	0.36	0.18	*Gracilaria sp.*	1.82	1.09	1.46

Halimeda macroloba (13.09 g/m^2) had the highest weight among the seaweeds with a weighted mean of 11.27g/m^2, followed by *Halimeda opuntia* (7.45 g/m^2) and *Sargassum* sp. (4.73 g/m^2). The wet biomass of *Padina* sp. and *Dictyota* sp. was lower than 3.00g/m^2, while *Halimeda cylindracea*, *Halicoryne* sp., and *Gracilaria* sp. measured below 2.00g/m^2. A majority of seaweeds found in Station 1 had biomass lower than 1.00g/m^2 which ranged from 0.15 to 0.73. *Halicoryne* sp. had the lowest biomass of 0.15g/m^2 in Station 1. Two species of *Caulerpa, Bornetella* sp., and *Udotea* sp. were found to have minimal weight lower than 0.50g/m^2. There was no sample collected of *Valonia* sp. because only one individual was noted in Station 1.

The wet biomass of seagrasses in Prieto Diaz showed that *Thalassia hemprichii* (118.00 g/m^2) had the highest value with a large difference from *Enhalus acoroides* (39.82g/m^2) across the two stations (Table 14). It can be noted that *T. hemprichii* was the most abundant seagrass in Prieto Diaz. *Syringodium isoetifolium* and *Cymodocea rotundata* had a larger number of biomass recorded in Station 1 compared to Station 2. The latter species only had 1.82 g/m^2 biomass, which was nearly the same figure with *Halophila minor* (1.45g/m^2) and *H. decipiens* (2.00g/m^2). *Halophila ovalis* had the least biomass of 0.18g/m^2 in Station 1 but it has 6.00g/m^2 estimated wet biomass in the other station. Minimal biomass record was also observed with *Halodule* species.

As stated in the IUCN Redlist, *Thalassia hemprichii* is fast-growing and is grazed by turtles and dugongs and is important for fish grazing. In the Indo-Pacific region, *Thalassia hemprichii* is commonly the climax seagrass species. Prieto Diaz showed to have a good condition of seagrass meadow with abundant *T. hemprichii* having the highest wet biomass record. Presence of rabbitfishes or siganids were noted feeding in this seagrass bed (Appendix P).

Table 14. Seagrasses and Seaweeds Biomass (g/m²) in Prieto Diaz, Sorsogon

Seagrasses/Seaweeds	Station 1	Station 2	Mean	Seagrasses/Seaweeds	Station 1	Station 2	Mean
Seagrasses				Seaweeds			
Cymodocea rotundata	16.18	1.82	9.00	*Caulerpa microphysa*	-	0.18	0.09
Cymodocea serrulata	2.91	-	1.46	*Caulerpa serrulata*	-	1.45	0.73
Halodule uninervis	2.00	6.82	4.41	*Caulerpa sertularioides*	0.73	-	0.37
Halodule pinifolia	-	2.55	1.28	*Dictyosphaeria cavernosa*	nil	0.73	0.37
Syringodium isoetifolium	18.36	1.82	10.09	*Halicoryne sp.*	0.73	-	0.37
Enhalus acoroides	25.82	39.82	32.82	*Halimeda cylindracea*	-	1.09	0.55
Halophila ovalis	0.18	6.00	3.09	*Halimeda macroloba*	-	3.64	1.82
Halophila minor	-	1.45	0.73	*Halimeda opuntia*	-	4.36	2.18
Halophila decipiens	-	2.00	1.00	*Neomeris sp.*	nil	nil	
Thalassia hemprichii	118.00	100.91	109.46	*Valonia sp. 1*	nil	-	
Seaweeds				*Hydroclathrus clathratus*	1.45	-	0.73
Bornetella nitida	0.31	-	0.16	*Padina sp.*	0.45	-	0.23
Bornetella sphaerica	0.15	0.11	0.13	*Laurencia sp.*	-	4.91	2.46

A species from *Laurencia* genus had the largest number at 4.91 g/m^2 in Station 2 or 2.46g/m^2 mean of wet biomass among the recorded seaweeds in this municipality. This was followed by *Halimeda opuntia* (4.36 g/m^2) and *H. macroloba* (3.64 g/m^2). In Station 1, only *Hydroclathrus clathratus* had a biomass of 1.45 g/m^2 while in Station 2, *Caulerpa serrulata* (1.45 g/m^2) and *Halimeda cylindracea* (1.09g/m^2) had more than 1.00g/m^2 biomass. A majority of these seaweeds had minimal values ranging from 0.11g/m^2 to 1.45g/m^2. The least biomass record was of *Bornetella sphaerica* with 0.11g/m^2. The wet biomass of several seaweeds was not determined due to the lack of significant samples.

Bacon District stations revealed that while *Enhalus acoroides* (44.73g/m^2) had the highest number of biomass in Station 2, *Syringodium isoetifolium* dominated the biomass in Stations 1 and 3 (Table 15). The latter had 18.44 g/m^2 and 12.73g/m^2 in Stations 1 and 3, respectively. *Enhalus acoroides* had a minimal biomass of 5.38g/m^2 in Station 1 and was not.

Table 15. Seagrasses and Seaweeds Biomass (g/m²) in Bacon District, Sorsogon

Seagrasses/Seaweeds	Station 1	Station 2	Station 3	Mean	Seagrasses/Seaweeds	Station 1	Station 2	Station 3	Mean
Seagrasses					Seaweeds				
Cymodocea rotundata	2.49	-	4.36	2.28	*Acetabularia sp.*	0.46	-	0.18	0.21
Cymodocea serrulata	7.11	10.18	2.91	6.73	*Bornetella sphaerica*	nil	-	-	
Halodule uninervis	5.00	-	10.18	5.06	*Halicoryne sp.*	8.53	-	-	2.84
Halodule pinifolia	6.93	-	3.64	3.52	*Halimeda cylindracea*	18.02	-	1.45	6.49
Syringodium isoetifolium	18.44	-	12.73	10.39	*Halimeda macroloba*	8.73	-	19.27	9.33
Enhalus acoroides	5.38	44.73	-	16.70	*Halimeda opuntia*	15.64	-	-	5.21
Halophila ovalis	2.62	5.82	2.91	3.78	*Neomeris sp.*	-	-	nil	
Halophila minor	1.20	-	-	0.40	*Udotea sp.*	0.28	-	-	0.09
Thalassia hemprichii	13.53	-	5.82	6.45	*Padina sp.*	1.82	-	3.27	1.70
					Jania sp.	-	-	1.82	0.61

identified in Section 3. The least recorded wet biomass was that of *Halophila minor* (1.20g/m^2). This species was found only in Station 1. Common to the three stations were *Cymodocea serrulata* and *Halophila ovalis* with biomass ranging from 2.62g/m^2 to 10.18 g/m^2. Higher biomass of *Halodule pinifolia* and *Thalassia hemprichii* was seen in Station 1 while

Cymodocea rotundata and *Halodule uninervis* were noted in Station 3. The seagrass beds in Bacon Districts have differences in the species biomass (Appendix Q).

The genus *Halimeda* has the highest biomass estimate recorded in the two stations of Bacon District. *Halicoryne* sp. (8.53g/m^2), along with *Acetabularia* sp. (0.46 g/m^2), was also noticeable in one area in Station 1 (Appendix R). *Udotea* sp. had the least biomass of 0.28g/m^2 and was only found in Station 1. *Padina* sp. also contributed to the biomass of the seagrass bed having 1.82 g/m^2 and 3.27g/m^2 in Stations 1 and 3, respectively. Samples of *Bornetella sphaerica* and *Neomeris* sp. had no significant weight recorded. The former species can only be found in Station 1 while the latter was distinct in Station 3. *Jania* sp. was found to have 1.82 g/m^2 biomass in Station 3.

In general, the wet biomass of the seagrass species found in Albay Gulf showed that *Enhalus acoroides* (261.28g/m^2), being the biggest seagrass species, had the highest record in three municipalities bordering this gulf. This was followed by *Cymodocea rotundata* (120.00g/m^2) in Sto. Domingo. *C. rotundata* is resilient to marginal conditions and can survive a moderate level of disturbance (IUCN Redlist). *Thalassia hemprichii* being commonly referred to as the climax species, had the highest biomass and dominated the seagrass beds in Prieto Diaz, Sorsogon while *Syringodium isoetifolium* in Bacon District.

The Associated Macroinvertebrates in Albay Gulf

Seagrasses support marine food webs and provide essential habitat for many coastal species, playing a critical role in the equilibrium of coastal ecosystems and human livelihoods (Short et al., 2016). The associated macroinvertebrates noted in Albay Gulf were part of the different seagrass and seaweed beds with a unique role of their own.

Among the municipalities surveyed, Prieto Diaz and Manito area had a minimal count of five to seven macroinvertebrates recorded. These macroinvertebrates were sponges, cnidarians, bivalve mollusks, gastropod mollusks, and echinoderms (Appendix S). Specifically, the chocolate chip sea star (*Proteaster nodosus*) and sea urchins (*Diadema* sp.) were common to the stations in Manito, Prieto Diaz, and Bacon District. Other important species noted belong to *Cypraea* and *Conus*.

A sea hare was noted in Station 2 at Prieto Diaz area while sea hare eggs were seen in another station (Appendix T). This species eats algae with their role as herbivores in tropical intertidal habitats (Clarke, 2004). A crab nesting site was also observed in this station.

The presence of sea snake locally named "walo-walo" by residents was noted distinctly in Manito area. Jelly fishes were also noted in Manito, while one from genus *Mastigia*, the Spotted jellyfish was found in large groups in Station 2 of Bacon District.

In Legazpi area, a scallop was noted, which is an economically important marine organism. However, it was only seen once. Only Holothurian species were noted in Sto. Domingo stations. From Station 1 in Rapu-Rapu, economically important crabs were found and an area of crab nesting site was observed (Appendix U). Long-spined sea urchin was also noted in this station. The other station in Rapu-Rapu had blood cockles (*Anadara* species) and brittle star.

The presence of few economically-important macroinvertebrates in the seagrass and seaweed beds in the study areas could imply that extensive gathering of these species happened

in the past that hampered their natural reproduction process. Other anthropogenic activities might have also contributed to the low population of these species.

Conclusion

Albay Gulf had 10 species in six genera of seagrasses. These were *Cymodocea rotundata*, *Cymodocea serrulata*, *Halodule pinifolia*, *Halodule uninervis* and *Syringodium isoetifolium* of family Cymodoceaceae and *Enhalus acoroides*, *Halophila ovalis*, *Halophila minor*, *Halophila decipiens*, and *Thalassia hemprichii* from family Hydrocharitaceae. Among the 36 seaweeds species, 11 genera were noted under Chlorophyceae, five from Phaeophyceae, and seven belong to Rhodophyceae. Species richness vary in the municipalities bordering this gulf due to differences in the physical condition in the area such as substratum.

Thalassia hemprichii was the most abundant seagrass found in Prieto Diaz among others followed by *Syringodium isoetifolium* in Bacon District and Sto. Domingo. *Cymodocea rotundata* dominated other seagrass species in Manito while *Halodule uninervis* was abundant in Rapu-Rapu. *Enhalus acoroides* was found to have the least abundant but had high percentage cover in Legazpi. The seagrass and seaweed habitat condition in Sto. Domingo was excellent while Prieto Diaz, Manito, and Bacon District were good. Legazpi and Rapu-Rapu areas had fair seagrass and seaweed bed condition.

Enhalus acoroides gained the highest biomass of 261.28g/m^2 measured in Manito. Parallel to its abundance, *Thalassia hemprichii* had the highest biomass in Prieto Diaz and *Syringodium isoetifolium* in Bacon District. *Acetabularia, Halicoryne, Halimeda, Neomeris, Padina* and *Sargassum* were commonly found in most of the stations with *Halimeda* spp., *Sargassum* and *Padina* species comprising high biomass. Associated macroinvertebrates such as sponges, sea cucumbers, cowrie, sea urchins, and starfishes were noted.

In general, the seagrass and seaweed bed status was influenced both by natural phenomena (e.g. seagrass wasting and decomposition) and anthropogenic activities (e.g. aquaculture, fishing methods, recreational activities and development). Areas near human settlement and establishments were vulnerable to physical disturbance that may affect this kind of ecosystem.

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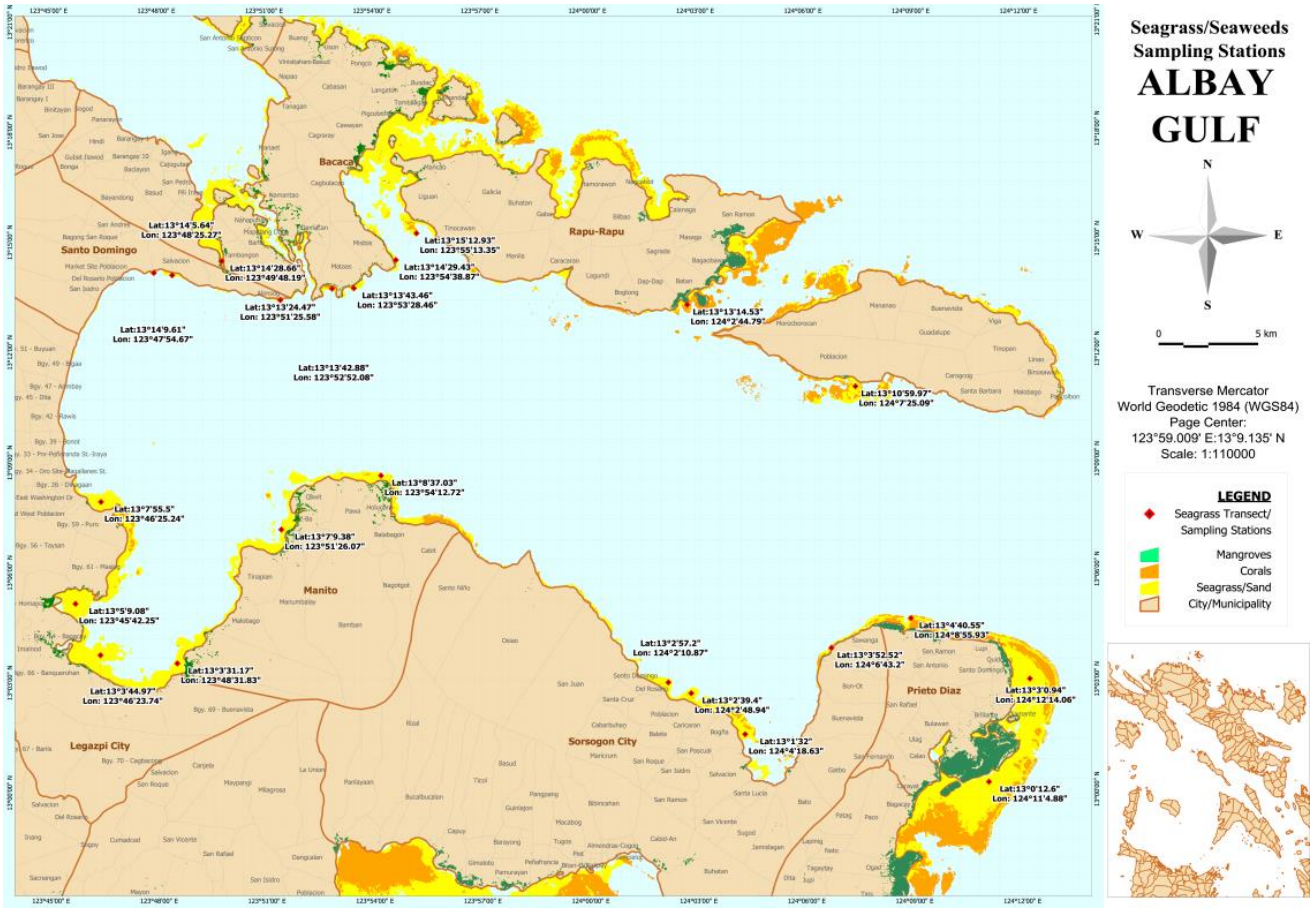
APPENDIX A



Sampling Sites in Albay Gulf.

APPENDIX B

The GPS coordinates at the start of every seagrass and seaweed bed transect line per study site in Albay Gulf.

Municipality	Barangay	Coordinates Transect 1	Coordinates Transect 2
Legazpi, Albay	Maslog	N 13° 6' 2.21"	N 13° 6' 0.57"
		E 123° 46' 41.54"	S 123° 46' 40.51"
Manito, Albay	Cawit-It-ba Boundary	N 13° 7' 35.46"	N 13° 7' 40.48"
		E 123° 51' 37.51"	S 123° 51' 34.78"
	Holugan	N 13° 8' 30.2"	N 13° 8' 30.9"
		E 123° 54' 10.8"	S 123° 54' 7.06"
Sto. Domingo, Albay	Calayucay		
	Alimsog		
Rapu-Rapu, Albay	Poblacion	N 13° 11' 10.32"	N 13° 11' 1.48"
		E 124° 7' 4.44"	S 124° 7' 28.5"
	Caracaran	N 13° 14' 7.8"	N 13° 13' 59.97"
		E 123° 59' 14.64"	S 123° 59' 18.28"
Prieto Diaz, Sorsogon	Rizal	N 13° 3' 5.61"	N 13° 2' 55.1"
		E 124° 12' 0.32"	S 124° 12' 3.74"
	Diamante	N 13° 2' 8.14"	N 13° 1' 55.91"
		E 124° 11' 53.18"	S 124° 11' 56.54"
Bacon District, Sorsogon	Poblacion	N 13° 2' 24.97"	N 13° 2' 23.29"
		E 124° 2' 48.97"	S 124° 2' 51.53"
	Salvacion (Banao)	N 13° 0' 48.36"	
		E 124° 4' 28.24"	

APPENDIX C

Seagrass species found in Albay Gulf. (a) *Cymodocea rotundata* (b) *Cymodocea serrulata*(c) *Halodule uninerves*

d) *Halodule pinifolia* (e) *Syringodium isoetifolium* (f) *Enhalus acoroides* (g) *Halophila ovalis* (h) *Halophila minor*

APPENDIX D.1

Species Count of Seaweeds Species in Albay Gulf

Municipality	Legazpi			Sto. Domingo		Manito		Rapu-Rapu		Prieto Diaz		Bacon District		
Stations	S1	S2	S3	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S3
Class Chlorophyceae														
Acetabularia sp.	-	-	+	+	-	+	-	+	+	-	-	+	-	+
Bornetella nitida	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Bornetella sphaerica	-	-	-	-	-	-	-	-	+	+	+	+	-	-
Caulerpa lentillifera	-	-	-	-	-	-	-	-	+	-	-	-	-	-
Caulerpa microphysa	-	-	-	-	-	-	-	-	-	-	+	-	-	-
Caulerpa racemosa	-	-	-	-	-	+	-	-	+	-	-	-	-	-
Caulerpa serrulata	-	-	-	-	-	-	-	-	-	-	+	-	-	-
Caulerpa sertularioides	-	-	-	-	+	-	-	-	-	+	-	-	-	-
Caulerpa sp.	-	-	-	-	-	+	-	-	-	-	-	-	-	-
Chaetomorpha sp.	-	-	-	-	-	+	-	-	-	-	-	-	-	-
Cladophora sp.	-	-	-	+	+	+	-	-	-	-	-	-	-	-
Dictyosphaeria cavernosa	-	-	-	-	-	+	-	-	-	+	+	-	-	-
Dictyosphaeria sp.	-	-	-	-	-	-	+	-	-	-	-	-	-	-
Halicoryne sp.	-	-	-	+	-	+	-	+	+	+	-	+	-	-
Halimeda cylindracea	-	-	-	-	-	+	-	-	+	-	+	+	-	+
Halimeda macroloba	-	-	-	+	-	+	-	+	+	-	+	+	-	+
Halimeda opuntia	-	-	-	+	-	+	-	-	+	-	+	+	-	-
Neomeris sp.	-	-	-	+	-	+	-	+	-	+	+	-	-	+
Udotea sp.	-	-	-	-	-	-	-	-	+	-	-	+	-	-
Valonia sp.	-	-	-	-	-	-	-	+	-	-	-	-	-	-
Valonia sp. 1 (green)	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Class Phaeophyceae														
Dictyota sp.	-	-	-	-	-	-	+	+	-	-	-	-	-	-
Hydroclathrus clathratus	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Padina sp.	-	+	-	+	+	+	-	+	+	+	-	+	-	+
Sargassum sp.	+	+	-	+	-	+	-	-	+	-	-	-	-	-
Turbinaria sp.	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Class Rhodophyceae														
Eucheuma sp.	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Galaxuara sp.	-	-	-	-	-	-	-	+	+	-	-	-	-	-
Gracilaria sp.	-	-	-	-	-	-	-	+	+	-	-	-	-	-
Gracilaria sp. 1	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Gracilaria sp. 2	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Gracilaria sp. 3	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Hypnea sp.	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Jania sp.	-	-	-	-	-	+	-	-	-	-	-	-	-	+
Kappaphycus sp.	-	-	-	-	-	+	-	-	-	-	-	-	-	-
Laurencia sp.	-	-	-	-	-	-	-	-	-	-	+	-	-	-
TOTAL	2	7	1	8	3	15	2	9	13	9	9	8	0	6

Legend: + = presence - = absence

APPENDIX D.1

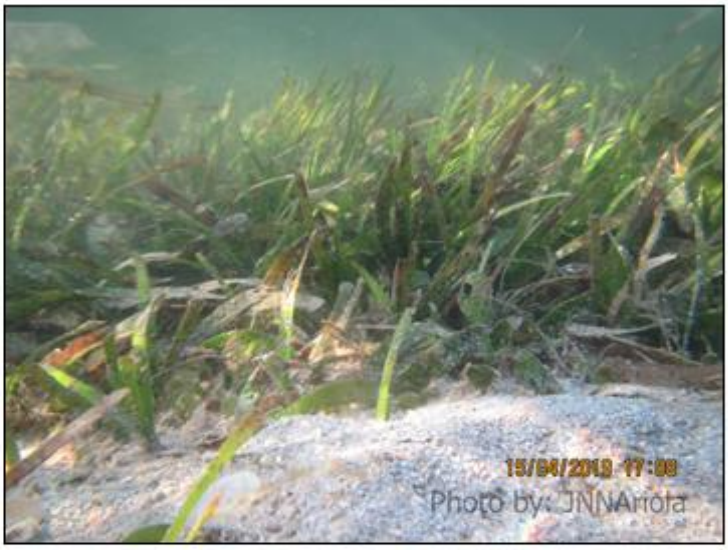
Seaweeds species found in Albay Gulf. (a) *Halicoryne* sp. and *Acetabularia* sp. (b) *Halimeda cylindracea* (c) *Udotea* sp. (d) *Dictyota* sp. (e) *Padina* sp. (f) *Sargassum* sp. (g) *Gracilaria* sp. (h) *Jania* sp. (i) *Laurencia* sp.

APPENDIX E

Seagrass bed in Barangay Diamante, Prieto Diaz showing epiphytes attached on *Thalassia hemprichii* and a seaweed *Halimeda* species.

APPENDIX F

(1)



(2)

Leaf reddening among seagrass leaves (1) *Cymodocea rotundata* in Prieto Diaz

(3) *Halophila ovalis* sample from Manito, Albay

APPENDIX G

Part of the sampling area of Station 3 in Legazpi showing *Enhalus acoroides* habit.

APPENDIX H

Part of the sampling area of Station 2 in Puro, Legazpi City showing reclamation activity.

APPENDIX I

A sample of *Syringodium isoetifolium* in its reproductive stage.

APPENDIX J

A quadrat in Station 1 in Rapu-Rapu showing *Halimeda* species habit with other seagrasses.

APPENDIX K

Portion of the quadrat in Station 1 in Prieto Diaz showing the clear water and sand with coral rubble substrate. *Thalassia hemprichii* habit with other seagrasses is also shown.

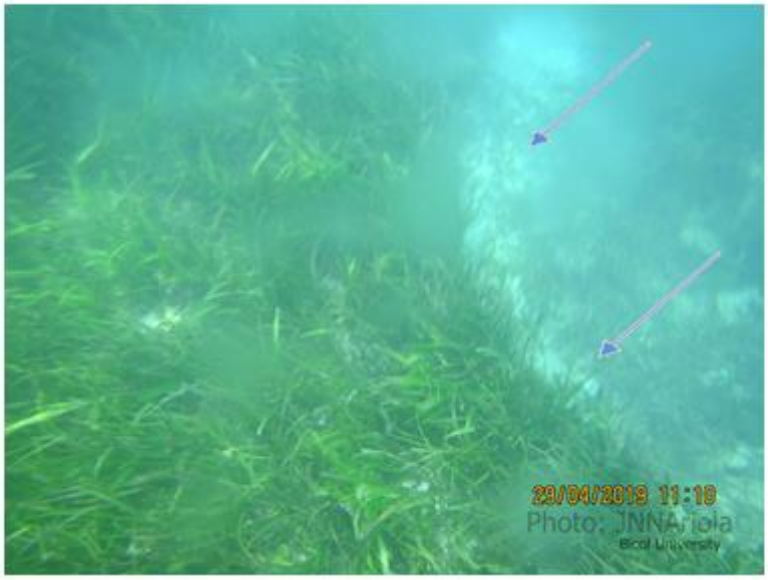
APPENDIX L

Majority of the seagrasses washed ashore in Station 1 of Bacon District is *Syringodium isoetifolium* .

APPENDIX M

(1)

(2)



Sampling sites in Bacon District. (a) local sea port in Station 1 with seagrass and seaweed species shown by two arrows washed ashore (b) portion of the seagrass bed in Del Rosario with barren area as shown by two arrows pointing to scraped area from boat anchors.

APPENDIX N

(1)

(2)

Station 2 in Bacon District (1) fishponds nearby household community as shown by two arrows and (2) a dike or breakwater.

APPENDIX O

Enhalus acroides found in Station 2 sampling area at Puro, Legazpi City.

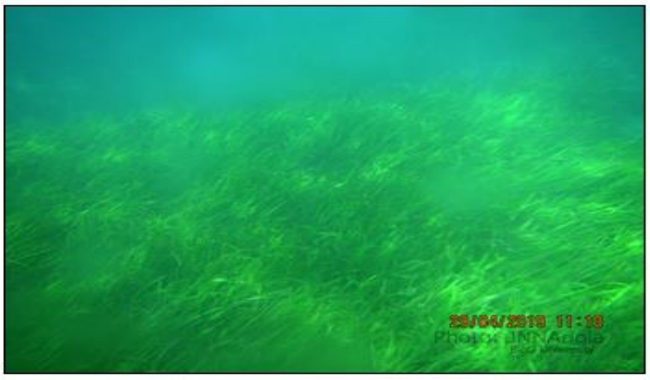
APPENDIX P

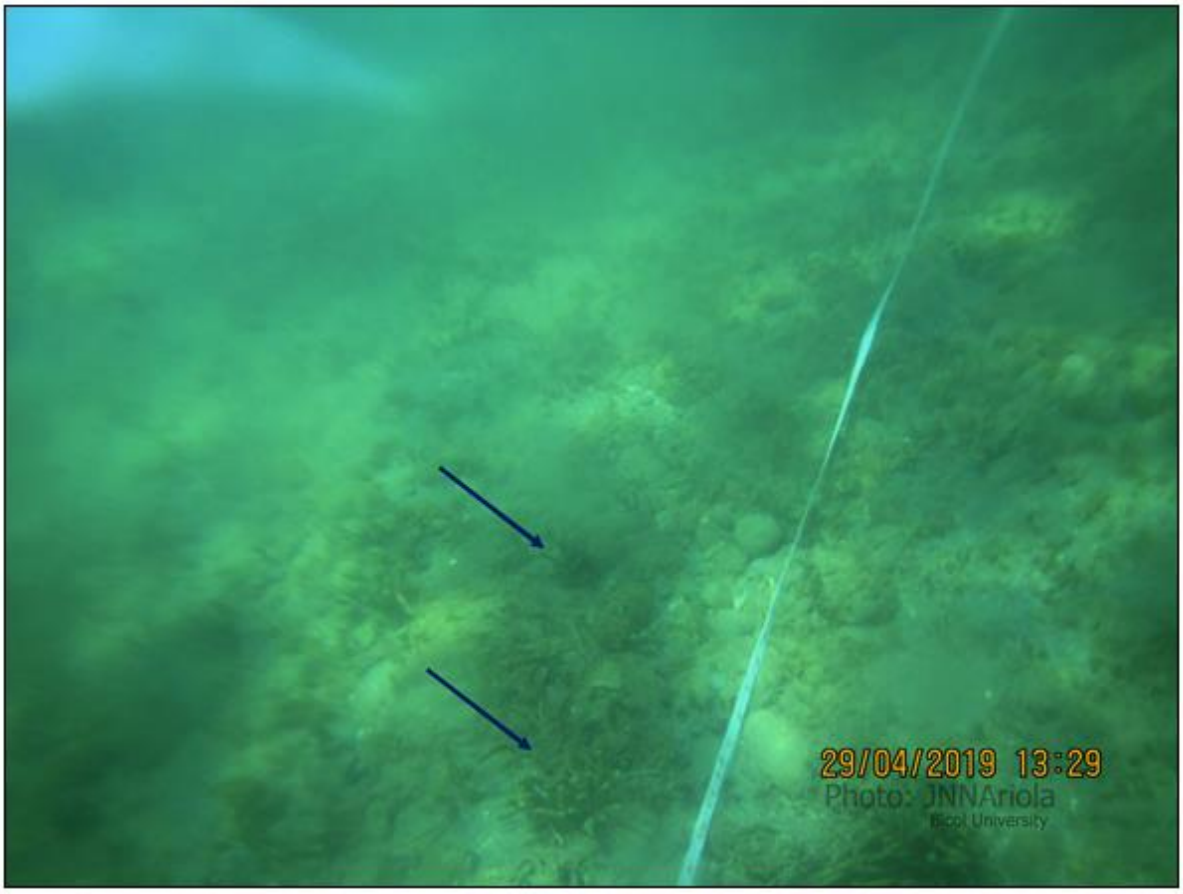
Portion of seagrass bed in Barangay Rizal, Prieto Diaz with a rabbitfish feeding as shown by an arrow. *Padina* sp. was shown growing along seagrasses *Thalassia hemprichii* and *Syringodium isoetifolium*.

APPENDIX Q

(a) 

(b) 

(c) 



Portion of the seagrass bed in Barangay Caricaran near a local seaport in Bacon District with seaweeds in the natural bed as shown by two arrows pointing to *Halicoryne* species. *Acetabularia* species is too small to be seen in this picture.

APPENDIX S

Some associated macroinvertebrates noted in the seagrass and seaweed beds in Albay Gulf.

APPENDIX T

(1)

(2)

Portion of seagrass bed in Prieto Diaz (1) sea hare feeding on the seagrass bed (2) eggs string found in the stations of Prieto Diaz, Sorsogon.

ASSESSMENT OF MANGROVES IN ALBAY GULF

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ABSTRACT

Mangroves were assessed in Albay Gulf. Line plot method was conducted to determine the present state and community structure of mangrove habitats. Eleven true mangrove species and five associated species were identified. These contributed to only one-third of the identified 47 "true mangroves" and associated species belonging to 26 families known in the country. Of the species identified, *R. apiculata* appeared as the dominant species with the highest density and frequency in the overall assessment and consistently present in almost all stations.

Community structure of different mangrove stations with highest relative density, relative frequency, relative dominance, and importance values include *R. apiculata* which appear mostly in rehabilitated areas of almost all monoculture plantations, *R. stylosa*, *A. marina*, and *S. alba*. They represent the highest number of species distribution. High regenerative capacity was observed in the Sorsogon areas Talisayon, Bacon and Prieto Diaz, high in Batan Island, and low in Cabuhatan, Cabacongan, Humapon, Manito, Buyo, and Poblacion. It was low at the mangroves of Homapon, as the number of seedlings are minimal. Disturbances and perturbations were observed, which included mangrove conversion to fishpond, land reclamation, presence of wastes in some areas particularly in Humapon and Buyo, and some cuttings. Overall, mangrove habitat conditions in the Albay Gulf are excellent in Bacon and Prieto Diaz, good in Cabacongan, Humapon, Buyo, Manito and Talisayan of Bacon District, fair in Poblacion, Rapu-Rapu, and poor in Buhatan, Sto. Domingo. Recommended management strategies could be along continued enforcement of regulations for the protection and rehabilitation of mangroves. Rehabilitation efforts shall observe the use of the right species for the available substrate. Nursery development for other species (non-Rhizophora) shall also be established. Community participation in the rehabilitation with support from government, non-government organizations, local government units, the academe, and the private sector for long term sustainability is a must.

Keywords: biodiversity, ecological habitat, mangrove, regenerative capacity

INTRODUCTION

Mangroves are salt tolerant trees that have adapted to living in salt and brackish water conditions. They are considered critical habitats in coastal areas with great ecological and socio-economic importance. It is a unique community that forms a link between the land and the sea. Mangroves serve as intermediary zone 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 as cited by Bao, 2011). This biological barrier reduces damages caused by storms by limiting wave energy and preventing the land from being flooded. Moreover, it prevents silt, sediments, and pollutants from reaching fragile habitats, such as seagrass meadows and coral reefs. They serve as shelter, spawning, and breeding grounds for birds, fish, crustaceans, mollusks, and other organisms. Mangroves is a rich habitat that serve as life support systems to about 75 percent of fish species and as to indeterminate numbers of crustaceans and wildlife (Baldevarona, 2001). Their intricate root systems provide protection and a wide range of support for estuarine and coastal fishery food chains. This is because, many fish, shellfish, birds and other wildlife species adopt the mangroves as breeding, feeding, and nursery areas. However, threats to mangroves are imminent both from the multitude of human uses and natural processes such as impacts of climate change. In fact, the mangrove cover of the country has been continuously threatened with the reduction of the near to half a million hectares in 1918 to just around 120,500 hectares in mid 1990s (Primavera 2004). Rehabilitation efforts have made some visible results in restoring some mangrove covering denuded areas. But threats about the modification of the species assemblage due to bias on fast growing and readily available planting materials and encroachment to nearby coastal habitats were noted.

In Albay Gulf, mangroves thrive in the coasts of all the surrounding municipalities and cities in Albay and Sorsogon provinces. These municipalities and cities include Sto. Domingo, Manito, Bacacay, Legazpi City, and Rapu-Rapu of Albay and Bacon district (part of Sorsogon City) and Prieto Diaz in the adjoining province of Sorsogon. Through the years, people living in coastal barangays made significant positive and negative impacts on these resource rich habitats. Many different activities such as road and infrastructure projects, land conversion and reclamation, mining, waste disposal and use mangrove in many economic activity contribute to its decline. Considering its intricate interconnection with other coastal habitats, continued deterioration of mangrove forests in Albay Gulf would have a serious implication to the fisheries, coastal defenses and the overall productivity of the gulf.

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 Albay Gulf. It also intended to obtain updated mangrove community structure information and provide reports about observable disturbances. This is the first gulf-wide assessment for the mangrove ecosystem in this small but rich fishing ground.

OBJECTIVES

This study intended to assess the status of mangrove communities in Albay Gulf. Specifically, it achieved the following:

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. Basal area
    e. Relative dominance
    f. Importance value;
3. Estimate the regenerative capacity of the mangrove communities; and
4. Document rehabilitation efforts, disturbances and observable perturbations.

METHODOLOGY

Location of mangrove areas were first determined by generating GIS maps from Landsat data. The mangrove maps were then ground truthed by actual onsite inspection. Final sampling stations were then identified and determined for comprehensive assessment. The mangrove habitat condition was evaluated using the Habitat Criteria Rating Chart for Mangroves outlined in the Participatory Coastal Resource Assessment (PCRA) guideline (see Table 1).

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, fishpond conversions, etc.
Poor	Nearly destroyed, reclaimed or filled, pollution, etc.

Data Gathering Procedure

Line Plot Method, outlined by English et al. (1997), was employed in order to assess the mangrove status and its community structure. Sampling stations in every municipality were assessed using this method, which covered the seaward margin, middle, and land part of the forest. A 100-meter transect line was laid perpendicular to the shoreline segmented every 5 meters with established sample plots (5 m x 5 m). 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.

Each mangrove species along each transect was identified, counted, and measured. This method provided quantitative descriptions of the species composition and community structure of mangrove forests. Tree girth measurements were taken at breast height, 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 can be converted into diameter at breast height (DBH) measurements by dividing them by 3.1416.

Ecological Diversity Indices

Ecological diversity relates to the different species of a particular genus which 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

- Simpson's Index (D) is a measure of diversity, which 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:

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

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:

Basal Area = $0.005454 \times (DBH)^2$ ft^2

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

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

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

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

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

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

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

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

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 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 100. The result would be the percentage of every species occurrence. This has something to 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 will be converted into basal area using the standard formula. The higher the basal area, the bigger the diameter of the trees, which will eventually dominate with high percentage compared to those 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 were included in the survey. This means that distribution, number of species that appeared and the sizes of mangrove species are 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 that appeared with the highest value become species of high importance to the mangrove stands.

Mangrove rehabilitation was documented in each sampling area through actual field observations of disturbance and other perturbations. Also, a simple interview with local residents and barangay officials was 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

Mangrove status

Table 2 shows the location, type, and the general state of the mangroves assessed in Albay Gulf. Mangroves in Prieto Diaz, Sorsogon and Bacon district of Sorsogon City were both in excellent state. Those in Prieto Diaz, in particular has been managed and maintained by a non-government organization (NGO) known as SEMANCOR since 1994, whose mission is to protect the seagrass, mangroves and corals in Prieto Diaz. Here, mangroves are estimated to cover an area of about 1,094 hectares, with 267 hectares planted with propagule producing tre**e**s *R. apiculata* and *R. stylosa*. Likewise, the mangroves of Bacon district appeared to be well managed, as there were no observed cuttings, minimal signs of disturbance; and were free from solid wastes. In fact, this site registered a very high regenerative capacity but still, propagules were planted in front of the mangrove zones as an initiative to expand seaward its coverage. This may affect the zonation of the mangroves and disrupt in the future, the overall functionality of the mangrove community. Mangroves in these Sorsogon sites were of fringing and basin types while those in Prieto Diaz were typically of fringing, basin, and riverine type.

Table 2. Location, Type and Status of Mangroves in Albay Gulf

Municipality/city	Stations	Coordinates	Mangrove type/s	Status
Sto. Domingo	Buhatan		riverine,basin	poor
Legaspi	Buyo	13º 07'14.5N, 123º 51'7.53E	fringing	good
	Humapon		Riverine	good
Manito	Cabacongan	13º 3'31.09N 123º 48'45.89E	fringing	good
	Manito	13º 07'44.1N 123º 51'8.14E	fringing	good
Rapu-Rapu	Batan island	13º 11'14.14N 124º 7'8.89E	overwashed	good
	Poblacion	13º 11'14.14N 124º 7'8.89E	fringing	fair
Sorsogon	Bato, Bacon	13º 13'30.43N 124º 2'59.53E	riverine,fringing,basin	excellent
Prieto Diaz	Talisayon	13º 4'30.24N 124º 8'27.86E	fringing,basin	good
	Diamante	13º 1'40.44N 124º 11'7.01E	riverine,fringing,basin,	excellent

Fair conditions were recorded in Poblacion, Rapu-rapu because of the presence of heavy cuttings for the past decades. There were also a very minimal presence of saplings and seedlings; hence, the capacity to regenerate is low. A mangrove area in Batan Island was in good condition. The same were observed in the mangroves of Buyo and Humapon of Legazpi City, Cabacongan and Manito, and a station in Bacon District (Talisayon). Except for Humapon and Talisayon, these mangrove areas that were in good state have recovered from poor to good condition due to massive reforestation and rehabilitation efforts by local and national agencies. The Talisayon and Humapon mangroves were still in their natural zonation pattern, but with the presence of solid wastes and settlements nearby, their recovery is in jeopardy. In Buhatan, Sto. Domingo, the mangroves were in poor state. Large portions of the mangrove area were

isolated from substantial connection to the sea due to coastal developments and the concrete roads that cut the mangroves into isolated sectors. These may disrupt and cause great impact on the survival of other mangrove species. They are very sensitive to environmental stressors, such as changes in hydrology, salinity, temperature, and exposure, among others. The elimination of other mangrove species may favor other species to proliferate in the area. Each of these mangrove species is adapted to different environmental requirements and follows the natural zonation pattern.

Community Structure

Diversity

Table 3 shows the mangrove species identified in Albay Gulf. It shall be emphasized here that these species were the ones encountered in the line plots. A total of 11 species were encountered belonging to six families of true mangrove species. This is comparably lower than the recorded 47 true mangrove species in the Philippines. The low species count can be due to rampant illegal cutting activities in the distant past and the rehabilitation initiatives that heavily relied on propagule-producing *Rhizophora* species. The latter practice in mangrove rehabilitation would disrupt the right zonation pattern, eliminate other species, and result in luxuriant growth of low number of species.

Associated mangrove species were also identified during ocular inspection wherein five species were noted belonging to five individual families. Summing this up with the 11 true mangroves, Albay Gulf would appear to harbor only one-third of the identified 47 "true mangroves" and associated species belonging to 26 families known in the country. The mangrove in Talisayon of Bacon District harbors the highest value of 1.571 among fair diversity mangrove species with eight species. The complete list of species is in Appendix 2.

Table 3. True Mangroves and Associated Species Identified in Albay 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	*Lumnitzera littorea*	Tabau
Arecaceae	*Nypa fruticans*	Nipa
Associated Species		
Aizoaceae	*Sesuvium portucalastrum*	Dampalit
Combretaceae	*Terminalia catappa*	Talisay
Convulvulaceae	*Ipomeapes-caprae*	Lambayong
Pteridaceae	*Acrostichum speciosum*	Lagolo
Rubiaceae	*Morinda citrifolia*	Bangkoro

The Shannon diversity index is a quantitative measure of species richness (the number of species in a given area) and their relative abundance. Species diversity increases with the complexity of habitat. The more species there are in a community relative to the number of individuals, the more complex it is. 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. The Shannon biodiversity index (H') in

Talisayon is H'=1.571. It reflects a fair diversity (Table 3.1). Poblacion, Bacon and Prieto Diaz still fall under fair condition, while Cabacongan, with a value of 0.938, is low diversity. Others were low in diversity but still in good condition. A typical example is the Humapon mangrove area.

Table 3.1 Diversity Indices, Dominance and Evenness of Mangroves in Albay Gulf

Municipality/City	Station	H	D	Evenness
Sto. Domingo	Buhatan	0.753	0.4705	0.685
Legaspi	Buyo			
	Humapon	0.539	0.2928	0.49
	Cabacongan	0.938	0.5653	0.854
Manito	Bacon	1.221	0	0.881
	Manito	0.064	0.0233	0.092
Rapu-rapu	Batan Island	1.01	0.573	0.729
	Poblacion	1.305	0.6822	0.728
Sorsogon	Talisayon	1.571	0.7312	0.755
	Prieto Diaz	1.228	0.6374	0.685

The evenness index (EI) designated as E takes into account how evenly the individuals among different species are distributed in an area. It is also a measure of the relative abundance of different species making up the richness of an area. An E value equal to 1.0 denotes complete evenness or equitability. The evenness value (E) Cabacongan and Bacon were 0.881 and 0.854, respectively, and dictates a nearly equal distribution. Prieto Diaz, Poblacion, Talisayon, Batan Island, and Buhatan had a relatively equal distribution. Others were partial or not evenly distributed.

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 two species, the Simpson Dominance Index (C) is about one-half (0.5). Simpson's approach uses the premise that the chance 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.

Other measures of community structure

Table 4 shows the community structure of the mangrove area in Poblacion and Batan Island of Rapu-rapu, Albay. Six true mangrove species were encountered in Poblacion, while there were only four in Batan. Mangroves in Poblacion have near to a thousand tree stands and dominated by *A. marina* (416 trees), *S. alba* (308 trees), and *R. apiculata* (180 trees). Raising these tree stand counts to one hectare would show the three species as the densest. Rehabilitation efforts in Poblacion were definitely very slow as only few propagules planted were seen, which will not generate and sustain its existence. Few of the species were natural stands while others were secondary growth. Most of the mangroves in Albay Gulf were secondary growth with a few remnants of old trees. Only a thin portion of the mangroves in Poblacion remain as evidence of mangrove stumps due to heavy cuttings for the past decades.

In fact, locals sell the soil for aquarium. Another threat to its survival is the rapid urbanization in the area.

Table 4. Community structure of mangroves in Poblacion and Batan Rapu-Rapu, Albay

Species	No. stand	Density (no. of indv./has.)	Rel. Dens.	Freq	RF	Basa Area (ft^2)	Rdom	IV
A. corniculatum	15	111.11	1.54	0.07	2.78	0.03	0.05	4.37
A. marina	416	3081.48	42.71	0.80	29.86	14.46	29.57	102.15
L. littorea	24	177.78	2.46	0.06	2.08	3.80	7.77	12.32
R. apiculata	180	1333.33	18.48	0.69	25.69	6.71	13.72	57.90
R. mucronata	31	229.63	3.18	0.20	7.64	0.87	1.78	12.60
S. alba	308	2281.48	31.62	0.85	31.94	23.03	47.10	110.67
Total	**974**	**7214.81**	**100**	**2.67**	**100**	48.90	**100**	**300**

Community structure of mangroves in Batan island

Species	No. stand	Density	RD	Frequency	RF	Basal Area (sq. ft)	RDom	IV
R. apiculata	4	266.67	21.05	1.00	43.10	190.98	14.03	78.18
R. stylosa	12	800.00	63.16	1.00	43.10	1145.91	84.15	190.41
S. alba	2	133.33	10.53	0.16	6.90	17.82	1.31	18.73
A. marina	1	66.67	5.26	0.16	6.90	7	0.51	12.67
Total	**19**	***1266.67***	**100.00**	**2.32**	**100.00**	**1361.71**	**100.00**	**300.00**

For Batan Island, minimal number of trees were encountered in the plots. *R. stylosa* was the densest species but *R. apiculata* registered the biggest estimate for basal area (190.98 sq. ft.). Unlike in Poblacion, massive reforestation was observed in Batan. In fact, very thick mangrove areas were observed in two areas and were mostly secondary growth with only two species. Though successful in their rehabilitations, natural zonation was obviously disrupted. Thus, thick mud and soil affected the sea grass and corals due to the lack of the right frontline mangroves. This is better performed by species such as *A. marina* and *S. alba* whose root systems are efficient traps and filters of silt. Threats to the survival of mangroves were also observed, such as coal mining, the presence of a pier that harbors passengers, and rapid urbanization.

Table 5 shows the community structure of mangroves in Buhatan, Sto. Domingo, Albay. As indicated earlier, the mangrove community in this location is on the stage of continued perturbation as an offshoot of its significant isolation from the processes of the sea due to physical barriers of developments. There were only three species encountered and minimal stands measured. *R. apiculata* dominated the mangrove assemblage in this location. *R. apiculata* had the highest importance value of 174.30. Some mangrove species were affected by these environmental changes as they are sensitive to environmental stressors, such as hydrology, exposure, salinity, and temperature as they follow the natural zonation that requires

individual environmental requirements. As a result, some mangrove species might not withstand these changes and might lead to elimination and give way to other mangrove species such as Nypa to proliferate in the area. This will negatively impact the mangroves' natural ecological functions.

Table 5. Community Structure of Mangroves in Buhatan, Sto. Doingo, Albay.

Species	No. of tree stands	Density (trees/ha)	Rel. Dens. (%)	Fre-quency	Rel Freq. (%)	Basal Area (sq.ft)	Rel. Dom.	Imp. Value
A. marina	4	533.33	23.53	1.00	56.25	25.46	27.59	107.37
R.apiculata	*12*	160	70.59	0.67	37.50	61.11	66.22	174.30
B.sexangula	*1*	133.33	5.88	0.11	6.25	5.72	6.2	18.33
Nypa fruticans	--	--	--	--	--	--	--	--
Total	*17*	*826.66*	*100*	*1.78*	*100*	*92.29*	*100.01*	*300*

Two mangrove stations were assessed in Legazpi City, both facing Polique Bay which is co-bounded by the coastal waters of the adjoining town of Manito. The community structures of the two mangrove areas are presented in Table 6. Humapon harbors three mangrove species, while only *R. apiculata* was encountered in Buyo. *R. apiculata* dominated the two mangrove communities in terms of number of stands, density, frequency, basal area, and dominance.

Table 6. Community Structure of Mangroves in Legazpi City.

Species	No. of tree stands	Density (trees/ha)	Rel. Dens. (%)	Fre-quency	Rel Freq. (%)	Basal Area (sq. ft)	Rel. Dom.	Imp. Value
Humapon								
A.marina	7	400	12.96	0.43	27.27	5.69	9.33	49.57
R. apiculata	*45*	2571.43	83.33	1.00	63.64	55.24	90.61	237.58
B.sengangula	*2*	114.29	3.70	0.14	9.09	0.33	0.05	12.85
Total	*54*	3085.72	*99.99*	*1.57*	*100*		*99.99*	
Buyo								
R. apiculata	*28*	5600.00	100.00	1.00	100.00	2.68	100.00	300.00
Total	*28*	*5600*	*100*	*1*	*100*		*100*	*300*

Humapon mangroves is a riverine type with many water passages and inlets that allow continuous flow of water. It has a concentration of mangroves in the center comprising mostly of *R. apiculata* with few stands of stunted *S. alba* as frontline species with patches *of A. marina* scattered and rare *B. sexangula*. It has a wide and deep river area. Both the left and right sides of the mangroves were filled with *A. marina* creating a spectacular view with a cove-shape appearance. A thick mangrove vegetation at the center was observed and thin vegetation on both the left and right sides of the mangrove area. Though it has a beautiful scenery when seen from a distance it is surrounded by local residents with no proper waste disposal. Once solid waste reaches the mangrove area, the seedlings will be put in danger.

Two mangrove stations were assessed in Manito. These were mangroves fronting Manito centro and Cabacongan. Only thin strips of mangroves line up the shorelines. Three species were encountered in these stations, with *R. apiculata* dominating in terms of number

of tree stands and density (Table 7). Massive rehabilitation of Bakawan lalaki species were successfully initiated by local officials for both Buyo and Manito areas. They used the same species in the rehabilitation of the coastlines. Some of the trees have started to produce

Table 7. Community structure of mangroves in Manito, Albay

Species	No. of tree stands	Density (trees/ha)	Rel. Dens. (%)	Fre-quency	Rel Freq. (%)	Basal Area (ft^2)	Rel. Dom.	Imp. Value
Manito								
Avecinia marina	2	100	1.18	0.25	20.00	0.49	1.44	22.62
Rhizophora apiculata	*168*	8400	98.82	1.00	80.00	33.51	98.56	277.38
Total	*170*	8500	*100*	*1.25*	*100*		*100*	
Cabacongan								
Avecinia marina	16	1066.67	25.81	0.83	33.33	9.72	38.54	97.68
Rhizophora apiculata	37	2466.67	59.68	0.83	33.33	6.06	24.03	117.04
Soneratia alba	9	600	14.52	0.83	33.33	9.44	37.43	85.28
Total	*62*	*4133.34*	*100.01*	*2.49*	*99.99*	*25.22*	*100*	*300*

propagules, which may sustain mangrove regenerate in the future. Old stumps of *R. apiculata* and *S. alba were* seen along the coastlines, with some few stunted old trees remaining. This is

an indication that these mangrove areas were originally dominated by the right frontline species that naturally grew and protected the shorelines from typhoons and big waves/storm surges. The landward area was dominated by Nypa. Deep mud was observed in the Buyo area and shallow in the Manito area, an indication of the planted mangrove species' inability to trap sediments and filter clay soil, which prevents further damage to seagrass and corals. Very dense mangroves were planted along a very long shoreline. It is better to remove the dead trees so as to give way to frontline species to be planted and restore the capability of the mangrove community to control silt and mud dissipation to nearby habitats. Continuous rehabilitation and planting of new mangrove propagules were observed. Thin mangrove stands remain in the Cabacongan area. For the past decades, illegal gathering of firewood and mangrove logs almost wiped the mangroves out. Gathered mangroves ended up at local bakeries as preferred fuel wood due to their very high heat and flame quality. Local officials and other groups initiated the planting of propagules but it is still not enough. What is required is correct, continuous, and sustained restoration efforts.

Thick mangrove vegetation was observed in the Bacon district. The coastlines were rocky. At least four species were recorded during the survey. Old growth trees lined up the coastal zones with planted propagules/seedlings in front, which may disrupt its natural zonation pattern. *A. marina* was found to be a very important species with a value of 156.29 or half of the species recorded with a relative dominance value of 70.44%, relative frequency of 40.91%, and relative density of 44.94%, which make it very important among other species (Table 8). The mangroves of Bacon district appeared to be well managed, as there were no observed cuttings, minimal signs of disturbance, and are free from solid wastes. In fact, this site registered a very high regenerative capacity but, still, propagules were planted in front of the mangrove zones as initiative to expand seaward its coverage. This may affect the zonation of the mangroves and disrupt in the future the overall functionality of the mangrove community. The roots of frontline species hold and sustain the mud soil thereby preventing them from going to the seagrass beds. This mangrove area has a high chance of long-term presence considering the big number of saplings and seedlings present for all four species. A riverine, fringing and

basin type mangrove that can withstand adverse environmental conditions, such as storm surges. Rehabilitation efforts were also recorded in the area where propagules of *Rhizophora* species was used. This is the same with other mangrove stations in Albay Gulf because they are easy and convenient to transport and to plant.

Table 8. Community Structure of Mangroves in Bacon District Sorsogon

Species	No. stand	Density	RD	Frequency	RF	Basal Area	RDom	IV
A. marina	40	1600.00	44.94	0.90	40.91	47.7	70.44	156.29
R. apiculata	13	520.00	14.61	0.50	22.73	5.05	7.46	44.79
S. alba	28	1120.00	31.46	0.60	27.27	14.58	21.53	80.26
C. decandra	8	320.00	8.99	0.20	9.09	0.39	0.58	18.66
Total	**89**	***3560.00***	**100.00**	**2.20**	**100.00**	**67.72**	**100.00**	**300.00**

Prieto Diaz, Sorsogon had the largest mangrove area in Sorsogon and found to be in excellent condition. In Diamante, large mature trees of *R. stylosa* or Bakawan lalaki dominate with the most number of tree stands (104), most dense (2,185 trees/ha), and with the largest basal area (1,115.7 ft^2). The basal area of this species is nearly half of the aggregate area estimated for the rest of the mangrove species. Old growth of *Sonneratia alba*, locally known as *pagatpat*, though few in number (26 trees), have bigger diameters hence, large basal area (566.9 ft^2). The mangroves of Prieto Diaz is well-managed and maintained by an NGO known as SEMANCOR since 1994. They were partnered then by the Department of Environment and Natural Resources (DENR), whose mission is to protect the seagrass, mangroves, and corals in the municipality. Here, mangroves are estimated to cover an area of about 1,094 hectares. A total of 267 hectares were planted with propagules producing tre**e**s *R. apiculata* and *R. stylosa*. Mangroves in Prieto Diaz are typically of fringing, basin, and riverine type.

Table 9. Community structure of Mangroves in Diamante, Prieto Diaz, Sorsogon

Species	No. stand	Density	RD	Frequency	RF	Basal Area	RDom	IV
A. marina	25	526.32	13.16	0.42	18.60	376.23	15.85	47.61
R. apiculata	33	694.74	17.37	0.63	27.91	298.26	12.57	57.84
R. stylosa	104	2189.47	54.74	0.47	20.93	1115.67	47.00	122.67
S. alba	26	547.37	13.68	0.63	27.91	566.96	23.89	65.48
RM	1	21.05	0.53	0.05	2.33	12.73	0.54	3.39
CD	1	21.05	0.53	0.05	2.33	3.82	0.16	3.01
Total	**190**	***4000.00***	**100.00**	**2.26**	**100.00**	**2373.67**	**100.00**	**300.00**

The seedlings in this area were three times more than mature trees, an indication of its very high regenerative capacity. It is a potential source of propagules for other mangrove sites that require immediate temporary rehabilitation. In fact, overcrowded seedlings were seen in large water channels but few inside the mangrove stands. They were already beginning to close some river channels. The presence of SEMANCOR helps to protect this area from illegal

loggers. In fact, the habitat supports a very viable ecotourism engagement, considered to be a tourism destination in the province of Sorsogon.

Mangroves in Talisayon, Quidolog, Prieto Diaz, Sorsogon were relatively thick and had the most number of species (8) compared to other areas surveyed in Albay Gulf (Table 10). Some mangrove stands were primary growths, but most were secondary growths.

Table 10. Community structure of mangroves in Talisayon, Sorsogon

Species	No. stand	Density	RD	Frequency	RF	Basal Area	RDom	IV
A. marina	32	1422.22	45.71	1.00	31.03	34.34	45.36	122.11
R. apiculata	13	577.78	18.57	0.67	20.69	13.95	18.43	57.69
R. mucronata	1	44.44	1.43	0.11	3.45	0.53	0.70	5.58
R. stylosa	3	133.33	4.29	0.22	6.90	3.88	5.13	16.31
A. rumphiana	2	88.89	2.86	0.11	3.45	0.78	1.03	7.34
S. alba	11	488.89	15.71	0.67	20.69	14.57	19.25	55.65
L. littorea	6	266.67	8.57	0.33	10.34	7.53	9.95	28.86
C. decandra	2	88.89	2.86	0.11	3.45	0.12	0.16	6.46
Total	**70**	***3111.11***	**100.00**	**3.22**	**100.00**	**75.70**	**100.00**	**300.00**

The landward portion is dominated by *A. rumphiana*, but *A. marin*a is consistently available in almost all quadrats with 32 stands and a computed density of 1,422 trees/hectare. It also registered the biggest basal area computed (34.34 ft^2), contributing half of the aggregate basal areas of the eight mangrove species encountered in the area. *A. marin*a plays a very important role in sediment stabilization and holding capacity because it can withstand storm surges with the presence of pencil-like pneumatophores preventing and protecting the shoreline from siltation and other marine species, particularly the seagrass sea beds and corals.

Regenerative Capacity

A mangrove forest is usually restored through natural regeneration 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 species.

The number of saplings and seedlings are more than 50% of the number of matured trees surveyed within the sample plots, a high probability of the forest to sustain its existence. If the sapling/seedling number is lower than 50% of matured trees, it may indicate low regenerative capacity (Participatory Methods in Community-based Coastal Resource Management Vol. 3, 1998). The very variable number 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. The presence of these seedlings and saplings could be supplemented by natural and human-assisted regeneration.

Mangrove stations in Sorsogon, particularly in Bacon and Prieto Diaz, have very high regenerative capacity because of low disturbances, presence of seed-producing mature trees (see also Tables 9 and 10), and the high number of saplings and seedlings. Batan mangroves are purely reforestation areas with mature trees producing propagules, an indication of high probability of recuperation. The rest of the mangrove areas have low regenerative capacities, as the number of saplings and seedlings fell short of the the reference of 50% of tree stands. These mangrove areas need regular monitoring and management interventions from various concerned agencies for their survival. Presence of human settlements, the solid wastes they produce, and the encroachment of development are critical concerns.

Table 11. Regenerative capacity of mangrove communities in Albay Gulf.

Municipality/city	Stations	Trees	No. of Seed/saplings	Regenerative capacity
Sto. Domingo	Buhatan	17	6	low
Legaspi City	Buyo	28	13	low
	Humapon	54	25	low
Manito	Cabacongan	62	19	low
	Manito	170	15	low
Rapu-Rapu	Batan island	280	150	high
	Poblacion	974	139	low
Sorsogon City	Bacon	89	210	very high
Prieto Diaz	Talisayan	70	127	very high

Observable Perturbations and Disturbances

Based on ocular inspection of mangroves surveyed, including mangrove areas not included due to security reasons but within or part of the Albay Gulf, the common threats of mangrove forests are the conversion of the mangrove area to fishponds, land reclamation and impacts of wastes. Fishponds can be economically beneficial but they contribute severely to the destruction and rapid depletion of the mangrove forests. Particularly, they alter the bio-ecological set-up and significantly affect the ecological functioning of the habitat. Their direct impacts are loss of nursery ground, depletion of detritus materials for marine animals, reduction of protection of shore and estuaries from storm surges and big waves, pollution, wildlife habitat loss, and diversity erosion. Also, the conversion of mangrove swamps substituted the formerly highly diverse and naturally productive ecosystem into an economically and ecologically unstable environment. Some photo-documentation of these disturbances are in Appendix A.

SUMMARY, CONCLUSION AND RECOMMENDATIONS

A total of 11 species were encountered belonging to six families of true mangrove species. This is comparably lower than the recorded 47 true mangrove species in the Philippines. The low species count can be due to rampant illegal cutting activities in the distant past and the rehabilitation initiatives that heavily relied on propagule-producing *Rhizophora* species. The latter practice in mangrove rehabilitation would disrupt the right zonation pattern, eliminate other species, and result in luxuriant growth of a low number of species. Five associated mangrove species were also encountered. The mangrove area in Talisayon (Prieto Diaz) and Bato, Bacon had the most number of encountered mangrove and associated species. Overall, the mangrove areas of Bacon and Diamante in Prieto Diaz were in excellent condition, while the one in Talisayon of Prieto Diaz, the stations in Manito, Legazpi, and Batan Island were in good condition. The mangroves of Poblacion in Rapu-Rapu were in fair state, while the one in Buhatan of Sto. Domingo was in poor state. Mangrove area development and conversion to varied economic uses, solid wastes, and improper rehabilitation practices have yielded these different states/condition of the habitat.

R. apiculata appeared as the most dense in many areas surveyed because it was chosen as the reforestation species. All mangrove stations surveyed were considered secondary, which means they were no longer old growth forests. Some areas had few mangrove species but with high percentage density of species occurrence because they truly dominated the entire stand with choices. Other mangrove stations surveyed were usually natural stands with few human interventions. They were found in Bacon and Talisayon, both in the province of Sorsogon. Efforts to replant mangrove species were for rehabilitation only, whose purpose was to increase the mangrove area but not to restore the original stand following the natural zonation pattern.

The regeneration capacity of the mangrove areas varied significantly. Sorsogon mangroves have very high regenerative capacities based on the abundance of saplings and seedlings, exceeding 50% of counted tree stands. Batan mangroves have high regenerative capacity, while the rest have poor capacities based on the same criteria.

With all these results, the following are highly recommended:

1. Put on check the continued encroachment of human settlement, coastal development and other forms of disturbances that would compromise the ecological and economic benefits of this habitat;

2. Include mangrove communities in the protection and management programs for coastal-marine environment of the LGUs,

3. Dead mangrove trees in plantation areas should be removed and be replaced with the right species. Ideally, with *A. marina* and *S. alba* as frontline species. Do not plant *R. apicula*ta for they are more suited to be planted behind these two frontline species. Nursery development for other mangrove species could help a lot.

4. Implementation of regulatory techniques by enforcing mangrove laws. Also, implement non-regulatory techniques, such as public education, slide presentation, video presentation, seminars, and other interventions.

5. Apply natural regeneration or restoration ecology instead of just rehabilitation to maintain diversity.

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APPENDIX A. Observed disturbances in the mangrove areas of Albay Gulf

1. Fishpond conversion/Bagacay pier

2. Mangrove land reclamation at Bagacay for ecotourism

3. Wastes and cuttings Buyo/Manito/ Humapon

WATER QUALITY ASSESSMENT IN ALBAY GULF

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ABSTRACT

Water quality assessment was carried out from selected stations scattered along Albay Gulf. Selection of number and locations of these stations were based on prevailing situations and issues in the gulf. 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% of the time to maintain its designated classification. This project, as part of the Participatory Resource and Socio-Economic Assessment (PRSA) Program, aims to establish baseline measurements for primary water quality parameters for marine waters and to assess the conditions of the water in the identified gulf.

Two approaches were employed in the assessment of primary water quality parameters in Albay Gulf. All measured primary parameters were compared to standards and minimum and range limits set under the Department Administrative Order (DAO) 2016-08 for SB classifications and usage. Primarily, the identified stations were covered by the local government units of Legazpi City, Sto. Domingo, Bacacay, Rapu-Rapu, Manito, Bacon and Prieto Diaz. All sampling stations along Albay Gulf exhibit normal values for *in situ*, parameters which were temperature (28.11-29.09°C), salinity (32. 39–33.95 psu), pH (8.10-8.25), and DO (6.09-6.58 ppm). These figures show that the condition of Albay Gulf conforms to the standards set by DAO 2016-08 considering the SB water classification and usage of marine waters. The mean values recorded for the in-situ parameters identified and the predominant activities encountered in the area further implies good water condition prevailing within the gulf. However, some of the identified stations exceeded the limits set by the standards, such as nitrates (11.6-16.10 mg/L), phosphate (0.14–5.04 mg/L) and fecal coliform levels (<1.1–3200 MPN/100ml). This implies that some of the parameters for the water quality stations are perturbed. The high nitrate and phosphate concentration can be ascribed from agricultural runoff, in addition to the prevailing nutrient load of the seawater. On the other hand, high fecal coliform values from the identified stations compared to the limits can be attributed to sources like runoffs, waste discharge, domestication of animals, and poor sanitation compliance along coastal areas.

Keywords: Water quality, standards, laboratory tests

INTRODUCTION

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 that indicate the condition and acceptability of water relative to its proposed or present use. Water quality assessments were carried out in selected stations scattered along the identified locations in Albay Gulf. Selection of number and locations of these stations were based on prevailing priorities, situations, and issues in the gulf. These were marine protected areas (MPAs), aquaculture sites, recreational zones, and areas where the presence of industries has the potential of perturbing the coastal environment.

Marine environments like Albay Gulf are important for fisheries as they provide habitats for many marine living species. Basically, water quality of gulfs is influenced by natural environmental processes and human activities. Philippine water quality is assessed based on the set of beneficial use as defined in a set of standards. 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 by 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 DAO 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), and temperature (0C and Total suspended solids (TSS, mg/L).

This study determined the status of the basic water quality of Albay 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 Albay Gulf such as:
    1. pH;
    2. Dissolved oxygen (DO);
    3. Temperature;
    4. Total Suspended Solids (TSS);
    5. Nitrates;
    6. Phosphates; and
    7. Fecal coliform

b. To assess the condition of the water in Albay Gulf based on established standards.

METHODOLOGY

Albay Gulf is located at the southern part of Luzon Island covering the provinces of Albay and Sorsogon. It has been one of the tourist attractions of these provinces due to its clear water, fine beaches, and the frequent sightings of whale sharks in its coastal areas.

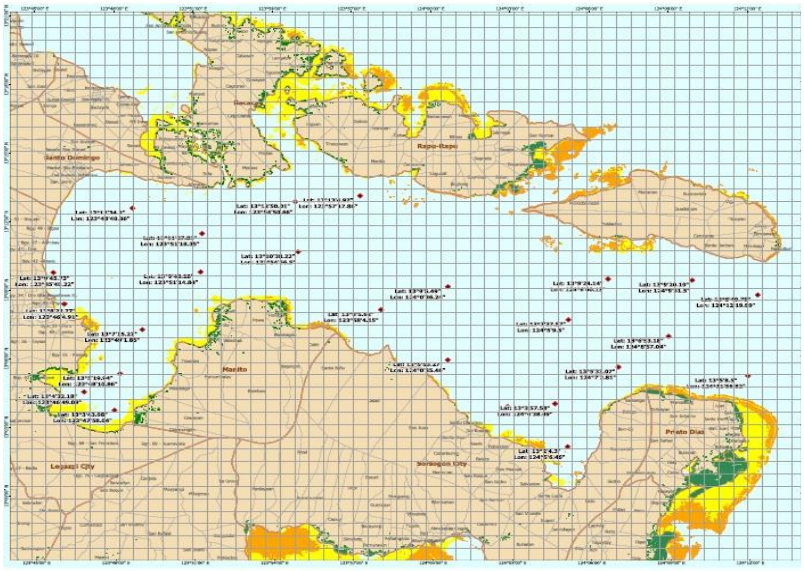


Fig 1. Water quality stations in Albay gulf

There were 13 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. Water quality stations in Albay Gulf are mainly covered by the local government units of Rapu-Rapu, Bacacay, Sto. Domingo, Legazpi, Manito, Bacon District, and Prieto Diaz.

Two approaches were employed in the assessment of primary water quality parameters in Albay Gulf. These were in-situ measurements and laboratory analysis. Laboratory analyses for nutrients (phosphate ad nitrate), fecal coliform, and TSS were undertaken at the 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 and five meters depth, using Kemmerer water sampler. Thirteen sampling stations were established in Albay Gulf and sanctuaries were prioritized for 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 seven parameters with instrument probe deployable to up five 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 can be made to remove/correct the turbidity, color, salinity, or dissolved organic compounds in the collected samples. This method is 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 is measured at 410nm. Temperature control of the color reaction is 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 and 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

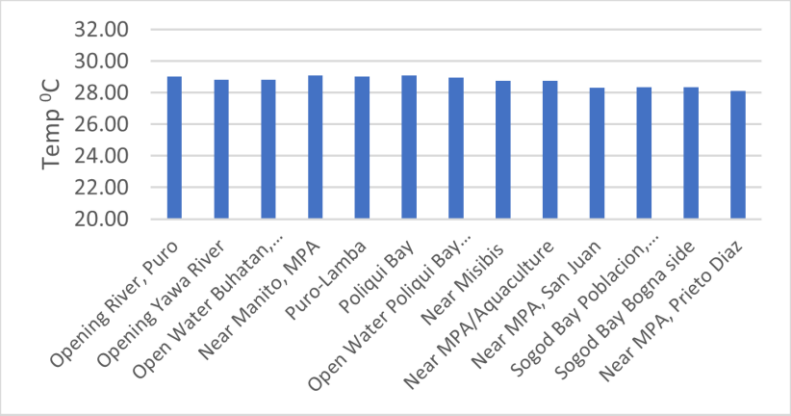
Table 1 summarizes the results of the in-situ measurements on different parameters for Albay Gulf water quality stations.

Table 1. Physico-Chemical Characteristics of Albay 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***			
AL 1	Opening River, Puro	8.21	29.01	6.28	46.44	22.85	32.39
AL 2	Opening Yawa River , San Roque	8.10	28.81	6.12	46.42	23.10	32.86
AL 3	Open Water, Buhatan, Sto. Domingo	8.22	28.83	6.33	46.42	23.16	32.94
AL 4	Near Manito, MPA	8.25	29.07	6.30	46.39	23.12	32.84
AL 5	Puro-Lamba	8.13	29.01	6.34	46.39	23.21	32.97
AL 6	Poliqui Bay	8.13	29.09	6.23	46.42	23.19	32.96
AL 7	Open Water, Poliqui Bay, Banquerohan Area	8.15	28.95	6.28	46.44	23.19	32.97
AL 8	Near Misibis	8.19	28.74	6.33	46.41	23.28	33.12
AL 9	Near MPA/Aquaculture	8.23	28.74	6.09	46.40	23.30	33.17
AL 10	Near MPA, San Juan	8.13	28.30	6.17	46.38	23.66	33.80
AL 11	Sogod Bay, Poblacion, Bacon, Sorsogon	8.12	28.33	6.58	46.36	23.66	33.88
AL 12	Sogod Bay Bogna side	8.12	28.35	6.19	46.37	23.66	33.95
AL 13	Near MPA, Prieto Diaz	8.12	28.11	6.19	46.38	23.66	33.93

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

Temperature and Salinity



All sampling stations along Albay Gulf exhibited normal values for *in situ* parameters, which were temperature, salinity, pH, and DO. Water temperature ranged from 28.11 to 29.09°C. The lowest temperature was recorded near the MPA in Prieto Diaz, while Poliqui Bay had the highest temperature (32.96^{0}C). Readings varied in different stations, but with only minimal differences that did 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 was high despite the proximity of river discharge areas. However, stations near the river had less salinity compared to stations located in open water. The lowest salinity with 32.39 Practical Salinity Unit (psu) was encountered near the Puro River discharge in Legazpi City, while the highest was recorded with 33.95 psu located at the Bogna Side of Sogod Bay. There were no standards set for the allowable limits of salinity measurements required in DAO 2016-08. However, salinity values normally range from 34 to 36 psu. The salinity of water varies from place to place. Variation can be observed on the recorded salinity measurements of the sampling stations. This variation might probably be due to varying influences of river inputs and submarine ground discharge (SDG) of fresh water. Generally, salinity is controlled by a balance between water removed by evaporation, freshwater added by rivers and SDG, and amount of precipitation received by the water body.

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

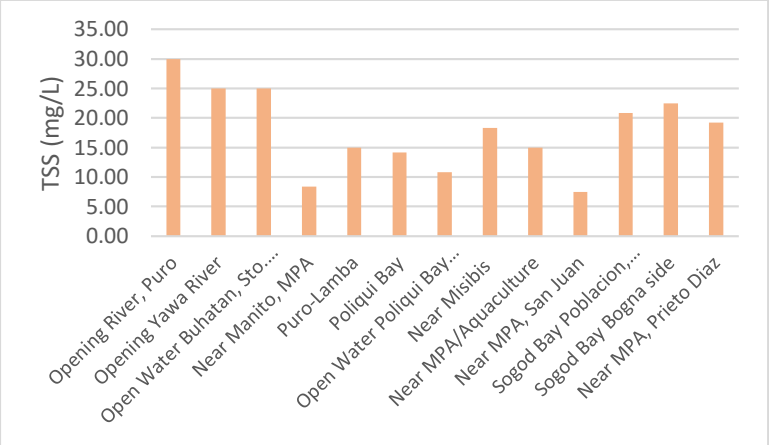


Fig 3. Total Suspended Solids

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 Albay Gulf ranged from 7.5 to 30.00 mg/L with a mean value of 17.82 mg/L. The highest value was obtained from a station near a river discharge zone of Puro in Legazpi City, while the lowest was recorded at a station near an MPA at San Juan in Bacon District. All stations gave TSS values lower than the limits set by DAO 2016-08 for SB classification.

Total dissolved solids (TDS) is 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 comprises all the disassociated electrolytes that make 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 Albay Gulf showed variety in terms of total dissolved solids. Recorded values exhibited slight variations ranging from 22.85 ppt as the minimum value and 23.66 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

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 come from dissolved salts and inorganic materials such as chloride, sulfides and the like. Seawater is expected to have a very high conductivity due to the presence of salt ions that conduct electricity as an effect of positive and negative charges. The conductivity values recorded for the sampling stations in Albay Gulf range from 46.36 to 46.46 mS/cm. Conductivity is not a pollutant itself. Rather, it serves as an indicator of the presence of pollutants. Conductivity is affected by the presence of dissolved substances in the water, including salts and even heavy metals. Some of these substances are known to be harmful to aquatic life and to humans especially at high concentrations. DAO 2016-08 has no standard for the EC values of marine waters.

pH and Dissolved Oxygen (DO)

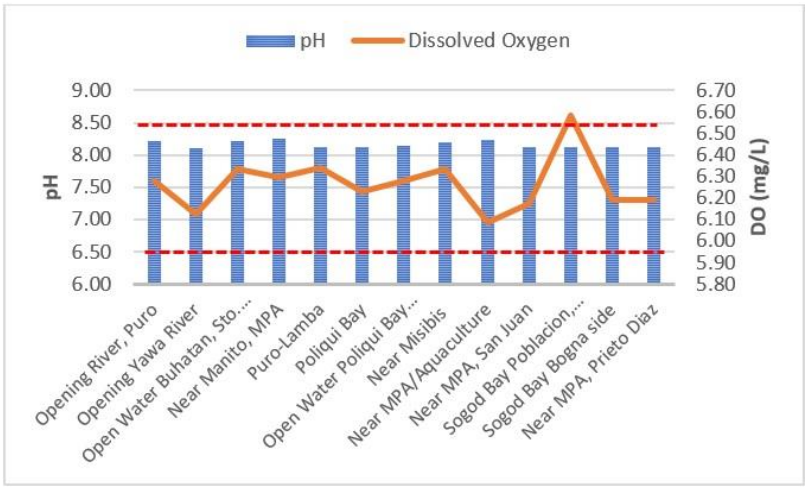


Fig 4. pH and DO levels at Albay Gulf

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 when in equal numbers, make the water neutral. pH is measured on a logarithmic scale of 0-14. Most aquatic organisms have a narrow pH tolerance range of 6.5-8.5, of which 7.0-8.5 is stated as the allowable pH range in DAO 2016-08 for class SB classification. Acidic waters can cause toxic heavy metals to be released into the water. pH is almost similar in all stations, which ranged from 8.10 to 8.25. This range is normal, in which ocean water is nearly alkaline because of numerous dissolved ions that are mostly alkaline in nature. All recorded values fell within the standard allowable pH value for Class SB marine waters as shown. This further indicates that the water is in good condition in terms of pH buffering system. As pH moves away from the standard range, either up or down, it can stress the system and reduce hatching and survival rate. In addition to these biological effects, extreme pH levels usually increase the solubility of elements and compounds, which further makes toxic chemicals more mobile and increase the risk of absorption by aquatic life.

With regard to Dissolved Oxygen (DO), all stations had normal readings with a narrow range of 6.09-6.58 ppm. The highest DO was encountered at a station within Sogod Bay in Bacon. DO is also one of the parameters of paramount importance in the aquatic system. It is a measure of the amount of gaseous oxygen that is dissolved in an aqueous solution, in this case, seawater, and this is also an essential basic requirement for the metabolism of aerobic organisms thriving in the gulf. It is an important parameter in assessing water quality because it highly influences the survival of many organisms living within the specified body of water. High DO levels or even too low values can harm aquatic life, which can eventually detrimentally affect the water quality.

Nutrient Levels

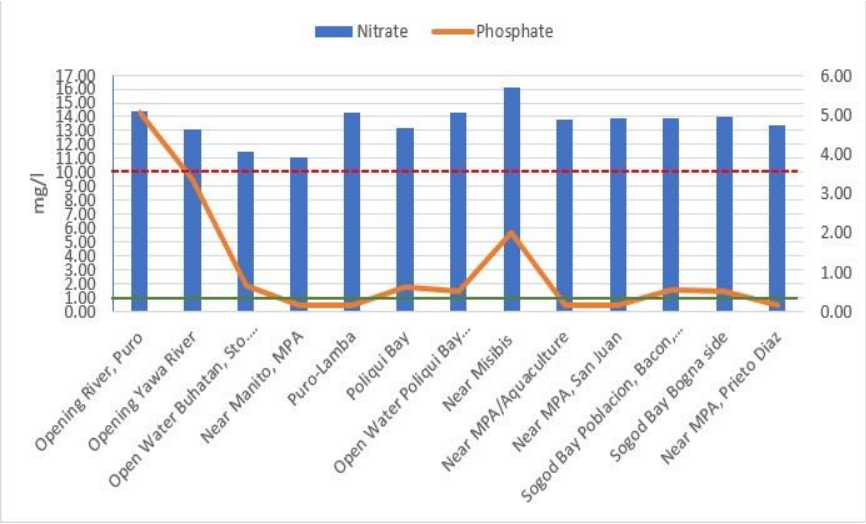
Nutrients such as nitrates and phosphates are essential for plant and animal growth and nourishment. However, the overabundance of certain nutrients in water can eventually cause several adverse and ecological effects. Summarized in Table 2 were the nutrient levels in Albay water quality stations, particularly nitrates and phosphates expressed in mg/L.

Table 2. Nutrient Levels in Albay Gulf Water Quality Stations

Station	***Site Description***	**Nitrates (mg/L)**	**Phosphates (mg/L)**
DAO 2016-08		**10.00**	**0.5**
AL 1	Opening River, Puro	14.35	5.04
AL 2	Opening Yawa River San Roque	13.05	3.34
AL 3	Open Water Buhatan, Sto. Domingo	11.50	0.66
AL 4	Near Manito, MPA	11.06	0.16
AL 5	Puro-Lamba	14.25	0.14
AL 6	Poliqui Bay	13.17	0.61
AL 7	Open Water Poliqui Bay Banquerohan	14.27	0.49
AL 8	Near Misibis	16.10	2.00
AL 9	Near MPA/Aquaculture	13.76	0.17
AL 10	Near MPA, San Juan	13.88	0.15
AL 11	Sogod Bay Poblacion, Bacon, Sorsogon	13.91	0.54
AL 12	Sogod Bay Bogna side	13.98	0.52
AL 13	Near MPA, Prieto Diaz	13.36	0.15

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 Albay Gulf. Unlike temperature and dissolved oxygen, the presence of normal levels of nitrates usually does not directly affect aquatic life. However, excess levels of nitrates in water can create conditions that can make it difficult for aquatic life to survive. All aquatic organisms excrete wastes. These activities create ammonia and some bacteria in the water change this ammonia to produce nitrite, which is then converted by other bacteria to nitrate. Nitrates also come from the earth. Soil contains organic matter, which contains nitrogen compounds. Although nitrates occur naturally in soil and water, an excess level of nitrogen can be considered contaminants. Nitrate levels in Albay Gulf ranged from 11.6 to 16.10 mg/L (ppm).



The highest was recorded at a station near Misibis in Bacacay, while the lowest was recorded in a station near an MPA in Manito, Albay. Comparing these obtained values with the standard limits set by DAO 2016-08, it can be deduced that a majority of the identified water quality stations exceeded values for SB classification.

On the other hand, the phosphate levels measured along the water quality stations ranged from 0.14 to 5.04 mg/L (ppm) with a mean value of 1.07 mg/L. These values suggest strong variation among the stations with the zone near Puro of Legazpi City having the highest (5.04 mg/L) concentration and the waters fronting Puro-Lamba having the lowest (0.14 mg/L). A majority of the stations showed higher phosphate levels compared to the limit set by the standard for SB classification, except for a station near Manito MPA, the zones fronting Puro-Lamba of Legazpi, near the MPA and aquaculture area (mariculture park) of Bacon district, and an MPA in Prieto Diaz. Those stations with the highest phosphorous concentrations were commonly near the discharge areas of huge river systems. Phosphates in water come from a variety of sources and runoff from fertilizer is 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 contain phosphates from surrounding communities. Phosphates are chemicals containing the element phosphorous and they affect water quality by causing excessive growth of algae that eventually lead to algal blooms that can impact wildlife, the fisheries, and the overall ecology of the aquatic system.

Fecal Coliform Levels in Albay Gulf

Table 3 presents the fecal coliform levels within the water quality stations in Albay Gulf. The water quality station near the opening of the river in Puro had the highest fecal coliform level, followed by the station near the Yawa river opening in San Roque. Fecal coliform (FC) have been widely used as standard indicators for sewage pollution and potential health hazard associated with fecal pollution. Although fecal coliform is generally not harmful it indicates the possible presence of 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 suggests that pathogenic microorganisms might also be present and that swimming and eating shellfish might be a health risk. The majority of the alarming values obtained from the water quality sampling stations in Albay Gulf exceeded the limits set by DAO for SB classification, except for stations near marine protected areas. Fecal coliform may be linked to human population and anthropogenic activities as observed from the highest recorded values of fecal coliform from the opening of rivers

Table 3. Fecal Coliform Levels

Station	*Site Description*	**Fecal Coliform (MPN/100ml)**
DAO 2016-08		100
AL 1	Opening River, Puro	3200
AL 2	Opening Yawa River,San Roque	2200
AL 3	Open Water, Buhatan, Sto. Domingo	200
AL 4	Near Manito, MPA	<1.1
AL 5	Near MPA	<1.1
AL 6	Open Water, Cawayan, Manito	175
AL 7	Open Water, Poliqui Bay, Banquerohan Area	250
AL 8	Near Misibis	375
AL 9	Near MPA/Aquaculture	<1.1
AL 10	Near MPA, San Juan	<1.1
AL 11	Sogod Bay, Poblacion, Bacon, Sorsogon	350
AL 12	Sogod Bay, Bogna side	390
AL 13	Near MPA, Prieto Diaz	<1.1

within Legazpi City. The presence of fecal coliform bacteria in aquatic environments indicates that the water has 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 can all contribute to fecal coliform contamination.

SUMMARY, CONCLUSION AND RECOMMENDATIONS

In Albay Gulf, there were thirteen identified water quality stations. These stations were prioritized based on the locations of marine protected areas, aquaculture, mariculture, discharge zones, and areas with important geographical locations. In-situ parameters such as pH, dissolved oxygen, total dissolved solids (TDS), 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, total suspended solids, and fecal coliform determinations.

Temperature is an important factor to consider when assessing water quality. In addition to its own effects, temperature greatly influences several other parameters and can alter the physical and chemical properties of the water. Considered alone, water temperature can affect the metabolic rates and biological activity of aquatic organisms. The present temperature profile of Albay Gulf (28.11-29.09°C) is within the range value of 26-30°C as set by the DAO 2016-08. This means that as far as water temperature is concerned, Albay Gulf is in good condition. Salinity in all stations is considered high despite the proximity of some to river discharge areas. There were no standards set for the allowable limits of salinity measurements required in DAO 2016-08. However, salinity values normally range from 34 to 36 psu. It can be noted that the measured salinity values among the water quality stations in Albay Gulf were within this range limit.

Normal values were also observed with the dissolved oxygen levels in Albay gulf with a narrow range of 6.09-6.58 ppm. These values even surpassed the 6 ppm DO levels as set by the standard, which is an indication of good water condition to support essential survival of all aquatic organisms. For TDS, recorded values exhibited slight variations ranging from 22.62 to 23.77 ppt. There was no standard limit set for TDS in DAO 2016-08. However, a concentration of total dissolved solids that is too high or too low may limit growth and may lead to the death of many aquatic organisms.

pH was almost similar in all stations that range from 8.10 to 8.25. 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. Thus, an indication of good condition and buffering capacity of Albay Gulf water. If the pH of water is too high or too low, the aquatic organism living within the area would eventually die. Apart from this effect, pH can also affect solubility and toxicity of chemicals and heavy metals present, if any, in the water.

Nitrate levels in Albay gulf ranged from 11.6 to 16.10 mg/L ppm, the highest of which was recorded near Misibis and the lowest near an MPA in Manito. Comparing these obtained values with the standard limits set by DAO 2016-08, it can be deduced that a majority of the identified water quality stations exceeded values for SB classification. Like dissolved oxygen, temperature, and pH, the nitrate concentration in water is determined by both natural processes and human interventions. A body of water may be naturally high in nitrates or have elevated nitrate levels as a result of human activities. Although nitrates can occur naturally, excess levels can be considered as contamination. Most sources of excess nitrates come from human activities and can be traced to agricultural activites, human wastes, or industrial pollution. Nitrogen fertilizers that have been applied to fields to promote growth of plants and rainwater can wash nitrates in the fertilizers into streams or rivers. This run-off problem tends to pose the most serious effects especially when the fertilizer is animal waste or manure. In addition to animal waste, untreated human sewage can also contribute to nitrate levels.

On the other hand, the phosphate levels measured along the water quality stations ranged from 0.14 to 5.04 mg/L (ppm). These values suggest strong variation among the stations with the station near the opening of the river in Puro as the highest (5.04 mg/L). A majority of the stations exceeded the phosphate concentration limits for class SB of marine water, which is 0.5 mg/l. Phosphorous generally gets into the water through urban and agricultural settings. It tends to attach to soil particles and move into surface water bodies from run-off. This excess phosphates in water, as can be observed from the values obtained for the water quality stations near opening of rivers in Puro, can affect water quality by excessive algae growth. Fertilizers containing phosphate can also be a factor in elevated levels of phosphates in water systems. Applying chemical fertilizers to soil that has been already saturated with phosphates and spreading excessive amounts of manure on land causes phosphates to runoff during heavy rainfall through rivers and streams.

For fecal coliform, a majority of the water quality sampling stations in Albay Gulf exceeded the allowable limit for fecal coliform for class SB marine waters except identified stations found near marine protected areas. The presence of fecal coliform bacteria in aquatic environment indicated that the water has been contaminated with fecal material of humans or another animal. At the same time, the water may have been contaminated by pathogens or disease producing bacteria or viruses which, can also exist in fecal matter.

Generally, the water in Albay Gulf is compliant to the standards set by DAO 2016-08, based only on the values for each basic physical (temperature and salinity) and chemical (pH and DO) parameters obtained by *in situ* measurement. However, the nitrate and the fecal coliforms recorded within the identified water quality stations obviously surpassed the limits for class SB for these parameters. The high nitrate concentration can be ascribed from agricultural runoff in addition to nutrient load of the seawater. On the other hand, the disparity on the fecal coliform values from the identified stations compared to the limits can be attributed to sources like runoffs, waste discharge, domestication of animals, and poor sanitation compliance along coastal areas.

Given the baseline data for the water quality condition of Albay Gulf in comparison with the existing DAO 2016-08, a more stringent water quality monitoring is recommended especially for the stations that exhibited irregular values for important water quality parameters. This can be done through regular monitoring as guided by regulatory guidelines. In addition, the high levels of nutrients, such as nitrates and phosphates, in some of the water quality stations within the gulf, which can be attributed mainly to agricultural contributions, calls for a need for the local government to revisit its conditions and management for sustainable agriculture. The solid waste management and proper household and industry sanitation initiatives of the municipalities along Albay Gulf should also be enhanced taking into consideration the seemingly alarming fecal coliform levels on areas near rivers and ecotourism facilities.

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APPENDIX A
PHOTO DOCUMENTATIONS

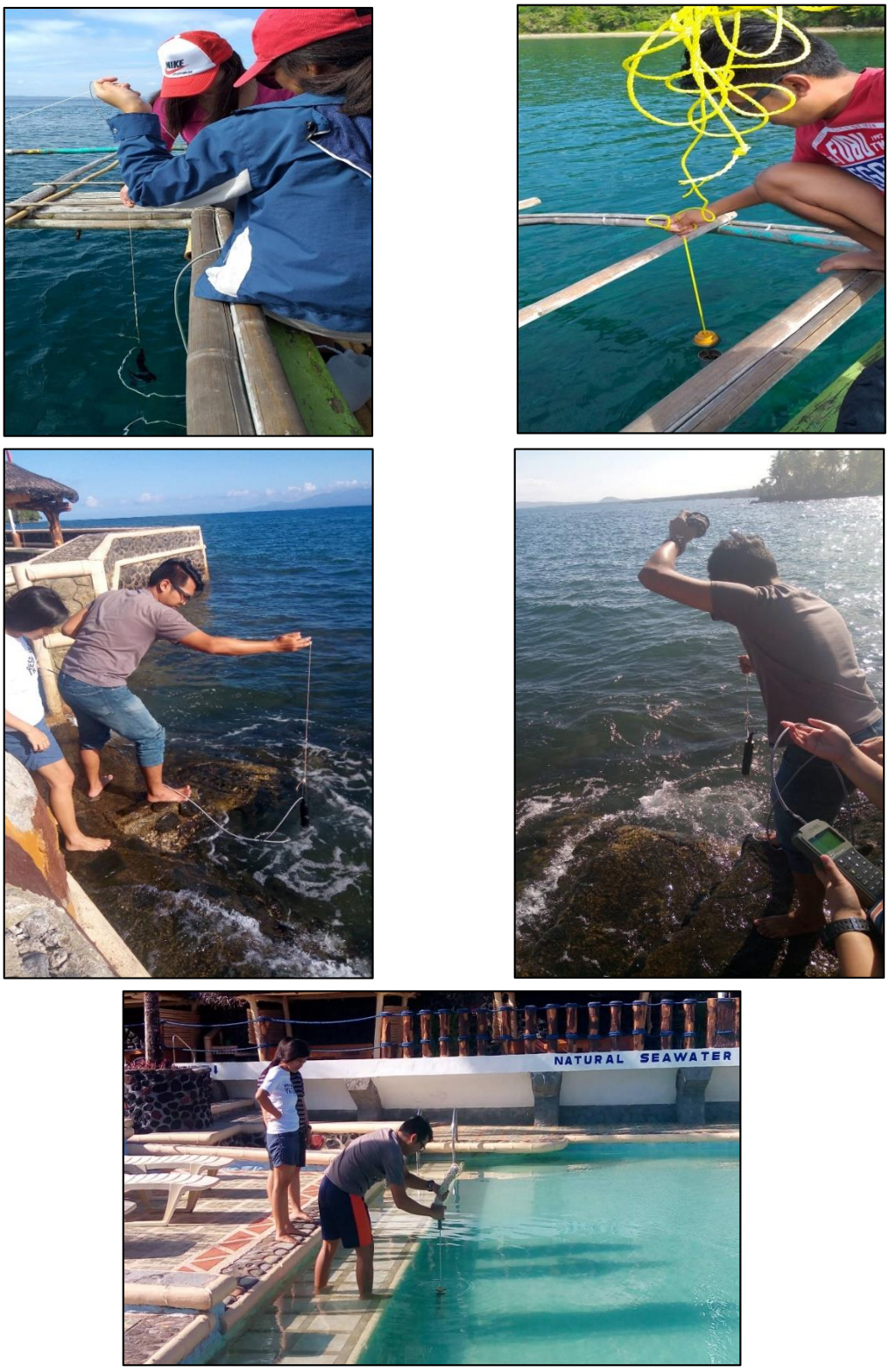

Fig 6. Method standardization on the use of multiparameter water quality meter and kemmerrer bottle

Fig 7. In-situ measurement at Albay gulf

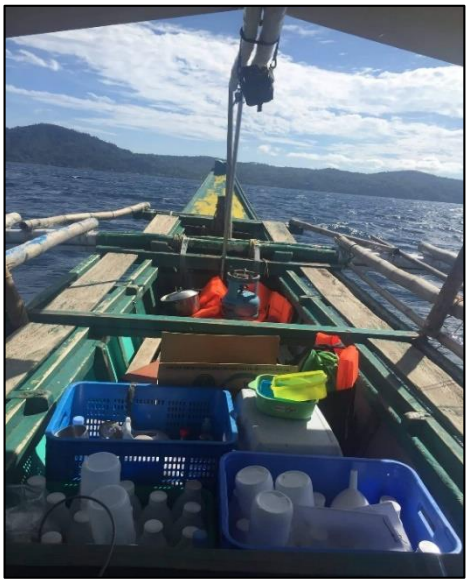




Fig 8. Water quality sample collection

CATCH AND EFFORT STATISTICS OF FISHERIES IN ALBAY GULF, PHILIPPINES

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ABSTRACT

Albay Gulf is one of the major fishing grounds in the Bicol Region characterized by a multi-species fishery with an estimated annual production of 11,756.46 MT. Fishers utilize gears, predominantly handlines (41.46%), entangling nets (16.91%), and the rest are shared by other gears. There are 9,141 gear units distributed to 31 distinct gear types commonly exploiting pelagic/demersal fish species and invertebrates from the gulf. The 10 most productive fishing gears are bottom-set gill net, multiple handline, bottom-set long line, simple handline, troll line, fish corral, bagnet, gleaning, trammel net, and drift gill net. These gears account for 84.35% of the total production in Albay Gulf, of which fishing operations are greatly influenced by temporal seasonality and availability of the target species. Indication of overfishing in the gulf was observed based on the estimated annual catch per unit area (15.27 MT/ km^2) as catch per unit effort of fishers are significantly reduced, highly seasonal and erratic availability of target species, disappearance of traditional species, and species replacement of less economic value.

Keywords: fishing, multi-species, fishing gear, fishery production, overfishing

1. Introduction

Fisheries are of paramount importance because of their economic contribution to the livelihood, employment, and income of the people (Nieves et al., 2009). Albay Gulf is one of the major fishing grounds in the Bicol Region providing livelihood, income, and employment to the families of fisherfolks living in the coastal areas. However, previous assessment of National Stock Assessment Program – Bureau of Fisheries and Aquatic Resurces (NSAP-BFAR) in Albay Gulf recorded a declining fish landed catch of 1,372 MT to 840 MT from 2014 to 2018. Moreover, record shows 50% to 90% of the common pelagic fish species are caught below their size of maturity, revealing a typical case of growth overfishing. The increasing demand for fish because of a rapid population growth and increasing exports has substantially increased fishing pressure, therefore resulting in declining catch rates in many traditional fishing grounds (Barut, Santos & Garces, 1997).

The status of overfishing in an area can be determined when the catch and catch rate are observed to be declining; increasing effort, mortalities, and exploitation rates are noted; and changes or shift in species composition, levelling of marine landings, and concentration of fishing effort within a small area are being observed (Armada, 2004). Capture fisheries assessment is basically an analysis of catch and effort, which is one of the key tools in providing basis for management of a fishing ground (Soliman & Dioneda, 1997). This reveals condition, efforts and, the degrees of harvesting of resources which in turn gives an idea on the abundance and the degree to which they are exploited. Thus, this study focused on the fisheries assessment of catch and effort to identify fishing gears used, catch rate, estimated production and key species caught in Albay Gulf.

2. Materials and Methods

2.1 Study Area

The study was carried out in 82 barangays along Albay Gulf from March 12, 2019 to May 10, 2019. The gulf is bounded by the local government units (LGUs) of Bacacay, Sto. Domingo, Manito, Rapu-Rapu and Legazpi City of Albay Province, and the LGUs of Prieto Diaz, Bacon District, and Sorsogon City of Sorsogon Province. It has an approximate area of 770 km^2 and located at the southeastern part of Luzon and eastern part of Bicol along the Pacific Coast of approximately between 13.124°N latitude and 123.99°E longitude.

2.2 Gear Inventory

Key informant interviews (KII) 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. KIIs as a form of gear inventory were conducted in 82 coastal barangays, constituting seven municipalities and two cities surrounding Albay Gulf. Identification of fishing gears and their classification were based on the guide of Umali (1950). Salient data (e.g., number of fishing gear unit and type) for specific localities were obtained for characterization of the gulf as fishing ground based on dominant fishing gear.

2.3 Catch and Effort

Catch and effort data were obtained through a recall interview of key informants. Barangay Fisheries and Aquatic Resources Management Council (BFARMC) officials and key fishers who were knowledgeable on fishing practices and dynamics in their area were the primary source of catch and effort data. An official form was prepared and used to derive the fishing trips and their seasonality, catch and species composition. Furthermore, related secondary data were obtained from the Municipal Agriculture Offices (MAO) of the coastal LGUs and the National Stock Assessment Program (NSAP-V) for records validation. Recall interview was also utilized to gather the data on catch composition. Only members of fishing communities with a minimum of five years' exposure in the gulf were the subjects of the study. Persons involved in fish landing were also part of the KIIs.

2.4 Fishery Production Estimation

The result of the data validation was used to estimate the overall production of fishing gear types in the gulf and the LGUs located in the area. The production per type of gear was determined by identifying the product of catch rate per specific gear unit multiplied by the product of fishing frequency and number of specific gear unit. The summation of the total fishery production per LGU shows the total fishery production in the gulf. Validated data were used to estimate the monthly and annual fishery production of the gulf per LGU and production contribution of fishing gear types.

3. Results and Discussions

3.1 Gear inventory

Fishers in Albay Gulf utilized 31 distinct types of fishing gears, ascribing a multi-gear fishery. These fishing gears can be classified into seven gear categories (Umali, 1950) namely entangling nets, handlines, longlines, barriers and traps, impounding nets, spear, and miscellaneous hand instruments. Entangling nets with eight variants included *panke-palubog* (bottom-set gill net), *three-ply* (trammel net), *pangasag* (crab gill net), panke-palutang (drift gill net), *largarete* (drift gill net), *pangkanoos* (drift gill net), *salupil-panke sa boya* (drift gill net), and *bugkat-pambugiw* (drift gill net). Handlines also had eight variants, which included *kawil* (simple handline), *lagulo* (simple handline), *rambo* (troll line), *kasikas* (troll line), *bigawnan* (pole and line), *tina-tina* (squid jigger), *buyod-buyod* (handline using artificial bait), and *og-og* (multiple handline). Impounding nets exhibited six variants, namely *pansilo* (dip net), *bintol-kasag* (crab lift net), *bintol-alimango* (crab lift net), *bintol-banagan* (lift net), *basnig* (bagnet), and *pang langaw-langaw* (push net). Barriers and traps, on the other hand were composed of five variants: the *bunoan* (fish corral), *bobo pansira* (fish pot), *bobo pangasag* (crab pot), *bobo panglokus/kanoos* (squid/cuttlefish pot), and *bobo-banagan* (lobster trap). Spears had two variants that were used in different times of fishing operations. Fishers used the *pamana* for daytime operation, and the flashlight for nighttime operation. The use of compressors in collecting economically important species using spear guns was also noted in the Rapu-Rapu area. Longlines and miscellaneous hand instruments both had one variant:

kitang (bottom set long line) and *pagtagati/panagun-has* (gleaning), respectively. Most of the fishers owned more than one type of fishing gear which were used on varying seasonality and abundance of the target species. Fishing gears in other areas of the Philippines have also undergone modifications from the original design and evolved into species-specific fishing gears with adopted local names (Hermes et al., 2004). These modifications will definitely lead to a more efficient catch of target species and a higher exploitation rate.

A total of 9,141 fishing gear units (Table 1), were distributed in Sorsogon (25%), Rapu-Rapu (23%), Manito (18%), Legazpi (18%), Sto.Domingo (8%), Prieto Diaz (4%), and Bacacay (3%) along Albay Gulf. Fishers utilized multi gears predominantly handlines with 3,790 units (41.46%), followed by entangling nets (16.91%), miscellaneous hand instruments (10.89%), spears (10.20%), barriers and traps (7.76%), longlines (6.57%), and impounding nets (6.21%). The most used handline was *og-og* with 1,036 units. P*anke-palubog*, with 898 units recorde the highest

Table 1. Types and count of fishing gears

Fishing Gears	*Variants*	*No. of units*	*Percentage*
Handlines	8	3,790	41.46
Entangling nets	8	1,546	16.91
Miscellaneous hand instruments	1	995	10.89
Spear	2	932	10.20
Barriers and Traps	5	709	7.76
Longlines	1	601	6.57
Impounding nets	6	568	6.21
Total	**31**	**9,141**	**100**

count for entangling nets. There were more nightine spearguns used (537 units) than daytime spear guns (395). *Bobo-pansira* recorded the highest use (381 units) for barriers and traps, while *pansilo* (210 units) exhibited the highest for impounding nets.

3.2 Key Species Caught, Catch Rate and Production Estimates

Albay Gulf is generally characterized as multi-species fisheries. Highlighting some of the fishing gears commonly caught, "bolinao" (*Encrasicholina sp*.) was recorded to be the usual catch of fishers using basnig. Panke-palutang (drift gill net), on the other hand, usually caught pelagic species like "malasugi" (*Istiophorus sp.*), "buraw" (*Rastrelliger kanagurta*), and "salay-salay" (*Atule mate*). Moreover, *kitang* (bottom set long line) usually caught major species of "kuwaw" (*Priacanthus sp.*), "bukhawon" (*Lethrinus sp.*), "maya-maya" (*Lutjanus sp.*), and other demersal fish species. Og-og commonly caught "pundahan" (*Katsuwonus pelamis*), "turingan" (*Auxis thazard*), and "bangkulis" (*Thunnus albacares*).

Catch rates of most fishing gears varied widely ranging from 0.25 kg/trip (*bigawnan, tina-tina, buyod-buyod, og-og, bunuan, bintol-kasag, flashlight, pamana, and pagtagati/panagun-has*) to as high as 350 kg/trip (*basnig*) (Appendix D). *Basnig* recorded its peak catch during the summer months due to the abundance of anchovies. *Bunoan* registered the second highest catch rate of 250 kg/trip. This was followed by *rambo* (troll line) with a

catch rate of 200 kg/trip and *panke-palubog* (bottom-set gill net), *panke-palutang* (drift gill net), and *kasikas* (troll line), all with the same catch rate of 100 kg/trip.

In terms of annual production, a total of 11,756.46 MT was estimated based on the fishing gears contributions along the gulf and resulted to a catch per unit area of 15.27 MT/km^2 relative to 770 km^2 area of the gulf. Silvestre and Hilomen (2004) stated that an extraction rate of about 15-20 km^2 catch per unit area is an indicative sign of overfishing. In fact, annual catch per unit area of Albay Gulf was more than twice higher compared to adjacent fishing ground, Lagonoy Gulf (6.5 MT/km^2) (Soliman et al. 2008) which really shows intense fishing pressure despite its smaller size. Table 2 shows the top fishing gears with the relative contribution to the production estimates. The top 10 fishing gears in terms of production were bottom-set gill net

Table 2. Production contribution (MT) of top ten fishing gears in Albay Gulf

Fishing Gears			Production (MT)	%
No.	**English Name**	**Location Name**		
1	Bottom-set gill net	Pamke-palubog	2,217.06	18.86
2	Multiple handline	Og-og	1,569.92	13.35
3	Bottom-set long line	Kitang	1,548.44	13.17
4	Simple handline	Kawil	1,523.67	12.96
5	Troll line	Rambo	777.32	6.61
6	Fish corral	Bunoan	492.97	4.19
7	Bagnet	Basnig	419.54	3.57
8	Gleaning	Pagtagati/Panagun-has	406.45	3.46
9	Trammel net	Three-ply	403.84	3.44
10	Drift gill net	Panke-palutang	342.92	2.92
		Largarete	68.68	0.58
		Bugkat (Pambugiw)	56.54	0.48
		Salupi (Panke sa boya)	46.17	0.39
		Pangkanoos	43.06	0.37
		Others	1,839.88	15.65
Total			**11,756.46**	**100.00**

(2,217.60 MT/18.86%), multiple handline (1,569.92 MT/13.35%), bottom-set long line (1,548.44 MT/13.17%), simple handline (1,523.67 MT/12.96%), troll line (777.32 MT/6.61%), fish corral (492.97 MT/4.19%), bagnet (419.54 MT/3.57%), gleaning (406.45 MT/3.46%), trammel net (403.84 MT/3.44%), and drift gill net (342.92 MT/2.92%), along with the other variants such as *largarete, bugkat, salupil, and pangkanoos* (214.44 MT). These 10 fishing gears contributed about 84.35% to the total production estimate in Albay Gulf.

On the other hand, production contribution per LGU showed Rapu-Rapu dominating by contributing 26.61% (3,128.72 MT); followed by Bacon District of Sorsogon City, 25.88% (3,042.60 MT); Legazpi, 16.25% (1,910.83 MT); Manito, 14.47% (1,700.65 MT); Sto. Domingo, 7.67% (901.44 MT); Bacacay, 5.73% (673.27 MT); and Prieto Diaz with the least share of 3.39% (398.95 MT) (Appendix E). These production contributions can be attributed to the number of fishing gears of the area. The top LGU production contributors, as shown in Appendix A, were Rapu-Rapu and Sorsogon, which also showed higher fishing gear units of 2,060 and 2,313 units, respectively.

Almost all fishing gears were being operated year-round except for the trap and lift net for lobsters with no operations during the third to early fourth quarter of the year due to scarcity of the target species (Appendix C). Other operations, such as trip frequency and production contribution of fishing gears, were greatly influenced by temporal seasonality. Emphasizing the top 10 fishing gears, *panke-palubog and og-og*, for instance, both obtained higher production contribution during the southwest monsoon or "habagat" season (June-October). On the other hand, higher catch for

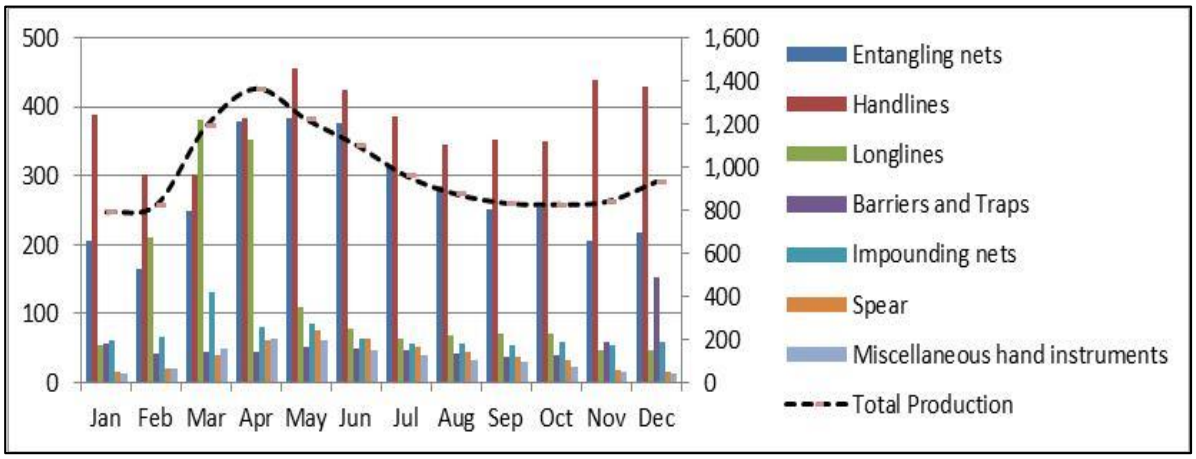

Figure 1. Production (MT) Seasonality of Major Gear Classification in Albay Gulf

kawil and bunoan were observed during the northeast monsoon "amihan" season (November-February). Meanwhile, *kitang*, *basnig*, *three-ply*, *panke-palutang*, and *pagtagati/panagun-has* had more production contribution during the trade winds on summertime. Generally, higher production contributions were recorded during the summertime (Figure 1), which endows the gulf with fair fishing conditions and, therefore, resulting in more fishing trips (Appendix C).

4. Conclusion

The fishery in Albay Gulf is characterized by multi-species and utilizes multi-fishing gears dominated by handlines and entangling nets. Fishing operations are year-round and, thus, fishing is a strong economic lifeline in the gulf. Fishing operations are greatly influenced by temporal seasonality and availability of the target species. Furthermore, the higher production contribution of fishing gears observed was attributed to the higher fishing frequencies as well as the higher number of fishing gear units in the area. Generally, the estimated annual production and catch per unit area indicate high fishing pressure and overfishing in the gulf. Inclusion of Albay Gulf in future capture fisheries monitoring/assessment is strongly recommended.

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Appendices

Appendix A. Number of Gear Units per Fishing Gear Types Identified Per Municipality in Albay Gulf

Appendix B. Total Fishing Trips (Efforts) Per Municipality in Albay Gulf

Appendix C. Monthly Total Fishing Trips (Efforts) in Albay Gulf

Appendix D. Catch Rate of Fishing Gear Types Exploiting Albay Gulf

Appendix E. Fishery Production of Various Fishing Gear Types per Municipality in Albay Gulf (MT)

Appendix F. Fishery Production Seasonality of Various Fishing Gears in Albay Gulf (MT)

Appendix A. Number of Gear Units per Fishing Gear Types Identified Per Municipality in Albay Gulf

Fishing Gears			Municipality							
English Name		Local name	Bacacay	Sto. Domingo	Legazpi	Manito	Sorsogon	Prieto Diaz	Rapu-rapu	Total
Entangling nets										
	Bottom-set gill net	Panke-palubog	85	62	216	304	77	1	153	898
	Trammel net	Three-ply		10		34	89	60	47	240
	Crab gill net	Pangasag	2		88	71	7		9	177
	Drift gill net	Panke-palutang	10			10	11	6	53	90
	Drift gill net	Largarete	10		17			5	4	36
	Drift gill net	Pangkanoos					1		40	41
	Drift gill net	Salupil (Panke sa boya)					15			15
	Drift gill net	Bugkat (Pambugiw)		4		5	11		29	49
Handlines										
	Simple handline	Kawil		86	183	102	340	15	220	946
	Simple handline	Lagulo			22	10				32
	Troll line	Rambo	33	39	54	73	200	22	122	543
	Troll line	Kasikas				5	31		170	206
	Pole and line	Bigawnan		60	11	93	132	20	168	484
	Squid jigger	Tina-tina		26	15				13	54
	Simple handline	Buyod-buyod	18	59	124	112	85	6	85	489
	Multiple handline	Og-og	70	213	187	38	260	35	233	1036
Longlines										
	Bottom-set long line	Kitang								
Barriers and Traps										
	Fish corral	Bunoan	13			28	48	6	25	120
	Fish pot	Bobo pansira			311	50	10		10	381
	Crab pot	Bobo pangasag			56	37	36	1		130
	Squid/cuttlefish pot	Bobo panglokus/kanoos			34	20			22	76
	Lobster trap	Bobo (banagan)		2						2
Impounding nets										
	Dip net	Pansilo		20	80	60		50		210
	Crab lift net	Bintol (Kasag)	5		40	123	10		15	193
	Crab lift net	Bintol (Alimango)			30	8	20	2		60
	Lift net	Bintol (Banagan)							17	17
	Bagnet	Basnig	10		3	1	31		3	48
	Push net	Pang langaw-langaw					40			40
Spear										
	Speargun	Flashlight	9	22	29	131	209	33	104	537
	Speargun	Pamana	13		12	87	135	25	123	395
Miscellaneous hand instruments										
	Gleaning	Pagtagati/Panagun-has		25		140	400	110	320	995
		Total	313	735	1,641	1,680	2,313	399	2,060	9,141

Appendix A1. Number of Gear Units per Fishing Gear Types Identified in Municipality of Bacacay

Fishing Gears			Barangay			
	English Name	**Local name**	**1**	**2**	**3**	**Total**
Entangling nets						
	Bottom-set gill net	Panke-palubog	30	50	5	85
	Gill nets for crabs	Pangasag			2	2
	Drift gill net	Panke-palutang	10			10
	Drift gill net	Largarete			10	10
Handlines						
	Troll line	Rambo		3	30	33
	Artificial bait (variable)	Buyod-buyod	10	8		18
	Multiple handline	Og-og	30	10	30	70
Longlines						
	Bottom-set long line	Kitang	5		30	35
Barriers and Traps						
	Fish corral	Bunoan	10		3	13
Impounding nets						
	Crab lift net	Bintol (Kasag)	5			5
	Bagnet	Basnig			10	10
Spear						
	Spear gun at night	Flashlight	5	3	1	9
	Spear gun	Pamana	5	5	3	13
		TOTAL	110	79	124	**313**

Barangay:

1. Sula 2. Mataas 3. Misibis

Appendix A2. Number of Gear Units per Fishing Gear Types Identified in Municipality of Sto.Domingo

Fishing Gears			Barangay											Total
	English Name	**Local name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	
Entangling nets														
	Bottom-set gill net	Panke-palubog		8		4			10			30	10	62
	Bottom-set gill net	3-ply											10	10
	Drift gill net for halfbo	Bugkat (Pambugiw)		4										4
Handlines														
	Simple handline	Kawil	15	2	2		2		15				50	86
	Troll line	Rambo	5		4								30	39
	Pole and line	Bigawnan				10		15	5				30	60
	Squid jigger	Tina-tina			1	5		5	15					26
	Artificial bait (variabl	Buyod-buyod	4		4			3		10	8	10	20	59
	Multiple handline	Og-og	15	2	30	12	2		15	37	30	20	50	213
Longlines														
	Bottom-set long line	Kitang		1		1					5	100		107
Barriers and Traps														
	Shrimp pot	Bobo (pangbanagan)											2	2
Impounding nets														
	Dip net	Pansilo										20		20
Spear														
	Spear gun at night	Flashlight								10			12	22
Miscellaneous hand instruments														
	Gleaning	Panagun-has		25										25
TOTAL			39	42	41	32	4	23	60	57	43	180	214	**735**

Barangay:

1. Lidong
2. Calayucay
3. Pandayan
4. San Isidro
5. San Vicente
6. San Francisco
7. Salvacion
8. San Juan
9. Sto. Domingo Street
10. Buhatan
11. Alimsog

Appendix A3. Number of Gear Units per Fishing Gear Types Identified in Legazpi City

Fishing Gears			Barangay																		
	English Name	**Local name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**Total**
Entangling nets																						
	Bottom-set gill net	Panke-palubog		10	2		5	12		5	3		10	15	5	30	5	70	12	17	15	216
	Gill nets for crabs	Pangasag																46	12	10	20	88
	Drift gill net	Largarete												9	5					3		17
Handlines																						
	Simple handline	Kawil	30	10		18	40			5		5	10				40	4		20	1	183
	Simple handline	Lagulo (3 hooks)																	2	20		22
	Troll line	Rambo	2		10		25				5				4	3				5		54
	Pole and line	Bigawnan					6													5		11
	Squid jigger	Tina-tina					10				5											15
	Artificial bait (varia	Buyod-buyod			4	20									20	20			20	20	20	124
	Multiple handline	Og-og	27	50	5	20	35				5					40					5	187
Longlines																						
	Bottom-set long lin	Kitang		50	1		5			2	5	20				30		5	3	5	3	129
Barriers and Traps																						
	Fish pot	Bobo Pansira			2		3	9	7					20					250	20		311
	Crab pot	Bobo pangasag																	50		6	56
	Squid/cuttlefish pot	Bobo panglokus/kanoos																	20	14		34
Impounding nets																						
	Dip net	Pansilo															10		20	50		80
	Crab lift net	Bintol (Kasag)												20					20			40
	Crab lift net	Bintol (Alimango)																	30			30
	Bagnet	Basnig												3								3
Spear																						
	Spear gun at night	Flashlight																10	7	7	5	29
	Spear gun	Pamana																	5	7		12
		TOTAL	59	120	24	58	129	21	7	12	23	25	20	67	34	123	55	135	451	203	75	**1,641**

Barangay:

1. Padang
2. Bigaa
4. Rawis
5. San Roque
6. Baybay
7. Pigcale
8. Sabang
9. Victory Village (N)
10. Victory Village (S)
11. Dapdap
12. Puro
13. Lamba
14. Maslog
15. Homapon
16. Bagacay
17. Banquerohan
18. San Francisco
19. Buenavista

Appendix A4. Number of Gear Units per Fishing Gear Types Identified in Municipality of Manito

Fishing Gears			Barangay											
	English Name	**Local name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
Entangling nets															
	Bottom-set gill net	Panke-palubog	20	15		20	4		15	100	50	30	30	20	304
	Bottom-set gill net	3-ply										30	4		34
	Gill nets for crabs	Pangasag	6							40	20	5			71
	Drift gill net	Panke-palutang							10						10
	Drift gill net for halfb	Bugkat (Pambugiw)							2			3			5
Handlines															
	Simple handline	Kawil	5			10	25		2	10	5	30		15	102
	Simple handline	Lagulo (3 hooks)										10			10
	Troll line	Rambo	3				40	4		10	10			6	73
	Troll line	Kasikas												5	5
	Pole and line	Bigawnan		20		10		10	3		10	20	10	10	93
	Artificial bait (variab	Buyod-buyod	15	5	20	10	6	10	2	5	20	10		9	112
	Multiple handline	Og-og	2	5			8	5		5	10			3	38
Longlines															
	Bottom-set long line	Kitang	2		30		2		1	80	20			3	138
Barriers and Traps															
	Fish corral	Bunoan			9	12				7					28
	Fish pot	Bobo Pansira	5	5						20		20			50
	Crab pot	Bobo pangasag							3	30				4	37
	Squid/cuttlefish pot	Bobo panglokus/kanoos								10		8		2	20
Impounding nets															
	Dip net	Pansilo								30				30	60
	Crab lift net	Bintol (Kasag)	5	5					3		100			10	123
	Crab lift net	Bintol (Alimango)							8						8
	Bagnet	Basnig								1					1
Spear															
	Spear gun at night	Flashlight			10					6	50	50		15	131
	Spear gun	Pamana	2								50	20	10	5	87
Miscellaneous hand instruments															
	Gleaning	Panagun-has							10	50	30	30		20	140
		TOTAL	65	55	69	62	85	29	59	404	375	266	54	157	**1,680**

Barangay:

1. Cabacongan
2. Cawayan
3. Malobago
4. Tinapian
5. Manumbalay
6. Buyo
7. It-Ba
8. Cawit
9. Pawa
10. Hologan
11. Balabagon
12. Cabit

Appendix A5. Number of Gear Units per Fishing Gear Types Identified in Sorsogon City

Fishing Gears		Barangay																		
English Name	Local name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total
Entangling nets																				
Bottom-set gill net	Panke-palubog		20	3	20		5		20		2	6						1		77
Bottom-set gill net	3-ply	2	10			3				8				50	10		6			89
Gill nets for crabs	Pangasag		2							5										7
Drift gill net	Panke-palutang				1														10	11
Drift gill net	Pangkanoos	1																		1
Drift gill net	Salupil (Panke sa boya)		15																	15
Drift gill net for hal	Bugkat (Pambugiw)		2					1	5										3	11
Handlines																				
Simple handline	Kawil	2	30	50			15	25	10	1		2	15	10		70	20	70	20	340
Troll line	Rambo		20	20				15	25							50		70		200
Troll line	Kasikas	1						20	10											31
Pole and line	Bigawnan	10	10	10	10	2				4	10	10	10	3	20	3		5	25	132
Artificial bait (varia	Buyod-buyod	10	10	15	5	5	5		5				5	5		15	5			85
Multiple handline	Og-og		20	50				25	25							30	20	70	20	260
Longlines																				
Bottom-set long lin	Kitang		1	20		2		15	20				6		3	3	20	10	15	115
Barriers and Traps																				
Fish corral	Bunoan									7	5	1		5	10	14	1	1	4	48
Fish pot	Bobo Pansira																		10	10
Crab pot	Bobo pangasag											6							30	36
Impounding nets																				
Crab lift net	Bintol (Kasag)										2	3		5						10
Crab lift net	Bintol (Alimango)																		20	20
Bagnet	Basnig													20	1	10				31
Push net	Langaw-langaw													40						40
Spear																				
Spear gun at night	Flashlight	25	25	20	8	15	50	10	15	9					5		7	10	10	209
Spear gun	Pamana	20		5		15	15		15		10				10	15	10	10	10	135
Miscellaneous hand instruments																				
Gleaning	Panagun-has	100	50		15		20		10	15	20				30	20	50		70	400
TOTAL		171	215	193	59	42	110	111	160	49	49	28	36	138	89	230	139	247	247	**2,313**

Barangay:

1. Sto. Nino	3. San Juan	5. Del Rosario	7. Poblacion	9. Bogna	11. Santa Lucia	13. Bato	15. Buenavista	17. Balogo
2. Osiao	4. Sto. Domingo	6. Rawis	8. Caricaran	10. Salvacion	12. Sugod	14. Gatbo	16. Bon-ot	18. Sawanga

Appendix A6. Number of Gear Units per Fishing Gear Types Identified in Municipality of Prieto Diaz

Fishing Gears			Barangay				
	English Name	**Local name**	**1**	**2**	**3**	**4**	**Total**
Entangling nets							
	Bottom-set gill net	Panke-palubog				1	1
	Bottom-set gill net	3-ply	5		5	50	60
	Drift gill net	Panke-palutang	4			2	6
	Drift gill net	Largarete		5			5
Handlines							
	Simple handline	Kawil	5	10			15
	Troll line	Rambo	20		2		22
	Pole and line	Bigawnan			20		20
	Artificial bait (variable)	Buyod-buyod	2	4			6
	Multiple handline	Og-og	20	15			35
Longlines							
	Bottom-set long line	Kitang		2			2
Barriers and Traps							
	Fish corral	Bunoan	1	1	1	3	6
	Crab pot	Bobo pangasag	1				1
Impounding nets							
	Dip net	Pansilo	50				50
	Crab lift net	Bintol (Alimango)		2			2
Spear							
	Spear gun at night	Flashlight	5	20	3	5	33
	Spear gun	Pamana	5	20			25
Miscellaneous hand instruments							
	Gleaning	Panagun-has	50	40	20		110
		TOTAL	168	119	51	61	**399**

Barangay:

1. Talisayan
2. Manlabong
3. San Ramon
4. Lupi

Appendix A7. Number of Gear Units per Fishing Gear Types Identified in Municipality of Rapu-rapu

Fishing Gears			Barangay															
	English Name	**Local name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**Total**
Entangling nets																		
	Bottom-set gill net	Panke-palubog	20		10	5			3	20	3	20	30	20	12	10		153
	Bottom-set gill net	3-ply	1		10		2		1	9		3	20				1	47
	Gill nets for crabs	Pangasag	5	3								1						9
	Drift gill net	Panke-palutang				3		10						4	2	30	4	53
	Drift gill net	Largarete	1									2	1					4
	Drift gill net	Pangkanoos														40		40
	Drift gill net for hal	Bugkat (Pambugiw)			3	4				1	1	4	5	4		7		29
Handlines																		
	Simple handline	Kawil	5	5	20	10	20	10	20		5	3		60	12	50		220
	Troll line	Rambo	4	12			20	10				60	10		5		1	122
	Troll line	Kasikas		3		5		10	15			20		60	7	50		170
	Pole and line	Bigawnan			5	10	10	20	20	20				50	20	10	3	168
	Squid jigger	Tina-tina					10									3		13
	Artificial bait (varia	Buyod-buyod	7		10	5	5	5	5	2			20	10	6	6	4	85
	Multiple handline	Og-og		4	10	10	5	10	15	3	1	50	10	60	5	50		233
Longlines																		
	Bottom-set long lin	Kitang	1	10	1	18	2		4	2	1	30	4			2		75
Barriers and Traps																		
	Fish corral	Bunoan	7	2	1		1			2				1		11		25
	Fish pot	Bobo Pansira										2	8					10
	Squid/cuttlefish pot	Bobo panglokus/kanoos		20									2					22
Impounding nets																		
	Crab lift net	Bintol (Kasag)				5						5			3		2	15
	Lift net	Bintol (Lobster)														17		17
	Bagnet	Basnig					3											3
Spear																		
	SPGN with compressor												4					4
	Spear gun at night	Flashlight				2	10		4	15		20		3	10	30	10	104
	Spear gun	Pamana				10	5		4	20		10			10	50	10	119
Miscellaneous hand instruments																		
	Gleaning	Panagun-has			20	20	30		30	50	10	50	30	10	30	20	20	320
		TOTAL	51	59	90	107	123	75	121	144	21	280	144	282	122	386	55	**2,060**

Barangay:

1. Liguan
2. Tinocawan
3. Manila
4. Caracaran
5. Lagundi
6. Bogtong
7. Dap-Dap
8. Batan
9. Bagaobawan
10. Morocborocan
11. Poblacion
12. Carogcog
13. Santa Barbara
14. Malobago
15. Pagcolbon

Appendix B. Total Fishing Trips (Efforts) Per Municipality in Albay Gulf

Fishing Gears			Municipality							
English Name		Local name	Bacacay	Sto. Domingo	Legazpi	Manito	Sorsogon	Prieto Diaz	Rapu-Rapu	Total
Entangling nets										
	Bottom-set gill net	Panke-palubog	29,700	23,224	108,324	88,320	18,704	140	27,266	295,678
	Trammel net	Three-ply		480		7,200	18,752	12,200	7,176	45,808
	Crab gill net	Panke-pangasag	384		22,960	15,320	728		1,174	40,566
	Drift gill net	Panke-palutang	2,240			3,360	3,480	1,312	7,472	17,864
	Drift gill net	Largarete	2,200		2,898			980	745	6,823
	Drift gill net	Pangkanoos					128		8,960	9,088
	Drift gill net	Salupil (Panke sa boya)					4,080			4,080
	Drift gill net	Bugkat (Pambugiw)		608		528	1,576		4,558	7,270
Handlines										
	Simple handline	Kawil		20,404	43,328	19,267	82,720	3,160	30,398	199,277
	Simple handline	Lagulo			6,264	720				6,984
	Troll line	Rambo	4,602	9,540	15,296	17,912	45,880	1,344	27,948	122,522
	Troll line	Kasikas				900	4,428		23,450	28,778
	Pole and line	Bigawnan		3,875	3,168	12,768	22,554	1,920	18,798	63,083
	Squid jigger	Tina-tina		1,700	2,160				1,212	5,072
	Simple handline	Buyod-buyod	3,352	8,820	18,044	17,818	13,785	884	14,608	77,311
	Multiple handline	Og-og	12,280	57,972	46,766	8,942	87,960	15,600	63,480	293,000
Longlines										
	Bottom-set long line	Kitang	9,900	10,996	33,706	33,918	21,364	576	16,276	126,736
Barriers and Traps										
	Fish corral	Bunoan	1,488			3,048	9,064	744	10,236	24,580
	Fish pot	Bobo pansira			22,084	3,000	2,240		1,248	28,572
	Crab pot	Bobo pangasag			7,552	4,914	8,064	336		20,866
	Squid/cuttlefish pot	Bobo panglokus/kanoos			5,310	4,088			2,248	11,646
	Lobster trap	Bobo (Banagan)		128						128
Impounding nets										
	Dip net	Pansilo		2,400	18,680	7,560		15,200	2,160	46,000
	Crab lift net	Bintol (Kasag)	1,160		9,240	21,560	1,128			33,088
	Crab lift net	Bintol (Alimango)			10,740	960	2,080	384		14,164
	Lift net	Bintol (Banagan)							1,836	1,836
	Bagnet	Basnig	1,440		432	36	7,024		252	9,184
	Push net	Pang langaw-langaw					22,400			22,400
Spear										
	Speargun at night	Flashlight	1,480	4,152	4,696	25,584	34,376	4,900	11,530	86,718
	Speargun	Pamana	2,544		2,410	16,028	28,240	7,120	17,028	73,370
Miscellaneous hand instruments										
	Gleaning	Pagtagati/Panagun-has		5,600		40,340	118,480	31,040	55,360	250,820
		TOTAL	72,770	149,899	384,058	354,091	559,235	97,840	355,419	**1,973,312**

Appendix C. Monthly Total Fishing Trips (Efforts) in Albay Gulf

Fishing Gears			Months												
English Name		Local name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Entangling nets															
	Bottom-set gill net	Panke-palubog	20,226	21,266	24,498	24,242	26,770	26,756	27,104	26,604	27,084	30,024	20,940	20,164	295,678
	Trammel net	Three-ply	4,072	3,760	4,812	4,384	4,576	4,376	4,264	4,300	3,272	2,792	2,600	2,600	45,808
	Crab gill net	Panke-pangasag	3,338	3,376	2,720	2,720	2,672	2,592	3,892	3,892	3,892	4,140	3,970	3,362	40,566
	Drift gill net	Panke-palutang	900	1,020	2,424	2,432	2,464	2,106	1,362	1,362	1,238	756	900	900	17,864
	Drift gill net	Largarete	403	579	681	641	641	651	651	658	548	548	411	411	6,823
	Drift gill net	Pangkanoos	8	8	1,288	1,288	1,304	1,304	1,288	1,288	1,288	8	8	8	9,088
	Drift gill net	Salupil (Panke sa boya)	180	180	420	420	420	420	420	420	420	420	180	180	4,080
	Drift gill net	Bugkat (Pambugiw)	476	476	622	610	610	666	662	662	722	644	560	560	7,270
Handlines															-
	Simple handline	Kawil	14,924	13,011	17,450	16,030	18,430	18,600	17,008	16,516	17,680	17,780	16,420	15,428	199,277
	Simple handline	Lagulo	480	480	528	620	620	620	660	660	660	648	528	480	6,984
	Troll line	Rambo	10,406	10,530	10,780	11,220	11,196	10,432	9,284	9,084	9,092	9,318	10,590	10,590	122,522
	Troll line	Kasikas	1,791	1,987	3,057	3,057	3,057	3,057	2,557	1,907	2,147	2,287	1,943	1,931	28,778
	Pole and line	Bigawnan	3,937	4,017	7,551	7,476	7,541	7,241	4,388	4,298	4,116	4,076	4,261	4,181	63,083
	Squid jigger	Tina-tina	120	120	867	967	827	407	381	381	381	381	120	120	5,072
	Simple handline	Buyod-buyod	5,634	5,544	6,811	6,976	7,592	7,764	6,604	6,124	6,384	6,366	5,756	5,756	77,311
	Multiple handline	Og-og	19,758	19,352	22,610	25,065	26,865	27,085	26,519	26,554	28,530	27,970	22,426	20,266	293,000
Longlines															-
	Bottom-set long line	Kitang	6,376	14,356	15,364	15,260	10,696	10,056	9,848	10,336	10,388	10,068	7,096	6,892	126,736
Barriers and Traps															-
	Fish corral	Bunoan	2,027	2,019	2,097	2,069	2,069	2,161	1,999	1,999	1,915	2,131	2,067	2,027	24,580
	Fish pot	Bobo pansira	96	96	3,560	3,560	3,560	3,588	3,588	3,588	3,572	3,172	96	96	28,572
	Crab pot	Bobo pangasag	1,054	1,048	2,556	2,556	2,556	2,556	1,608	1,608	1,608	1,608	1,054	1,054	20,866
	Squid/cuttlefish pot	Bobo panglokus/kanoos	414	414	1,418	1,418	1,418	1,258	1,228	1,228	1,228	794	414	414	11,646
	Lobster trap	Bobo (Banagan)	16	16	16	16	16	16					16	16	128
Impounding nets															-
	Dip net	Pansilo	3,120	3,080	3,940	3,940	4,100	3,980	3,980	3,820	3,820	3,820	3,120	3,120	43,840
	Crab lift net	Bintol (Kasag)	3,116	3,076	2,676	2,720	2,720	2,700	2,758	2,842	2,842	2,842	3,800	3,156	35,248
	Crab lift net	Bintol (Alimango)	1,500	1,440	1,164	1,164	1,164	1,164	1,164	1,164	1,180	1,180	940	940	14,164
	Lift net	Bintol (Banagan)	340	340	119	119	119	119					340	340	1,836
	Bagnet	Basnig	700	700	784	932	932	848	848	688	688	688	688	688	9,184
	Push net	Pang langaw-langaw	2,240	2,240	2,240	1,600	1,600	1,600	1,600	1,600	1,600	1,600	2,240	2,240	22,400
Spear															-
	Speargun at night	Flashlight	4,370	5,220	8,611	9,595	9,715	9,073	8,065	8,041	7,921	7,367	4,370	4,370	86,718
	Speargun	Pamana	3,459	4,795	6,605	8,123	8,147	8,197	6,999	6,999	6,669	6,379	3,499	3,499	73,370
Miscellaneous hand instruments															-
	Gleaning	Pagtagati/Panagun-has	17,660	17,800	24,000	24,000	24,200	22,880	21,800	21,400	20,840	20,520	17,860	17,860	250,820
		TOTAL	133,141	142,346	182,269	185,220	188,597	184,273	172,529	170,023	171,725	170,327	139,213	133,649	**1,973,312**

Appendix C1. Monthly Total Fishing Trips (Efforts) in Sto. Domingo

Fishing Gears			Months												Total
English Name		Local name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Entangling nets															
	Bottom-set gill net	Panke-palubog	2544	984	408	472	2032	2032	2448	2448	2384	2384	2544	2544	23224
	Trammel net	Three-ply	120	120									120	120	480
	Drift gill net	Bugkat (Pambugiw)	32	32				112	112	112	112	32	32	32	608
Handlines															
	Simple handline	Kawil	1720	520	464	984	2184	2184	2144	2152	2152	1972	1964	1964	20404
	Troll line	Rambo	720	720	720	720	768	908	956	956	816	816	720	720	9540
	Pole and line	Bigawnan	410	410	450	495	500	500	140	50	50	50	410	410	3875
	Squid jigger	Tina-tina			705	565	425	5							1700
	Simple handline	Buyod-buyod	1037	867	835	885	885	885	395	395	395	407	917	917	8820
	Multiple handline	Og-og	4348	3048	3112	3304	4504	4984	6612	6612	6228	6228	4496	4496	57972
Longlines															
	Bottom-set long line	Kitang	160	3160	3164	3164	180	176	176	176	160	160	160	160	10996
Barriers and Traps															
	Lobster trap	Bobo (Banagan)	16	16	16	16	16	16					16	16	128
Impounding nets															
	Dip net	Pansilo	600	600									600	600	2400
Spear															
	Speargun at night	Flashlight	362	362	362	362	362	362	314	314	314	314	362	362	4152
Miscellaneous hand instruments															
	Gleaning	Pagtagati/Panagun-has	300	300	700	700	700	700	700	300	300	300	300	300	5600
		TOTAL	9825	10155	10528	11195	10524	10832	11549	11067	10527	10279	10097	10097	**149,899**

Appendix C2. Monthly Total Fishing Trips (Efforts) in Legazpi City

Fishing Gears		Months												
English Name	Local name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Entangling nets														
Bottom-set gill net	Panke-palubog	6968	8644	9928	9808	9808	9808	9808	9728	9668	9668	7592	6896	108,324
Crab gill net	Panke-pangasag	1344	1424	2112	2112	2112	2112	2112	2112	2112	2112	1952	1344	22,960
Drift gill net	Largarete	144	180	282	282	282	292	292	292	282	282	144	144	2,898
Handlines														
Simple handline	Kawil	2512	3204	4212	3772	3952	3912	3952	3952	4332	4212	2804	2512	43,328
Simple handline	Lagulo	480	480	528	540	540	540	540	540	540	528	528	480	6,264
Troll line	Rambo	1248	1248	1248	1312	1312	1312	1312	1312	1248	1248	1248	1248	15,296
Pole and line	Bigawnan	264	264	264	264	264	264	264	264	264	264	264	264	3,168
Squid jigger	Tina-tina				240	240	240	360	360	360	360			2,160
Simple handline	Buyod-buyod	580	920	1768	1768	2248	2248	2248	1768	1768	1568	580	580	18,044
Multiple handline	Og-og	1816	2992	4488	5202	5202	5202	4488	4488	4488	4488	2096	1816	46,766
Longlines														
Bottom-set long line	Kitang	2084	2876	3398	3398	3398	2888	2888	2888	2888	2808	2108	2084	33,706
Barriers and Traps														
Fish pot	Bobo pansira			2768	2768	2768	2796	2796	2796	2796	2596			22,084
Crab pot	Bobo pangasag			944	944	944	944	944	944	944	944			7,552
Squid/cuttlefish pot	Bobo panglokus/kanoos			690	690	690	690	690	690	690	480			5,310
Impounding nets														
Dip net	Pansilo	1520	1480	1520	1520	1680	1680	1680	1520	1520	1520	1520	1520	18,680
Crab lift net	Bintol (Kasag)	160	160	1000	1000	1000	1000	1000	1000	1000	1000	760	160	9,240
Crab lift net	Bintol (Alimango)	900	840	900	900	900	900	900	900	900	900	900	900	10,740
Bagnet	Basnig	36	36	36	36	36	36	36	36	36	36	36	36	432
Spear														
Speargun at night	Flashlight	120	120	527	527	527	527	527	527	527	527	120	120	4,696
Speargun	Pamana		120	260	290	290	290	290	290	290	290			2,410
TOTAL		20,176	24,988	36,873	37,373	38,193	37,681	37,127	36,407	36,653	35,831	22,652	20,104	**384,058**

Appendix C3. Monthly Total Fishing Trips (Efforts) in Manito

Fishing Gears			Months											
English Name		Local name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Entangling nets															
	Bottom-set gill net	Panke-palubog	4864	5824	8728	8128	8128	8144	8164	8084	8324	10124	4944	4864	88320
	Trammel net	Three-ply	320	320	800	800	800	800	800	800	800	320	320	320	7200
	Crab gill net	Panke-pangasag	1864	1864	384	384	336	336	1536	1536	1536	1816	1864	1864	15320
	Drift gill net	Panke-palutang	280	280	280	280	280	280	280	280	280	280	280	280	3360
	Drift gill net	Bugkat (Pambugiw)	72	72	56	56	56					72	72	72	528
Handlines															
	Simple handline	Kawil	1696	1691	1896	1436	1436	1436	1476	1476	1476	1876	2036	1336	19267
	Simple handline	Lagulo				80	80	80	120	120	120	120			720
	Troll line	Rambo	2616	2528	848	824	824	784	944	944	944	1056	2800	2800	17912
	Troll line	Kasikas	75	75	75	75	75	75	75	75	75	75	75	75	900
	Pole and line	Bigawnan	851	931	1331	1371	1371	1051	1000	1000	1000	1000	971	891	12768
	Simple handline	Buyod-buyod	1466	1466	1534	1564	1564	1564	1347	1347	1347	1687	1466	1466	17818
	Multiple handline	Og-og	736	646	568	872	872	872	632	712	700	700	816	816	8942
Longlines															
	Bottom-set long line	Kitang	880	3760	3818	3850	3410	3320	3280	3280	3280	3280	880	880	33918
Barriers and Traps															
	Fish corral	Bunoan	168	216	426	426	426	378	168	168	168	168	168	168	3048
	Fish pot	Bobo pansira			400	400	400	400	400	400	400	200			3000
	Crab pot	Bobo pangasag	90	84	600	600	600	600	540	540	540	540	90	90	4914
	Squid/cuttlefish pot	Bobo panglokus/kanoos			554	554	554	554	524	524	524	300			4088
Impounding nets															
	Dip net	Pansilo			1020	1020	1020	900	900	900	900	900			7560
	Crab lift net	Bintol (Kasag)	2600	2560	1360	1360	1360	1360	1450	1450	1450	1450	2560	2600	21560
	Crab lift net	Bintol (Alimango)							240	240	240	240			960
	Bagnet	Basnig	12	12	12										36
Spear															
	Speargun at night	Flashlight	1302	2152	2722	2722	2722	2272	2272	2272	2272	2272	1302	1302	25584
	Speargun	Pamana	320	1536	1676	1684	1684	1704	1696	1696	1696	1696	320	320	16028
Miscellaneous hand instruments															
	Gleaning	Pagtagati/Panagun-has	3220	3120	3820	3820	3820	3220	3220	3220	3220	3220	3220	3220	40340
		TOTAL	23,432	29,137	32,908	32,306	31,818	30,130	31,064	31,064	31,292	33,392	24,184	23,364	**354,091**

Appendix C4. Monthly Total Fishing Trips (Efforts) in Sorsogon City

Fishing Gears			Months											
English Name		Local name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Entangling nets															
	Bottom-set gill net	Panke-palubog	716	728	1764	1764	1824	1944	1936	1936	2396	2264	716	716	18704
	Trammel net	Three-ply	1352	1112	1728	1728	1744	1744	1744	1744	1648	1648	1280	1280	18752
	Crab gill net	Panke-pangasag			136	136	136	80	80	80	80				728
	Drift gill net	Panke-palutang	168	168	528	536	536	536	168	168	168	168	168	168	3480
	Drift gill net	Pangkanoos	8	8	8	8	24	24	8	8	8	8	8	8	128
	Drift gill net	Salupil (Panke sa boya)	180	180	420	420	420	420	420	420	420	420	180	180	4080
	Drift gill net	Bugkat (Pambugiw)	56	56	196	196	196	196	192	192	92	92	56	56	1576
Handlines															
	Simple handline	Kawil	6608	5208	7388	6768	7928	8288	6936	6436	6912	6912	6668	6668	82720
	Troll line	Rambo	3220	3220	3820	4420	4900	4900	3780	3580	3800	3800	3220	3220	45880
	Troll line	Kasikas	480	480	252	252	252	252	252	252	492	492	492	480	4428
	Pole and line	Bigawnan	1492	1492	2264	2104	2164	2194	2064	2064	1882	1842	1496	1496	22554
	Simple handline	Buyod-buyod	845	845	1100	1185	1355	1355	1395	1395	1395	1225	845	845	13785
	Multiple handline	Og-og	5760	5760	7040	7440	8040	8040	7600	7600	8920	8920	7080	5760	87960
Longlines															
	Bottom-set long line	Kitang	1244	2316	2788	2704	1684	1656	1608	1608	1664	1424	1424	1244	21364
Barriers and Traps															
	Fish corral	Bunoan	655	655	727	727	727	867	867	867	727	895	695	655	9064
	Fish pot	Bobo pansira			280	280	280	280	280	280	280	280			2240
	Crab pot	Bobo pangasag	936	936	984	984	984	984	96	96	96	96	936	936	8064
Impounding nets															
	Crab lift net	Bintol (Kasag)	68	68	68	112	112	92	68	108	108	108	108	108	1128
	Crab lift net	Bintol (Alimango)	560	560	240	240	240	240							2080
	Bagnet	Basnig	532	532	532	692	692	692	692	532	532	532	532	532	7024
	Push net	Pang langaw-langaw	2240	2240	2240	1600	1600	1600	1600	1600	1600	1600	2240	2240	22400
Spear															
	Speargun at night	Flashlight	1630	1630	3490	3634	3706	3706	3466	3466	3394	2994	1630	1630	34376
	Speargun	Pamana	1895	1895	2735	2735	2735	2765	2465	2465	2365	2315	1935	1935	28240
Miscellaneous hand instruments															
	Gleaning	Pagtagati/Panagun-has	7960	8280	10920	10920	11120	10760	10760	10760	10360	10320	8160	8160	118480
		TOTAL	38,605	38,369	51,648	51,585	53,399	53,615	48,477	47,657	49,339	48,355	39,869	38,317	**559,235**

Appendix C5. Monthly Total Fishing Trips (Efforts) in Prieto Diaz

Fishing Gears			Months											
English Name		Local name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Entangling nets															
	Bottom-set gill net	Panke-palubog					28	28	28	28	28				140
	Trammel net	Three-ply	1560	1560	1740	1140	1300	1300	1300	1300	340	340	160	160	12200
	Drift gill net	Panke-palutang	56	56	136	136	168	168	168	168	88	56	56	56	1312
	Drift gill net	Largarete		140	140	140	140	140	140	140					980
Handlines															
	Simple handline	Kawil	240	240	380	380	240	240	240	240	240	240	240	240	3160
	Troll line	Rambo	16	16	576	576	24	24	24	24	16	16	16	16	1344
	Pole and line	Bigawnan	80	80	320	320	320	320	80	80	80	80	80	80	1920
	Simple handline	Buyod-buyod	68	68	102	102	68	68	68	68	68	68	68	68	884
	Multiple handline	Og-og	360	720	1760	1760	1760	1760	1760	1760	1760	920	920	360	15600
Longlines															
	Bottom-set long line	Kitang	48	48	48	48	48	48	48	48	48	48	48	48	576
Barriers and Traps															
	Fish corral	Bunoan	48	48	64	36	36	36	92	92	92	104	48	48	744
	Crab pot	Bobo pangasag	28	28	28	28	28	28	28	28	28	28	28	28	336
Impounding nets															
	Dip net	Pansilo	1000	1000	1400	1400	1400	1400	1400	1400	1400	1400	1000	1000	15200
	Crab lift net	Bintol (Alimango)	40	40	24	24	24	24	24	24	40	40	40	40	384
Spear															
	Speargun at night	Flashlight	304	304	464	464	512	512	472	452	404	404	304	304	4900
	Speargun	Pamana	480	480	620	700	700	700	660	660	580	580	480	480	7120
Miscellaneous hand instruments															
	Gleaning	Pagtagati/Panagun-has	2280	2200	2840	2840	2840	2840	2840	2840	2680	2280	2280	2280	31040
		TOTAL	6,608	7,028	10,642	10,094	9,636	9,636	9,372	9,352	7,892	6,604	5,768	5,208	**97,840**

Appendix C6. Monthly Total Fishing Trips (Efforts) in Rapu-Rapu

Fishing Gears			Months											
English Name		Local name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Entangling nets															
	Bottom-set gill net	Panke-palubog	2074	2026	1670	1910	2790	2640	2800	2460	2364	2364	2084	2084	27266
	Trammel net	Three-ply	720	648	544	716	732	532	420	456	484	484	720	720	7176
	Crab gill net	Panke-pangasag	74	64	64	64	64	40	140	140	140	188	98	98	1174
	Drift gill net	Panke-palutang	236	356	1240	1240	1240	882	586	586	542	92	236	236	7472
	Drift gill net	Largarete	59	59	59	59	59	59	59	66	66	66	67	67	745
	Drift gill net	Pangkanoos			1280	1280	1280	1280	1280	1280	1280				8960
	Drift gill net	Bugkat (Pambugiw)	316	316	370	358	358	358	358	358	518	448	400	400	4558
Handlines															
	Simple handline	Kawil	2148	2148	3110	2690	2690	2540	2260	2260	2568	2568	2708	2708	30398
	Troll line	Rambo	2316	2528	2692	2492	2492	2348	2112	2112	2112	2112	2316	2316	27948
	Troll line	Kasikas	1236	1432	2730	2730	2730	2730	2230	1580	1580	1720	1376	1376	23450
	Pole and line	Bigawnan	840	840	2922	2922	2922	2912	840	840	840	840	1040	1040	18798
	Squid jigger	Tina-tina	120	120	162	162	162	162	21	21	21	21	120	120	1212
	Simple handline	Buyod-buyod	1277	1157	1251	1251	1251	1423	930	930	1050	1050	1519	1519	14608
	Multiple handline	Og-og	5258	5346	4802	5647	5647	5387	4587	4542	5594	5594	5538	5538	63480
Longlines															
	Bottom-set long line	Kitang	1220	1216	1168	1176	1176	1168	1048	1536	1548	1548	1736	1736	16276
Barriers and Traps															
	Fish corral	Bunoan	1032	976	756	756	756	756	748	748	804	840	1032	1032	10236
	Fish pot	Bobo pansira	96	96	112	112	112	112	112	112	96	96	96	96	1248
	Squid/cuttlefish pot	Bobo panglokus/kanoos	414	414	174	174	174	14	14	14	14	14	414	414	2248
Impounding nets															
	Crab lift net	Bintol (Kasag)	208	208	128	128	128	128	120	204	204	204	292	208	2160
	Lift net	Bintol (Banagan)	340	340	119	119	119	119					340	340	1836
	Bagnet	Basnig			84	84	84								252
Spear															
	Speargun at night	Flashlight	568	568	954	1734	1734	1542	862	862	862	708	568	568	11530
	Speargun	Pamana	564	564	1114	2514	2514	2514	1664	1664	1514	1274	564	564	17028
Miscellaneous hand instrur															
	Gleaning	Pagtagati/Panagun-has	3900	3900	5720	5720	5720	5360	4280	4280	4280	4400	3900	3900	55360
		TOTAL	25,016	25,322	33,225	36,038	36,934	35,006	27,471	27,051	28,481	26,631	27,164	27,080	**355,419**

Appendix C7. Monthly Total Fishing Trips (Efforts) in Bacacay

Fishing Gears			Months											
English Name		Local name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Entangling nets															
	Bottom-set gill net	Panke-palubog	3060	3060	2000	2160	2160	2160	1920	1920	1920	3220	3060	3060	29700
	Crab gill net	Panke-pangasag	56	24	24	24	24	24	24	24	24	24	56	56	384
	Drift gill net	Panke-palutang	160	160	240	240	240	240	160	160	160	160	160	160	2240
	Drift gill net	Largarete	200	200	200	160	160	160	160	160	200	200	200	200	2200
Handlines															
	Troll line	Rambo	270	270	876	876	876	156	156	156	156	270	270	270	4602
	Simple handline	Buyod-buyod	361	221	221	221	221	221	221	221	361	361	361	361	3352
	Multiple handline	Og-og	1480	840	840	840	840	840	840	840	840	1120	1480	1480	12280
Longlines															
	Bottom-set long line	Kitang	740	980	980	920	800	800	800	800	800	800	740	740	9900
Barriers and Traps															
	Fish corral	Bunoan	124	124	124	124	124	124	124	124	124	124	124	124	1488
Impounding nets															
	Crab lift net	Bintol (Kasag)	80	80	120	120	120	120	120	80	80	80	80	80	1160
	Bagnet	Basnig	120	120	120	120	120	120	120	120	120	120	120	120	1440
Spear															
	Speargun at night	Flashlight	84	84	92	152	152	152	152	148	148	148	84	84	1480
	Speargun	Pamana	200	200	200	200	224	224	224	224	224	224	200	200	2544
		TOTAL	6935	6363	6037	6157	6061	5341	5021	4977	5157	6851	6935	6935	**72,770**

Appendix D. Catch Rate of Fishing Gear Types Exploiting Albay Gulf

Fishing Gears			Catch Rate Range (kg/trip)		Mean
English Name		Local name	Minimum	Maximum	
Entangling nets					
	Bottom-set gill net	Panke-palubog	0.50	100.00	7.20
	Trammel net	Three-ply	0.50	60.00	8.28
	Crab gill net	Pangasag	0.50	10.00	2.66
	Drift gill net	Panke-palutang	0.50	100.00	12.57
	Drift gill net	Largarete	0.50	50.00	12.82
	Drift gill net	Pangkanoos	0.50	19.50	5.00
	Drift gill net	Salupil (Panke sa boya)	6.00	15.00	10.54
	Drift gill net	Bugkat (Pambugiw)	0.50	30.50	7.98
Handlines					
	Simple handline	Kawil	0.50	50.00	6.87
	Simple handline	Lagulo	0.50	3.00	1.70
	Troll line	Rambo	0.50	200.00	8.88
	Troll line	Kasikas	0.50	100.00	10.32
	Pole and line	Bigawnan	0.25	10.00	1.88
	Squid jigger	Tina-tina	0.25	5.50	2.05
	Simple handline	Buyod-buyod	0.25	30.00	2.47
	Multiple handline	Og-og	0.25	60.00	5.35
Longlines					
	Bottom-set long line	Kitang	0.50	60.00	8.65
Barriers and Traps					
	Fish corral	Bunoan	0.25	250.00	21.09
	Fish pot	Bobo pansira	0.50	10.00	2.97
	Crab pot	Bobo pangasag	0.50	16.00	2.23
	Squid/cuttlefish pot	Bobo panglokus/kanoos	0.50	40.00	4.74
	Lobster trap	Bobo (banagan)	0.50	1.00	0.70
Impounding nets					
	Dip net	Pansilo	0.50	20.00	5.57
	Crab lift net	Bintol (Kasag)	0.25	50.00	5.64
	Crab lift net	Bintol (Alimango)	0.50	5.00	2.23
	Lift net	Bintol (Banagan)	2.00	10.50	5.29
	Bagnet	Basnig	3.00	350.00	134.10
	Push net	Pang langaw-langaw	1.00	15.00	5.83
Spear					
	Speargun	Flashlight	0.25	15.00	3.03
	Speargun	Pamana	0.25	50.00	3.26
Miscellaneous hand instruments					
	Gleaning	Pagtagati/Panagun-has	0.25	20.00	2.37

Appendix E. Fishery Production of Various Fishing Gear Types per Municipality in Albay Gulf (MT)

Fishing Gears			Municipality							
English Name		Local name	Bacacay	Sto. Domingo	Legazpi	Manito	Sorsogon	Prieto Diaz	Rapu-rapu	Total
Entangling nets										
	Bottom-set gill net	Panke-palubog	238.28	169.12	598.91	422.37	337.85	0.18	450.36	2,217.06
	Trammel net	Three-ply		6.96		88.12	128.61	28.18	151.97	403.84
	Crab gill net	Panke-pangasag	0.95		64.08	36.24	1.76		3.47	106.50
	Drift gill net	Panke-palutang	9.40			45.64	31.64	23.26	232.98	342.92
	Drift gill net	Largarete	8.34		18.06			21.98	20.30	68.68
	Drift gill net	Pangkanoos					0.18		42.88	43.06
	Drift gill net	Salupil (Panke sa boya)					46.17			46.17
	Drift gill net	Bugkat (Pambugiw)		1.06		4.85	16.11		34.51	56.54
Handlines										
	Simple handline	Kawil		110.52	311.67	124.98	632.81	17.68	326.00	1,523.67
	Simple handline	Lagulo			9.66	1.56				11.22
	Troll line	Rambo	48.74	50.69	89.53	137.56	154.87	10.69	285.25	777.32
	Troll line	Kasikas				1.65	39.84		297.47	338.96
	Pole and line	Bigawnan		6.61	8.71	27.37	35.70	2.16	46.87	127.41
	Squid jigger	Tina-tina		2.10	2.34				3.67	8.11
	Simple handline	Buyod-buyod	7.31	13.29	47.79	42.24	16.74	1.62	71.23	200.21
	Multiple handline	Og-og	39.12	213.11	172.47	20.81	613.85	177.78	332.78	1,569.92
Longlines										
	Bottom-set long line	Kitang	106.60	282.96	282.43	376.88	300.70	2.64	196.22	1,548.44
Barriers and Traps										
	Fish corral	Bunoan	4.69			46.58	105.74	2.91	333.05	492.97
	Fish pot	Bobo pansira			77.08	9.36	3.78		2.83	93.05
	Crab pot	Bobo pangasag			22.46	11.46	12.94	0.43		47.29
	Squid/cuttlefish pot	Bobo panglokus/kanoos			15.11	7.70			9.13	31.94
	Lobster trap	Bobo (Banagan)		0.09						0.09
Impounding nets										
	Dip net	Pansilo		28.80	53.44	5.67		33.00		120.91
	Crab lift net	Bintol (Kasag)	5.52		32.72	36.61	2.36		19.63	96.84
	Crab lift net	Bintol (Alimango)			18.84	3.84	4.28	0.60		27.56
	Lift net	Bintol (Banagan)							9.82	9.82
	Bagnet	Basnig	189.00		63.00	4.80	91.34		71.40	419.54
	Push net	Pang langaw-langaw					147.20			147.20
Spear										
	Speargun	Flashlight	5.75	7.36	14.88	69.81	115.13	11.53	49.56	274.01
	Speargun	Pamana	9.58		7.67	46.85	62.33	16.59	55.77	198.78
Miscellaneous hand instruments										
	Gleaning	Pagtagati/Panagun-has		8.78		127.71	140.67	47.72	81.57	406.45
		TOTAL	673.27	901.44	1,910.83	1,700.65	3,042.60	398.95	3,128.72	11,756.46

Appendix F. Fishery Production Seasonality of Various Fishing Gears in Albay Gulf (MT)

Fishing Gears		Months												
English Name	Local name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Entangling nets														
Bottom-set gill net	Panke-palubog	163.48	118.98	127.09	138.26	230.69	266.69	223.52	207.61	194.74	209.10	160.59	176.32	2,217.06
Trammel net	Three-ply	23.67	22.75	39.14	47.93	56.49	43.94	44.16	38.07	27.16	20.59	20.17	19.78	403.84
Crab gill net	Panke-pangasag	6.05	5.71	6.50	6.37	8.03	8.75	11.30	12.21	12.30	10.76	10.67	7.85	106.50
Drift gill net	Panke-palutang	4.81	7.82	51.64	138.87	56.61	33.22	16.51	12.07	6.15	3.43	6.00	5.79	342.92
Drift gill net	Largarete	3.46	6.32	7.12	7.46	7.90	7.74	6.72	6.38	3.08	3.52	4.40	4.57	68.68
Drift gill net	Pangkanoos	0.00	0.00	7.05	24.97	5.81	1.99	1.29	1.29	0.65	0.00	0.00	0.00	43.06
Drift gill net	Salupil (Panke sa boya)	1.08	1.44	4.20	5.04	5.46	6.30	5.88	5.25	4.62	4.20	1.44	1.26	46.17
Drift gill net	Bugkat (Pambugiw)	2.25	1.92	5.88	9.53	12.57	8.40	3.47	2.56	2.70	2.41	2.31	2.54	56.54
Handlines														
Simple handline	Kawil	177.04	126.75	109.99	103.76	109.82	110.83	101.47	97.93	84.25	101.02	190.49	210.32	1,523.67
Simple handline	Lagulo	0.24	0.48	0.77	1.34	1.41	1.78	1.41	1.20	1.08	0.77	0.50	0.24	11.22
Troll line	Rambo	80.58	63.00	50.54	72.42	85.64	66.23	67.25	59.99	46.40	45.54	68.46	71.27	777.32
Troll line	Kasikas	29.57	15.71	31.85	39.06	55.34	24.56	22.06	16.30	23.73	25.22	28.83	26.73	338.96
Pole and line	Bigawnan	4.26	5.93	16.67	21.04	20.67	16.80	9.53	9.37	7.37	6.35	5.46	3.97	127.41
Squid jigger	Tina-tina	0.18	0.24	1.49	1.88	1.12	0.81	0.41	0.63	0.56	0.37	0.24	0.18	8.11
Simple handline	Buyod-buyod	16.42	16.58	14.84	17.92	19.94	22.07	15.66	13.86	13.61	12.92	16.24	20.15	200.21
Multiple handline	Og-og	80.50	72.67	75.49	125.90	162.67	180.95	168.03	145.85	176.25	156.72	128.45	96.44	1,569.92
Longlines														
Bottom-set long line	Kitang	52.95	211.13	380.18	351.18	108.58	78.55	63.83	67.83	69.65	71.11	47.37	46.10	1,548.44
Barriers and Traps														
Fish corral	Bunoan	50.10	39.33	28.05	26.43	24.99	22.62	24.80	22.43	20.41	27.97	56.35	149.50	492.97
Fish pot	Bobo pansira	0.13	0.13	8.97	11.34	16.07	15.09	14.09	11.60	9.60	5.89	0.08	0.08	93.05
Crab pot	Bobo pangasag	3.50	1.80	4.16	4.87	5.85	6.43	4.61	4.59	4.26	3.52	1.60	2.09	47.29
Squid/cuttlefish pot	Bobo panglokus/kanoos	1.98	1.21	2.21	2.61	3.86	4.67	4.16	3.85	2.87	1.81	1.18	1.54	31.94
Lobster trap	Bobo (Banagan)	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.02	0.09
Impounding nets														
Dip net	Pansilo	16.80	6.46	10.17	10.52	9.66	9.44	9.03	7.43	7.39	7.23	11.56	15.22	120.91
Crab lift net	Bintol (Kasag)	7.18	6.02	5.27	6.99	7.98	7.42	7.08	10.41	9.44	9.43	11.01	8.60	96.84
Crab lift net	Bintol (Alimango)	1.93	2.60	1.85	2.18	2.50	2.83	3.44	3.35	3.08	2.27	0.98	0.53	27.56
Lift net	Bintol (Banagan)	3.57	0.65	0.30	0.24	0.30	0.00	0.00	0.00	0.00	2.55	2.21	0.00	9.82
Bagnet	Basnig	8.98	16.15	79.84	59.16	61.98	40.44	34.94	30.89	30.89	27.79	17.59	10.90	419.54
Push net	Pang langaw-langaw	22.40	33.60	33.60	1.60	1.60	2.40	2.40	3.20	3.20	9.60	11.20	22.40	147.20
Spear														
Speargun	Flashlight	8.48	10.37	19.22	31.96	45.42	38.44	29.95	28.15	23.57	18.81	10.07	9.59	274.01
Speargun	Pamana	6.60	10.75	19.06	30.16	29.50	25.00	20.45	16.64	13.61	12.50	7.74	6.76	198.78
Miscellaneous hand instruments														
Gleaning	Pagtagati/Panagun-has	12.93	18.96	49.05	63.48	62.08	47.50	39.92	32.78	29.06	22.38	16.06	12.25	406.45
	TOTAL	791.09	825.49	1,192.19	1,364.47	1,220.54	1,101.90	957.36	873.72	831.68	825.78	839.26	932.98	**11,756.46**

Appendix F1. Fishery Production Seasonality of Various Fishing Gears in Bacacay (MT)

Fishing Gears			Months											
English Name		Local name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Entangling nets															
	Bottom-set gill net	Panke-palubog	40.36	28.86	7.44	9.72	11.28	9.24	5.04	5.16	5.40	27.28	38.18	50.32	238.28
	Crab gill net	Panke-pangasag	0.17	0.06	0.05	0.05	0.04	0.04	0.02	0.02	0.04	0.05	0.20	0.22	0.95
	Drift gill net	Panke-palutang	0.08	0.32	1.20	2.40	2.04	1.44	0.48	0.40	0.32	0.32	0.24	0.16	9.40
	Drift gill net	Largarete	1.20	0.70	0.60	0.40	0.32	0.16	0.24	0.32	0.60	0.70	1.10	2.00	8.34
Handlines															
	Troll line	Rambo	2.10	2.10	10.28	16.93	8.47	0.65	0.53	0.46	0.46	1.68	2.52	2.57	48.74
	Simple handline	Buyod-buyod	1.07	0.25	0.27	0.27	0.25	0.42	0.39	0.48	0.75	0.79	1.13	1.26	7.31
	Multiple handline	Og-og	6.76	2.34	1.92	1.68	0.84	0.78	1.02	1.68	2.10	3.36	8.40	8.24	39.12
Longlines															
	Bottom-set long line	Kitang	5.50	13.02	25.41	16.88	7.24	6.88	6.20	5.96	5.28	5.44	4.81	3.98	106.60
Barriers and Traps															
	Fish corral	Bunoan	0.33	0.35	0.46	0.45	0.47	0.45	0.57	0.47	0.37	0.30	0.16	0.31	4.69
Impounding nets															
	Crab lift net	Bintol (Kasag)	0.08	0.20	0.78	1.20	1.02	0.84	0.60	0.24	0.20	0.16	0.12	0.08	5.52
	Bagnet	Basnig	6.00	9.00	12.00	18.00	24.00	30.00	27.00	24.00	18.00	12.00	6.00	3.00	189.00
Spear															
	Speargun	Flashlight	0.29	0.50	0.72	1.03	0.95	0.69	0.41	0.33	0.33	0.23	0.13	0.13	5.75
	Speargun	Pamana	0.48	0.76	1.23	1.70	1.46	1.05	0.83	0.62	0.54	0.47	0.20	0.24	9.58
		TOTAL	64.42	58.46	62.36	70.71	58.37	52.63	43.33	40.15	34.38	52.78	63.19	72.50	**673.27**

Appendix F2. Fishery Production Seasonality of Various Fishing Gears in Sto.Domingo (MT)

Fishing Gears			Months											
English Name		Local name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Entangling nets															
	Bottom-set gill net	Panke-palubog	34.43	6.52	0.98	1.29	12.67	17.68	12.36	10.14	9.97	12.46	21.90	28.72	169.12
	Trammel net	Three-ply	2.16	1.56									1.44	1.80	6.96
	Drift gill net	Bugkat (Pambugiw)	0.02	0.02	0.00	0.00	0.00	0.11	0.39	0.28	0.17	0.03	0.03	0.02	1.06
Handlines															
	Simple handline	Kawil	3.37	1.34	1.34	6.44	12.33	14.51	15.87	19.01	11.85	9.86	7.83	6.77	110.52
	Troll line	Rambo	1.08	0.72	1.44	2.52	3.29	4.23	7.01	11.58	7.22	5.83	3.60	2.16	50.69
	Pole and line	Bigawnan	0.38	0.74	0.95	1.25	1.37	1.13	0.17	0.04	0.03	0.01	0.37	0.19	6.61
	Squid jigger	Tina-tina			0.88	0.99	0.23	0.01							2.10
	Simple handline	Buyod-buyod	1.54	2.13	1.49	1.24	1.24	3.42	0.26	0.25	0.27	0.22	0.53	0.70	13.29
	Multiple handline	Og-og	17.32	4.15	4.34	5.43	14.60	19.34	28.48	30.21	32.54	19.34	18.19	19.16	213.11
Longlines															
	Bottom-set long line	Kitang	0.58	76.88	107.95	92.53	1.50	0.93	0.96	0.59	0.33	0.32	0.24	0.16	282.96
Barriers and Traps															
	Lobster trap	Bobo (Banagan)	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.02	0.09
Impounding nets															
	Dip net	Pansilo	12.00										6.00	10.80	28.80
Spear															
	Speargun	Flashlight	0.47	0.57	0.84	1.13	1.19	1.01	0.54	0.39	0.23	0.23	0.33	0.43	7.36
Miscellaneous hand instruments															
	Gleaning	Pagtagati/Panagun-has	0.15	0.30	0.70	1.75	2.45	1.40	1.05	0.30	0.30	0.15	0.15	0.08	8.78
		TOTAL	73.51	94.94	120.92	114.58	50.87	63.78	67.10	72.78	62.90	48.46	60.62	70.99	**901.44**

Appendix F3. Fishery Production Seasonality of Various Fishing Gears in Legazpi City (MT)

Fishing Gears			Months												
English Name		Local name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Entangling nets															
	Bottom-set gill net	Panke-palubog	34.80	36.04	46.92	43.86	53.85	62.85	72.25	70.94	58.83	48.27	38.23	32.07	598.91
	Crab gill net	Panke-pangasag	1.34	1.98	5.47	5.57	7.49	7.97	7.85	7.30	7.68	5.69	4.41	1.34	64.08
	Drift gill net	Largarete	0.58	1.42	2.11	2.51	2.67	2.74	1.99	1.61	1.02	0.75	0.40	0.27	18.06
Handlines															
	Simple handline	Kawil	20.74	25.04	34.79	27.64	33.46	36.82	29.98	23.33	24.70	22.80	15.27	17.10	311.67
	Simple handline	Lagulo	0.24	0.48	0.77	1.26	1.29	1.62	1.11	0.84	0.78	0.53	0.50	0.24	9.66
	Troll line	Rambo	12.07	10.16	9.05	7.66	6.79	6.36	4.59	3.92	4.37	5.84	7.52	11.18	89.53
	Pole and line	Bigawnan	0.38	0.58	0.64	0.83	0.96	1.15	1.09	0.96	0.77	0.64	0.46	0.26	8.71
	Squid jigger	Tina-tina				0.12	0.12	0.24	0.36	0.60	0.54	0.36			2.34
	Simple handline	Buyod-buyod	0.40	0.97	2.92	5.17	7.83	8.52	8.17	6.02	4.49	2.55	0.46	0.29	47.79
	Multiple handline	Og-og	2.16	6.70	14.60	22.71	29.75	32.01	21.84	15.28	13.42	8.81	3.30	1.90	172.47
Longlines															
	Bottom-set long line	Kitang	7.65	34.18	68.21	60.16	32.70	21.74	17.34	12.48	11.07	8.23	5.10	3.57	282.43
Barriers and Traps															
	Fish pot	Bobo pansira			7.66	9.07	13.11	12.69	11.95	9.38	7.95	5.27			77.08
	Crab pot	Bobo pangasag			2.14	2.94	3.74	3.82	3.02	2.62	2.29	1.89			22.46
	Squid/cuttlefish pot	Bobo panglokus/kanoos			1.17	1.52	2.45	3.03	2.58	2.00	1.41	0.96			15.11
Impounding nets															
	Dip net	Pansilo	3.80	4.96	6.68	5.76	5.14	4.34	4.38	3.48	3.44	3.98	4.06	3.42	53.44
	Crab lift net	Bintol (Kasag)	0.32	0.48	2.36	3.60	4.50	5.10	5.20	4.00	3.10	2.60	1.22	0.24	32.72
	Crab lift net	Bintol (Alimango)	0.45	0.84	1.35	1.80	2.25	2.70	2.70	2.25	1.80	1.35	0.90	0.45	18.84
	Bagnet	Basnig	1.80	3.60	5.40	9.00	10.80	9.00	7.20	5.40	3.60	3.60	1.80	1.80	63.00
Spear															
	Speargun	Flashlight	0.30	0.42	1.13	1.52	1.79	1.97	2.19	2.22	1.66	1.09	0.30	0.30	14.88
	Speargun	Pamana		0.18	0.45	0.73	0.95	1.09	1.45	1.31	0.87	0.65			7.67
		TOTAL	87.04	128.02	213.82	213.42	221.64	225.76	207.23	175.91	153.78	125.85	83.92	74.44	**1,910.83**

Appendix F4. Fishery Production Seasonality of Various Fishing Gears in Manito (MT)

Fishing Gears		Months												
English Name	Local name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Entangling nets														
Bottom-set gill net	Panke-palubog	37.73	33.35	27.90	30.64	27.83	26.68	29.12	43.81	42.31	43.63	36.62	42.74	422.37
Trammel net	Three-ply	2.80	3.48	9.56	11.04	11.88	12.40	10.52	9.32	8.48	3.28	2.88	2.48	88.12
Crab gill net	Panke-pangasag	4.40	3.61	0.77	0.50	0.22	0.17	2.69	4.13	3.70	4.42	5.66	5.99	36.24
Drift gill net	Panke-palutang	0.14	0.84	6.32	10.03	11.80	5.90	3.37	2.78	1.88	1.60	0.56	0.42	45.64
Drift gill net	Bugkat (Pambugiw)	0.61	0.29	0.87	1.12	0.56					0.18	0.50	0.72	4.85
Handlines														
Simple handline	Kawil	6.97	7.56	12.68	11.28	12.38	9.93	10.56	9.74	7.00	14.55	17.13	5.20	124.98
Simple handline	Lagulo				0.08	0.12	0.16	0.30	0.36	0.30	0.24			1.56
Troll line	Rambo	34.23	20.11	3.65	3.44	3.29	2.95	3.55	4.35	4.37	4.02	24.03	29.56	137.56
Troll line	Kasikas	0.04	0.11	0.15	0.23	0.23	0.19	0.15	0.15	0.15	0.11	0.11	0.04	1.65
Pole and line	Bigawnan	1.15	1.48	2.97	4.04	3.48	3.10	2.58	2.44	2.26	1.56	1.40	0.92	27.37
Simple handline	Buyod-buyod	4.39	3.26	3.42	5.03	4.49	3.53	1.99	1.78	1.48	2.87	4.13	5.88	42.24
Multiple handline	Og-og	1.70	1.36	0.94	1.31	1.60	1.79	1.37	1.75	2.10	2.02	2.24	2.61	20.81
Longlines														
Bottom-set long line	Kitang	6.31	46.29	113.41	122.92	28.82	15.32	12.92	8.79	7.07	6.15	2.37	6.52	376.88
Barriers and Traps														
Fish corral	Bunoan	0.60	5.94	8.70	10.25	7.83	3.59	2.59	2.04	1.97	1.68	0.91	0.48	46.58
Fish pot	Bobo pansira	0.03	0.03	0.42	0.99	1.48	1.40	1.48	1.72	1.32	0.43	0.03	0.03	9.36
Crab pot	Bobo pangasag	0.23	0.21	0.72	0.98	1.17	1.19	1.49	1.80	1.76	1.40	0.27	0.27	11.46
Squid/cuttlefish pot	Bobo panglokus/kanoos			0.57	0.68	0.85	1.08	1.16	1.57	1.20	0.60			7.70
Impounding nets														
Dip net	Pansilo			0.69	1.26	1.02	0.90	0.45	0.45	0.45	0.45			5.67
Crab lift net	Bintol (Kasag)	6.34	4.97	1.95	1.61	1.63	0.93	1.18	1.79	1.70	2.18	4.88	7.45	36.61
Crab lift net	Bintol (Alimango)							0.72	1.08	1.20	0.84			3.84
Bagnet	Basnig	0.30	2.40	2.10										4.80
Spear														
Speargun	Flashlight	1.90	3.40	4.47	6.50	7.35	8.38	9.78	10.12	8.53	6.12	1.95	1.30	69.81
Speargun	Pamana	0.56	3.74	5.71	7.80	5.90	5.54	5.05	4.57	3.61	3.25	0.60	0.52	46.85
Miscellaneous hand instruments														
Gleaning	Pagtagati/Panagun-has	3.22	5.42	17.00	21.65	16.47	12.84	13.50	11.89	9.53	7.50	5.14	3.55	127.71
TOTAL		113.63	147.85	224.97	253.37	150.39	117.95	116.51	126.44	112.35	109.08	111.43	116.67	**1700.65**

Appendix F5. Fishery Production Seasonality of Various Fishing Gears in Sorsogon City (MT)

Fishing Gears			Months											
English Name		Local name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Entangling nets															
	Bottom-set gill net	Panke-palubog	1.31	0.75	29.26	34.17	35.01	42.33	42.23	47.39	51.55	49.60	2.36	1.89	337.85
	Trammel net	Three-ply	7.67	5.70	11.57	11.58	12.36	12.55	16.79	16.72	8.74	8.93	8.51	7.49	128.61
	Crab gill net	Panke-pangasag			0.16	0.20	0.24	0.52	0.32	0.20	0.12				1.76
	Drift gill net	Panke-palutang	0.50	0.82	3.92	7.90	10.56	5.31	0.84	0.58	0.42	0.34	0.18	0.26	31.64
	Drift gill net	Pangkanoos	0.00	0.00	0.01	0.01	0.05	0.07	0.01	0.01	0.01	0.00	0.00	0.00	0.18
	Drift gill net	Salupil (Panke sa boya)	1.08	1.44	4.20	5.04	5.46	6.30	5.88	5.25	4.62	4.20	1.44	1.26	46.17
	Drift gill net	Bugkat (Pambugiw)	0.11	0.11	1.36	1.80	4.99	3.93	1.60	1.08	0.43	0.37	0.16	0.16	16.11
Handlines															
	Simple handline	Kawil	111.20	66.05	24.64	18.81	22.37	23.37	25.07	26.91	33.99	38.58	105.29	136.52	632.81
	Simple handline	Lagulo													
	Troll line	Rambo	11.49	11.62	1.69	3.38	12.67	18.90	24.08	15.89	13.97	12.98	16.01	12.19	154.87
	Troll line	Kasikas	14.48	4.00	1.00	0.64	0.48	0.16	0.36	0.48	2.96	4.40	6.64	4.24	39.84
	Pole and line	Bigawnan	1.77	2.43	3.46	3.30	4.01	3.59	3.92	4.21	2.91	2.79	1.87	1.45	35.70
	Simple handline	Buyod-buyod	0.60	0.75	0.94	1.33	1.45	1.50	1.74	1.88	2.12	1.83	1.48	1.12	16.74
	Multiple handline	Og-og	27.29	22.11	16.05	29.09	46.83	63.98	68.29	55.68	83.26	96.97	67.26	37.04	613.85
Longlines															
	Bottom-set long line	Kitang	26.64	34.34	49.72	41.15	20.53	20.82	16.40	14.85	21.57	17.24	19.87	17.57	300.70
Barriers and Traps															
	Fish corral	Bunoan	8.07	7.78	2.91	2.51	1.51	8.06	14.28	11.29	7.33	10.87	19.23	11.90	105.74
	Fish pot	Bobo pansira			0.56	0.70	0.84	0.56	0.42	0.28	0.28	0.14			3.78
	Crab pot	Bobo pangasag	3.22	1.55	1.27	0.92	0.92	1.42	0.10	0.14	0.19	0.19	1.27	1.74	12.94
Impounding nets															
	Crab lift net	Bintol (Kasag)	0.03	0.03	0.04	0.48	0.73	0.46	0.05	0.12	0.12	0.17	0.09	0.05	2.36
	Crab lift net	Bintol (Alimango)	1.40	1.68	0.48	0.36	0.24	0.12							4.28
	Bagnet	Basnig	0.88	1.15	43.54	2.76	1.98	1.44	0.74	1.49	9.29	12.19	9.79	6.10	91.34
	Push net	Pang langaw-langaw	22.40	33.60	33.60	1.60	1.60	2.40	2.40	3.20	3.20	9.60	11.20	22.40	147.20
Spear															
	Speargun	Flashlight	3.71	4.10	7.48	11.30	16.76	16.69	12.88	11.90	10.25	8.84	5.50	5.72	115.13
	Speargun	Pamana	1.98	2.94	7.09	9.00	9.72	8.98	7.57	5.26	3.14	2.46	2.29	1.90	62.33
Miscellaneous hand instruments															
	Gleaning	Pagtagati/Panagun-has	3.82	6.14	15.98	19.79	21.85	19.72	15.32	11.47	10.49	8.08	4.81	3.20	140.67
		TOTAL	249.66	209.11	260.92	207.81	233.18	263.16	261.27	236.26	270.97	290.78	285.27	274.22	**3,042.60**

Appendix F6. Fishery Production Seasonality of Various Fishing Gears in Prieto Diaz (MT)

Fishing Gears			Months												
English Name		Local name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Entangling nets															
	Bottom-set gill net	Panke-palubog					0.01	0.03	0.07	0.04	0.03				0.18
	Trammel net	Three-ply	3.08	4.48	2.96	2.15	3.04	3.42	3.01	3.01	1.28	1.15	0.32	0.28	28.18
	Drift gill net	Panke-palutang	0.18	0.33	1.73	2.31	5.26	6.02	4.06	1.96	0.57	0.33	0.30	0.20	23.26
	Drift gill net	Largarete		2.80	3.01	3.15	3.50	3.43	3.08	3.01					21.98
Handlines															
	Simple handline	Kawil	1.32	1.20	4.00	4.68	0.36	0.24	0.12	0.36	1.20	1.32	1.44	1.44	17.68
	Troll line	Rambo	0.04	0.05	4.25	5.65	0.12	0.13	0.13	0.14	0.05	0.05	0.05	0.03	10.69
	Pole and line	Bigawnan	0.04	0.04	0.32	0.48	0.48	0.64	0.04	0.02	0.02	0.02	0.02	0.04	2.16
	Simple handline	Buyod-buyod	0.17	0.14	0.19	0.17	0.10	0.07	0.07	0.07	0.14	0.14	0.17	0.20	1.62
	Multiple handline	Og-og	0.36	14.40	18.52	20.56	24.36	32.32	26.76	20.16	17.04	1.84	1.10	0.36	177.78
Longlines															
	Bottom-set long line	Kitang	0.07	0.05	0.05	0.10	0.34	0.41	0.48	0.46	0.36	0.14	0.12	0.07	2.64
Barriers and Traps															
	Fish corral	Bunoan	0.45	0.36	0.30	0.09	0.07	0.03	0.08	0.11	0.15	0.28	0.34	0.65	2.91
	Crab pot	Bobo pangasag	0.06	0.04	0.03	0.03	0.01	0.01	0.01	0.03	0.03	0.04	0.06	0.08	0.43
Impounding nets															
	Dip net	Pansilo	1.00	1.50	2.80	3.50	3.50	4.20	4.20	3.50	3.50	2.80	1.50	1.00	33.00
	Crab lift net	Bintol (Alimango)	0.08	0.08	0.02	0.02	0.01	0.01	0.02	0.02	0.08	0.08	0.08	0.08	0.60
Spear															
	Speargun	Flashlight	0.14	0.28	1.48	2.01	1.81	1.74	1.50	1.56	0.37	0.32	0.15	0.14	11.53
	Speargun	Pamana	0.24	0.48	0.83	2.94	3.15	2.73	2.34	2.34	0.53	0.53	0.24	0.24	16.59
Miscellaneous hand instruments															
	Gleaning	Pagtagati/Panagun-has	1.64	2.66	4.12	5.42	6.02	6.12	5.64	4.94	4.74	2.64	2.14	1.64	47.72
TOTAL			8.87	28.89	44.60	53.26	52.15	61.56	51.62	41.73	30.09	11.69	8.02	6.46	**398.95**

Appendix F7. Fishery Production Seasonality of Various Fishing Gears in Rapu-rapu (MT)

Fishing Gears			Months											
English Name		Local name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Entangling nets															
	Bottom-set gill net	Panke-palubog	14.84	13.46	14.59	18.59	90.04	107.89	62.44	30.12	26.64	27.87	23.30	20.58	450.36
	Trammel net	Three-ply	7.96	7.52	15.05	23.16	29.21	15.57	13.83	9.02	8.66	7.23	7.02	7.73	151.97
	Crab gill net	Panke-pangasag	0.13	0.07	0.06	0.05	0.05	0.06	0.42	0.56	0.77	0.61	0.40	0.29	3.47
	Drift gill net	Panke-palutang	3.90	5.51	38.47	116.23	26.95	14.55	7.76	6.35	2.95	0.84	4.72	4.75	232.98
	Drift gill net	Largarete	1.69	1.40	1.40	1.40	1.40	1.41	1.41	1.45	1.47	2.07	2.91	2.30	20.30
	Drift gill net	Pangkanoos			7.04	24.96	5.76	1.92	1.28	1.28	0.64				42.88
	Drift gill net	Bugkat (Pambugiw)	1.51	1.50	3.65	6.61	7.02	4.36	1.47	1.20	2.10	1.83	1.61	1.64	34.51
Handlines															
	Simple handline	Kawil	33.44	25.55	32.54	34.92	28.91	25.96	19.88	18.58	5.52	13.90	43.52	43.29	326.00
	Troll line	Rambo	19.57	18.23	20.19	32.84	51.01	32.99	27.36	23.64	15.96	15.14	14.73	13.58	285.25
	Troll line	Kasikas	15.05	11.60	30.70	38.19	54.64	24.22	21.55	15.67	20.62	20.71	22.07	22.46	297.47
	Pole and line	Bigawnan	0.54	0.67	8.34	11.15	10.37	7.20	1.73	1.71	1.39	1.34	1.34	1.11	46.87
	Squid jigger	Tina-tina	0.18	0.24	0.61	0.77	0.77	0.57	0.05	0.03	0.02	0.01	0.24	0.18	3.67
	Simple handline	Buyod-buyod	8.24	9.08	5.61	4.71	4.58	4.63	3.04	3.39	4.37	4.54	8.34	10.71	71.23
	Multiple handline	Og-og	24.91	21.60	19.11	45.12	44.69	30.72	20.27	21.09	25.80	24.37	27.96	27.13	332.78
Longlines															
	Bottom-set long line	Kitang	6.19	6.37	15.43	17.44	17.46	12.45	9.52	24.71	23.97	33.59	14.87	14.23	196.22
Barriers and Traps															
	Fish corral	Bunoan	40.65	24.89	15.69	13.13	15.10	10.49	7.28	8.53	10.59	14.83	35.70	136.15	333.05
	Fish pot	Bobo pansira	0.10	0.10	0.33	0.58	0.64	0.44	0.24	0.22	0.05	0.05	0.05	0.05	2.83
	Squid/cuttlefish pot	Bobo panglokus/kanoos	1.98	1.21	0.47	0.41	0.57	0.56	0.42	0.28	0.27	0.25	1.18	1.54	9.13
Impounding nets															
	Crab lift net	Bintol (Kasag)	0.41	0.34	0.15	0.10	0.10	0.09	0.06	4.26	4.32	4.32	4.70	0.78	19.63
	Lift net	Bintol (Banagan)	3.57	0.65	0.30	0.24	0.30					2.55	2.21		9.82
	Bagnet	Basnig			16.80	29.40	25.20								71.40
Spear															
	Speargun	Flashlight	1.66	1.10	3.09	8.47	15.57	7.96	2.65	1.64	2.19	1.97	1.71	1.57	49.56
	Speargun	Pamana	3.34	2.65	3.75	7.99	8.33	5.61	3.22	2.55	4.92	5.15	4.41	3.86	55.77
Miscellaneous hand instruments															
	Gleaning	Pagtagati/Panagun-has	4.10	4.44	11.25	14.87	15.29	7.42	4.41	4.18	4.00	4.01	3.82	3.78	81.57
		TOTAL	193.95	158.21	264.61	451.32	453.94	317.06	210.30	180.46	167.20	187.15	226.81	317.71	**3,128.72**

DATABASING AND GIS MAPPING FOR ALBAY GULF

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Balilo B.B., D.B. Balmadrid, J.C.N. Vibar, D.J.N. Sy, H.L. Maraña. 2019. Databasing and GIS Mapping for Albay Gulf. Pp 172-189. In Dioneda R.R., A.P. Candelaria and G.A.A. Naz (Eds). 2019. Participatory Resource and Socio-Economic Assessment of Albay Gulf. 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 189 pp.

ABSTRACT

The increasing demand for the development of information system embedded with relational database provides a critical role in project management considering the call towards project automation. Field assessors, study leaders, and project managers take considerable effort in data collection. However, information gathered is just part of an Excel-like concept and common storage method. This paper presents the development of a working database and GIS map, which served as the repository of information of the Participatory Resource and Socio-Economic Assessment (PRSA) implemented by Bicol University with multi-agency partners under the Department of Agriculture - Bureau of Fisheries and Aquatic Resources (DA-BFAR) as part of the Fisheries, Coastal Resources, and Livelihood (FishCORAL) project. The system laid down the important components of the project, which serve as a model to database the socio-economic profiling, aquatic ecology and habitat assessment, water quality, and capture fisheries assessment of Albay Gulf. Software testing was used to evaluate the internal and external characteristics of the developed system. The evaluation revealed that both parameters were satisfied based on standard system requirements. Thus, this study presents the characteristics of information system, which can be used and implemented in any public and private research project.

I. INTRODUCTION

The Participatory Resource and Socio-Economic Assessment (PRSA) is a project implemented under the Fisheries, Coastal Resources and Livelihood (FishCORAL) project of the Bureau of Fishieries and Aquatic Resource of the Department of Agriculture (DA-BFAR). The project is in collaboration with various agencies covering three target assessment areas, namely Albay, Ragay, and Asid (side of Bicol area) gulfs covering several Municipalities of Albay, Sorsogon, Camarines Sur and Masbate. Its implementation served as a mechanism to assess and address the alarming poverty incidence in fishing communities and provide protection and conservation of coastal resources. The project component includes assessments for socio-economic profiling, aquatic ecology and coastal habitat, water quality, and capture fisheries resources of the target sampling areas. It also aims to facilitate the rendering of maps for geo-tagging of target sampling areas for SW/SG, corals, and mangrove areas.

Managing the data collected and rendering the map are the challenging concern of many projects. Normally, internal and funded projects do not include a database component, which is a crucial concern of data management. In order to facilitate the management and processing of data, there is a need to design a reliable and efficient information system.

By definition, an information system (IS) is a bunch of 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). This provides the building blocks for the Government Information System Projects (GISP) which covers the projects under the ICT developments of the country. The Public Services Information System (PSIS) and Electronic Procurement System (EPS), to name a few, provide 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).

The geographical information system (GIS) has been an integral part in creating and storing vital records in the field of marine biology. GIS technologies integrate a range of geographical information into a single analytical model, in which diverse data are "geo-referenced" to cartographic projections (Maliene, et al., 2011). This integration makes it easy for users to mark certain geographical locations with corresponding data needed for processing needed information. GIS has 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). Additionally, the system has embedded GIS to make possible the rendering of maps and plotting the target sampling sites for coral, seagrass/seaweeds, and mangrove area.

This study aims to develop and implement an information system model to store, update, and manage the information of various components. 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.

II. METHODOLOGY

The development of an information system follows a methodology that analyzes and presents the necessary system requirements, data and process modeling techniques, and software testing.

A. Development Methodology

The system development life cycle is a methodology in system analysis and development that assists designers analyze and identify key system requirements. For this study, the researchers used the Agile Development – Rational Unified Process (RUP) which relates on building the essential output requirements of the system. This methodology is based on a set of building blocks and content elements, describing what is to be produced (artifacts) and deals with a life cycle that ends with a milestone. This also provides a specific plan for each step of the development process, helps prevent resources from being wasted, and, reduces unexpected development costs. An application was utilized to facilitate the site validation of the target coordinates for mangrove, seagrass/seaweeds, and water quality assessment.

B. System Architecture

This defines the structure of the system in terms of various subsystem components and their relationships with internal and external systems (Pradhan, 2013). The system has two main components, PRSA system and tools/utilities. The PRSA components are composed of sub-modules linked with other sub-modules. That is, the data stored in a sub-module can be an inputted to the other module (Table 1).

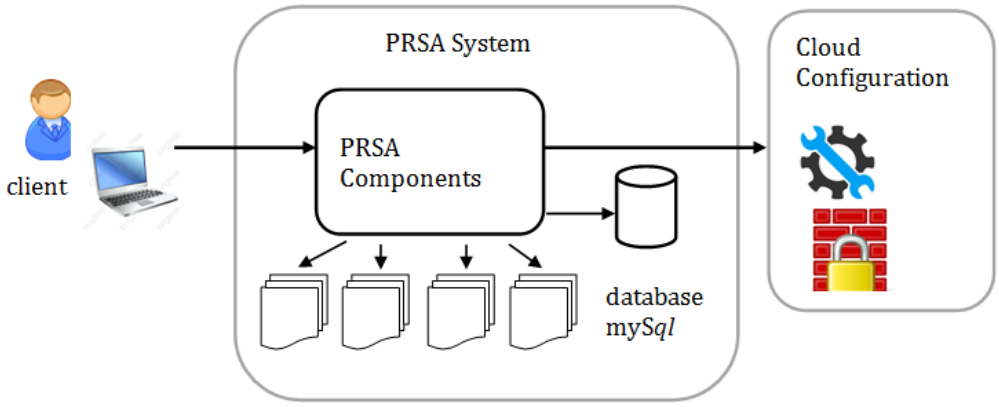


Figure 1. System Architecture of the System

C. Software/Hardware Requirements

The following technologies were used in the development of the system: Apache HTTP server, Mysql, PHP, HTML, CSS, Javascript technology, Bootstrap framework, OpenStreetView, GIS map, leaflet, and application programming interface (API).

D. Testing and Operating Procedure

Software testing (white box and black box) was done to analyze the internal and external structure, design and implementation of the system. The construction of test cases allows the system to easily check on the requirement and evaluate the expected results if achieved. Software testing is a process to ultimately look for software bugs within a program or application. Since software bugs are defects in the system, this can result in a poor product, which can eventually lose customers once operating in the business world. Nevertheless, it is imperative as nobody wants a flaw in their system to crop up (Lozancic, 2016).

1. Black Box– Also known as Behavioral Testing, a method of testing wherein software internals/design and implementation is unknown to the tester. Thus, as the name implies, the user cannot see the internal workings of a black box.

2. White Box – Also known as Glass box testing, relies on the internal knowledge of system as a method for testing. Test cases were used to test the internal structure, design, and implementation of the developed system. These test cases are focused on the defined objectives of the study.

III. RESULTS AND DISCUSSION

The system has provided an authentication mechanism by inputting the username and password. A level of privileges was assigned for project leaders and end-users. Figure 2 shows the user login window of the developed system. A form validation was integrated in the system to check that user input is accurate and guarantees that only registered users shall be logged in into the system.

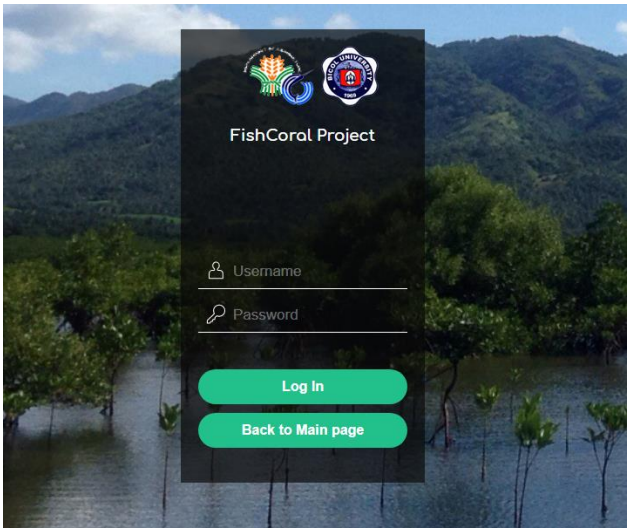


Figure 2. User login window

Each user is given an account processed by the root administrator. This method is a security mechanism that limits the access to authorized users only and increase the level of integrity of the system. In the login process, the user needs to supply the assigned username and password. The web server, having a mutual agreement with the database server, looks into

the records and processes the login request. In the event of invalid user entry, an error message appears prompting the user to supply the valid entries.

The system is classified into several module components. These components are composed of socio-economic assessment, aquatic ecology and habitat assessment, water quality assessment, and capture fisheries resource assessment. Figure 3 shows the interface of the socio-cultural, economic, and institutional/policy components. This allows the user to browse and view the results of the assessment, not limited to demographic characteristics, socio-cultural activities, economic activities, community involvement, and fishing activities.

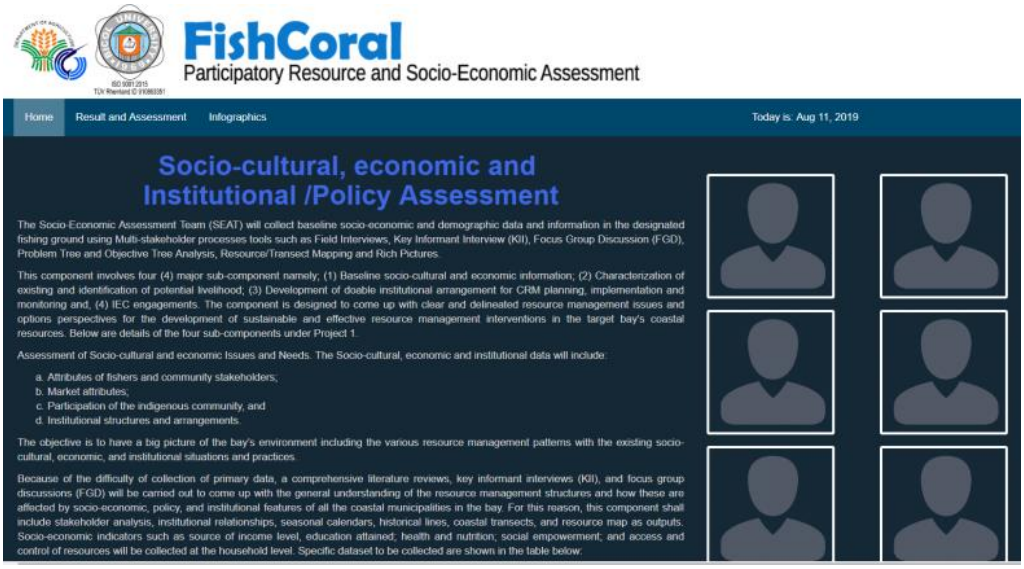


Figure 3. Interface showing the socio-cultural and economic assessment

To capture the information, field inputs are provided and displayed for the project leader's entry. The entries are classified into socio-demographic profile, household members, housing profile, property ownership, economic profile, credit facility, health data, income generating projects, fishing practices/methods and skills, fishing areas, fishing grounds, gleaning activity, marketing of fish, expenditure from fishing, and destructive fishing methods as shown in Figure 4. These category forms are labeled in numeric format and enabled after clicking the "Next" button. If all category forms are ready for submission, clicking the "Submit" button will store the forms into the database.

Information is recorded in summary (not raw data) per barangay starting from the gulf, which served as the key to automatically retrieve the information per province, municipality, and barangay. Field entries are temporarily and will be saved to the master database after submitting the form. This way, in the event of unwarranted system occurrences, no action in the database shall be observed and entertain only those inputs with final form submission.

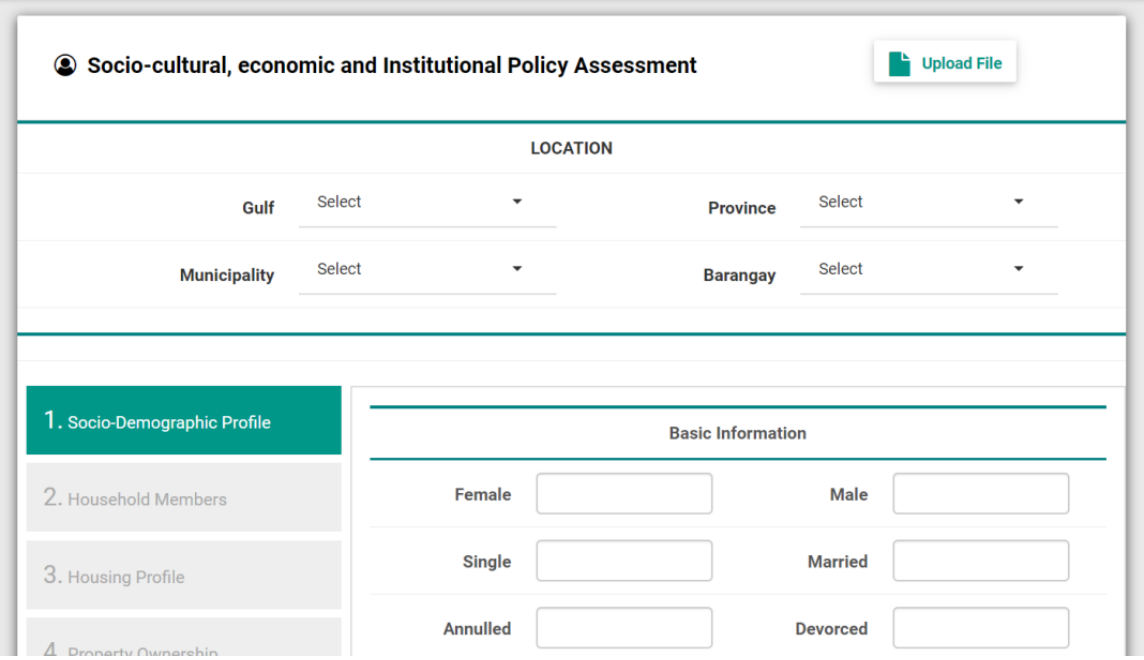


Figure 4. Interface showing field inputs for socio-economic assessment

Project 2 deals with aquatic ecology and habitat assessment. The sampling target sites were based on identified target sites (see Appendices). Shown in Figure 5 is the interface with project leader's privilege. The account has the privilege to insert new record for fish species richness, coral reef (live form), and assessments for mangrove and seagrass/seaweeds. The end-user simply views the information stored in the database. The system provides the user the option to select the name of fish species. The local and scientific name shall be provided when the name of the species is selected. Also, a "+" button was provided to allow repetition of target sampling sites. This eliminates the redundant process of recording similar data by capturing the inputted results from the same sampling target sites. Valid field inputs for sampling sites shall be alphacharacters referring to the actual name of locations where the activity was conducted and number of species as numeric values.

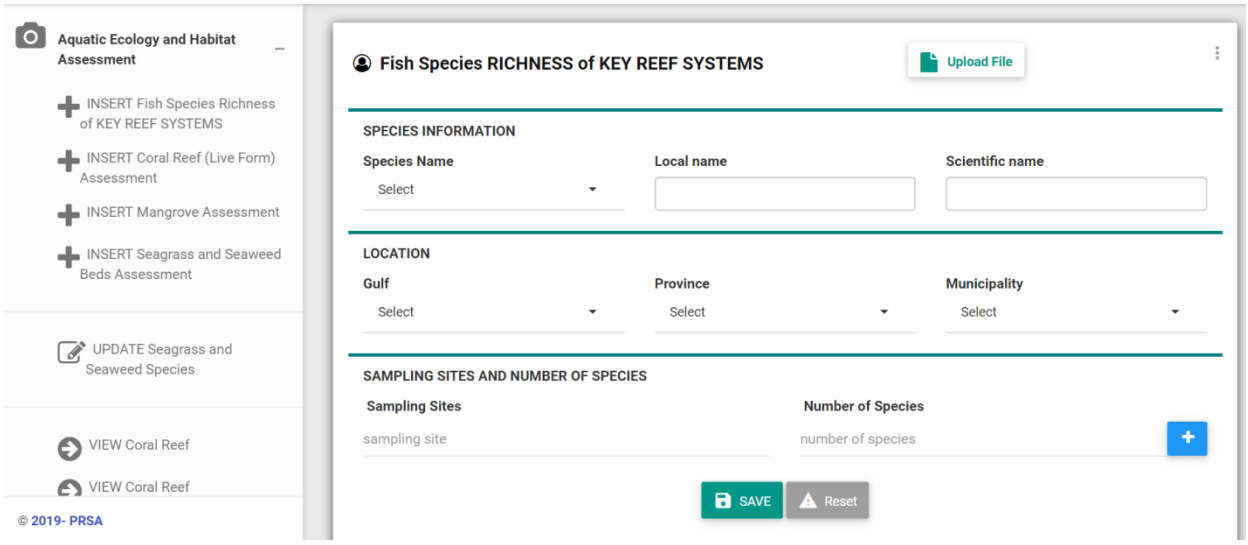


Figure 5. Insert Interface for Fish species richness of key reef systems

The sanctuaries within the gulf are the priority targets for coral assessment. Summary data was considered as the main source for databasing. The parameters are the percentage results of hard corals, soft corals, dead corals, algae, abiotic environment, and TWB (Figure 6).

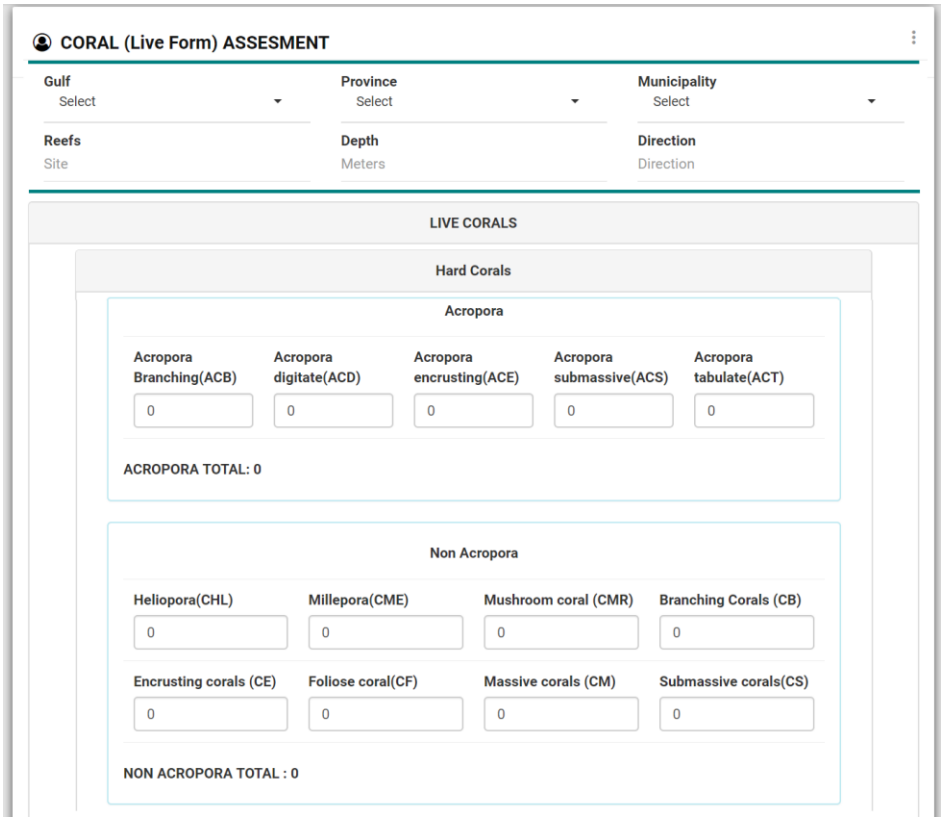


Figure 6. Interface for Coral Assessment Insert records

Basic parameters like target sites (gulf, province, municipality, and barangay), reef, depth, and direction shall be provided. As identified, there shall be constant names for hard corals, dead corals, and others. For hard corals the given names are acropora branching (ACB), acropora digitate (ACD), acropora encrusting (ACE), acropora submassive (ACS), and acropora tabulate (ACT). Other parameters are reflected in the field inputs. The names identified appeared as ease in the interface to directly recognize the label and shall capture the summary data of the sample target sites.

The detail of selected target sites is shown in Figure 7. Presented are the three gulf, each of which could be selected and display the target sampling sites. As in the case of Albay Gulf, the list of cities/municipalities both for Albay and Sorsogon shall be displayed. This allows the user the benefit of selecting and viewing the information. The information includes the total percentage of each parameter per target site.

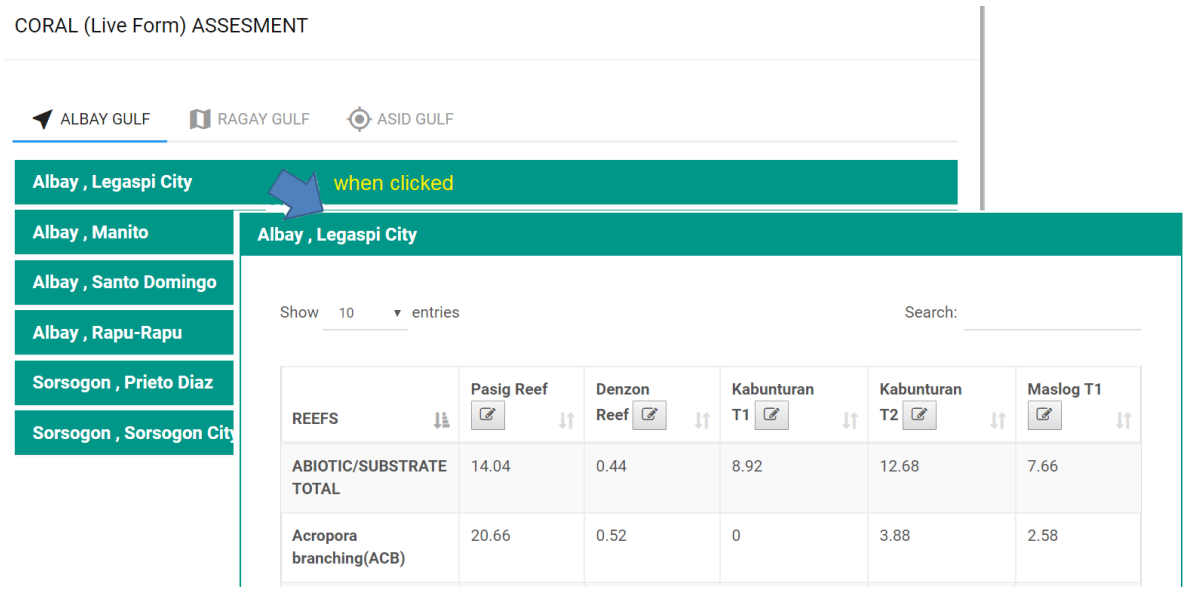


Figure 7. Interface showing the details of selected target site

Same with corals, the ground truthing validation of mangrove was easily identified because of the presence of a GIS map (see Appendix B). The parameters needed to be stored in this module include sampling stations, diversity, density, basal area, and other measures of community structures. Also, the regenerative capacity and zonation patterns of mangrove shall be included. To cater these parameters, Figure 8 shows the interface on how to store the assessment of mangrove in the database. This gives the detailed field inputs covering the above parameters. These field inputs are number of plots, plot area, total sample area, and general comments. Also, the species information is included like species name, number of stands, density, relative density, frequency, relative frequency, basal area, relative dominance, and important values.

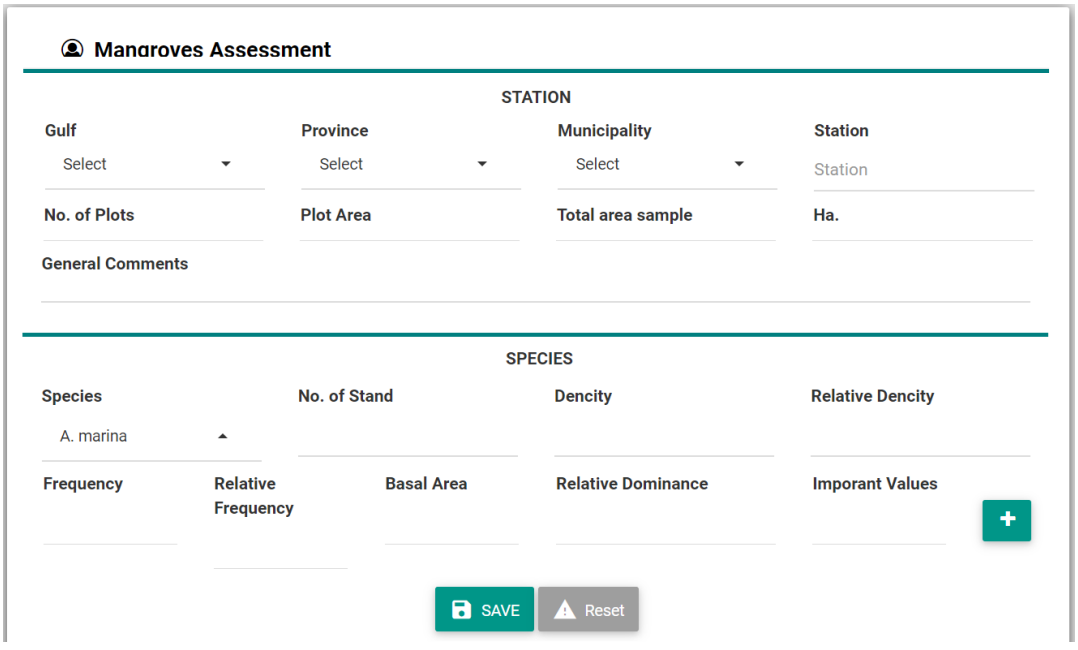


Figure 8. Mangrove Insert record interface

In case of multiple species, add "+" button offers record repetition of species with similar sampling stations. The user shall simply select the species name and values for the parameters. Figure 9 shows the interface of mangrove information per location. The species information depends on the values stored in the database. This information could be printed in csv, Excel, and pdf formats.

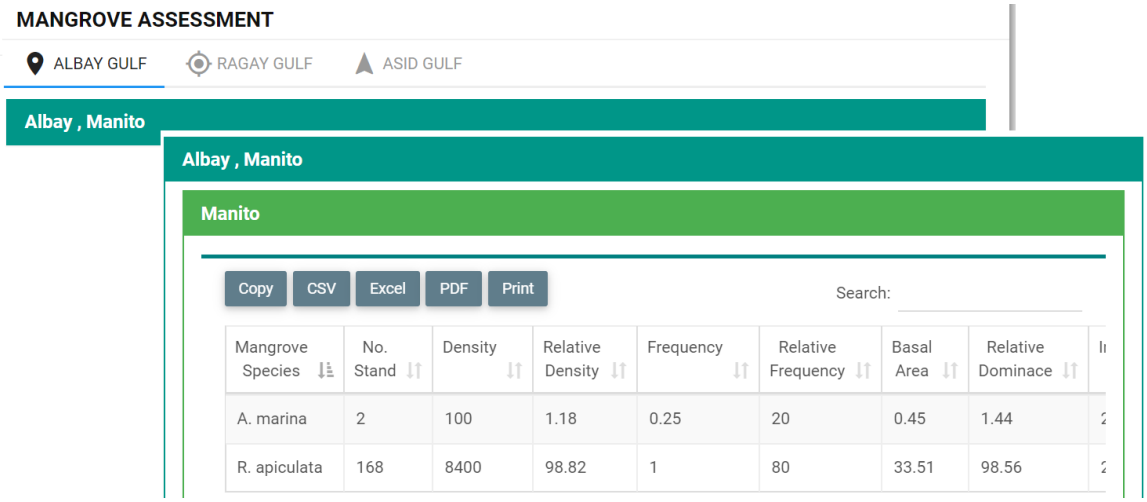


Figure 9. Interface showing the information of Mangrove per location

The location of sampling sites of seagrass and seaweeds was generated by a GIS map application (see Appendix C). The summary data is based on identified sampling sites and the extent of the occurrences of seaweed/seagrass. To capture these parameters for storing in the database, Figure 10 shows the interface for seaweed and seagrass.

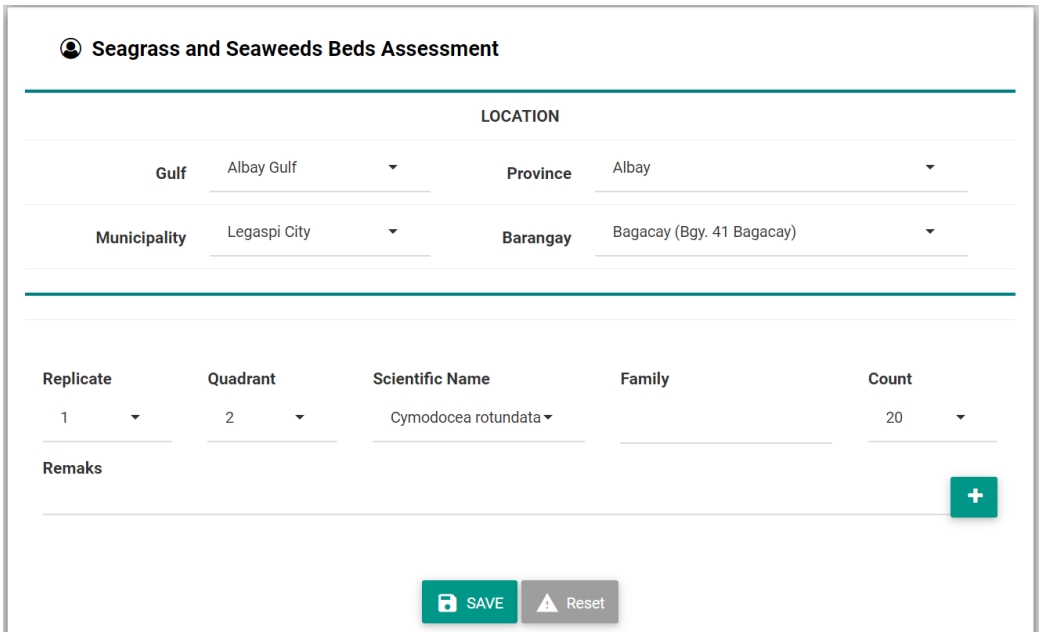


Figure 10. Seaweed/Seagrass Interface

Given the location, the needed input values are summarized data parameters for replicate, quadrant, scientific name, family, number of counts and remarks. These parameters can be repeated without leaving the page and will be stored in the database once the form is submitted.

In case of empty entries and modification to current values, the system has provided actions on how to update the field entries. Figure 11 shows the interface in updating the records.

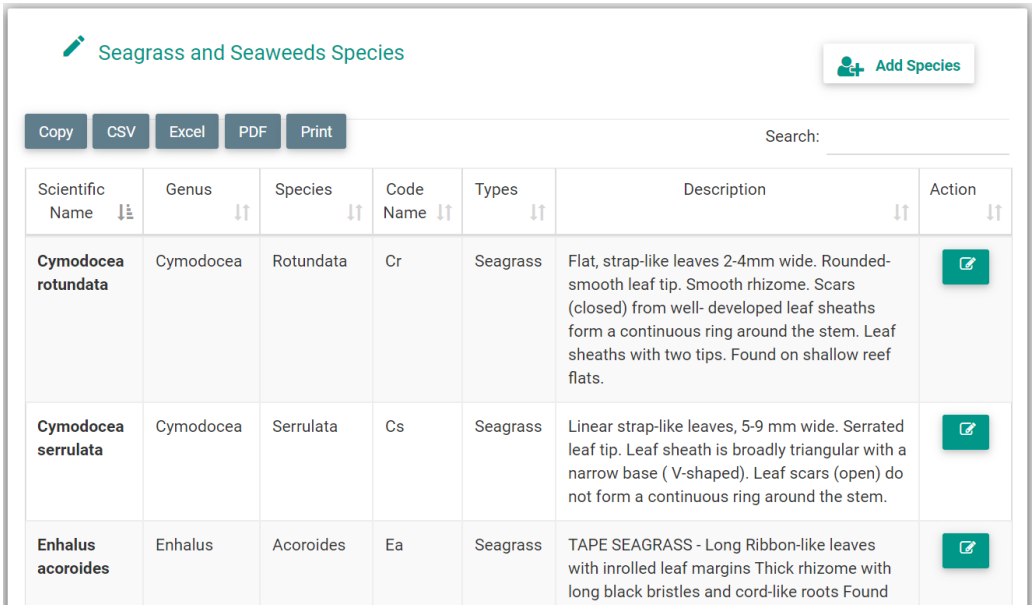


Figure 11. Update interface for Seaweed and Seagrass

By clicking the update button, an update interface shall appear, allowing the user to make the necessary updates. It is essential to have this interface because sometimes users do not have the final values and simply jump to the next entries and simply return to it if values become available. The update feature changes the records in the database.

The reports capturing the location and extent of occurrence of sea grass and seaweed beds are also recorded and can be printed in text or in graphical format (Figure 12). The report is displayed in two sections, namely frequency and average biomass covered. The frequency section displays the count of family species spotted in each quadrant.

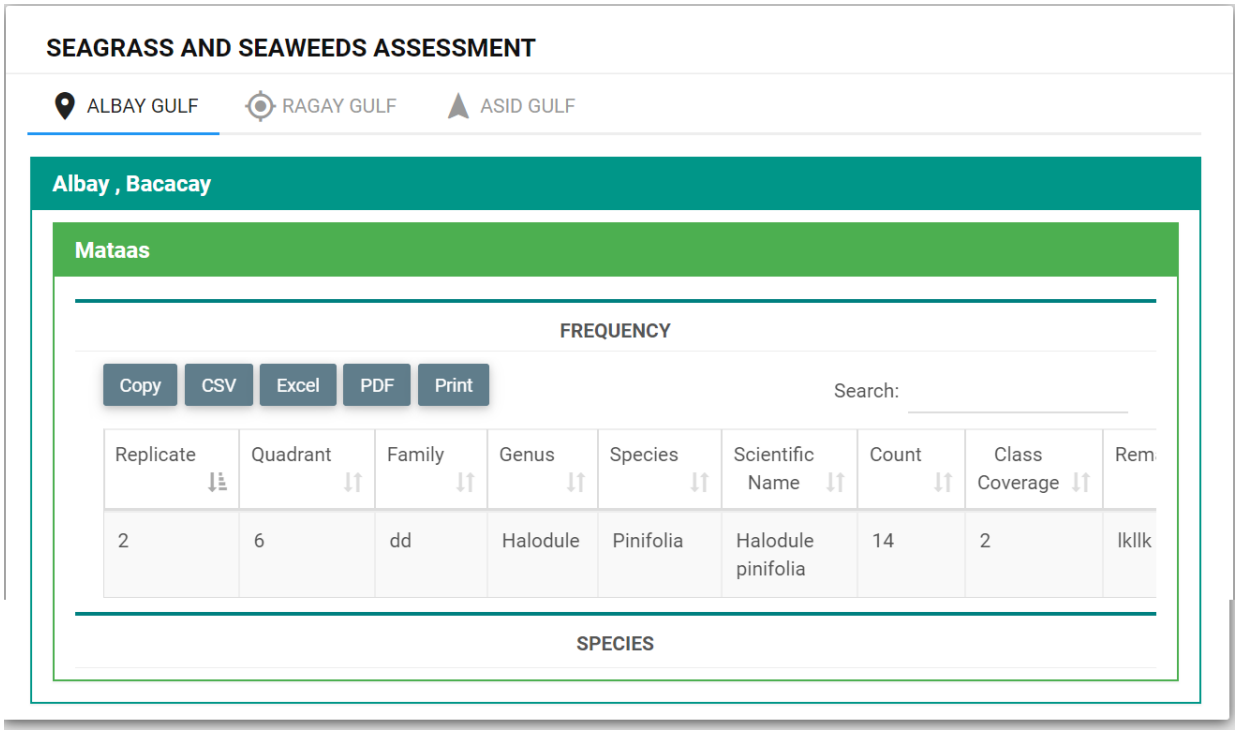


Figure 12. Sample Frequency of seaweed and sea grass species richness in Albay Gulf

The water quality assessment results are obtained from the given parameters as outlined in Department Order No. 2016-08, which were set as minimum water quality parameters. Based on the water quality guidelines (WQG), the enumerated parameters are 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).

Results can be uploaded in Excel format or typed-in using a form submission template, as shown in Figure 13. Entries should be in number values, and negative values are also accepted. The system also recognizes NULL and zero entries for each parameter.

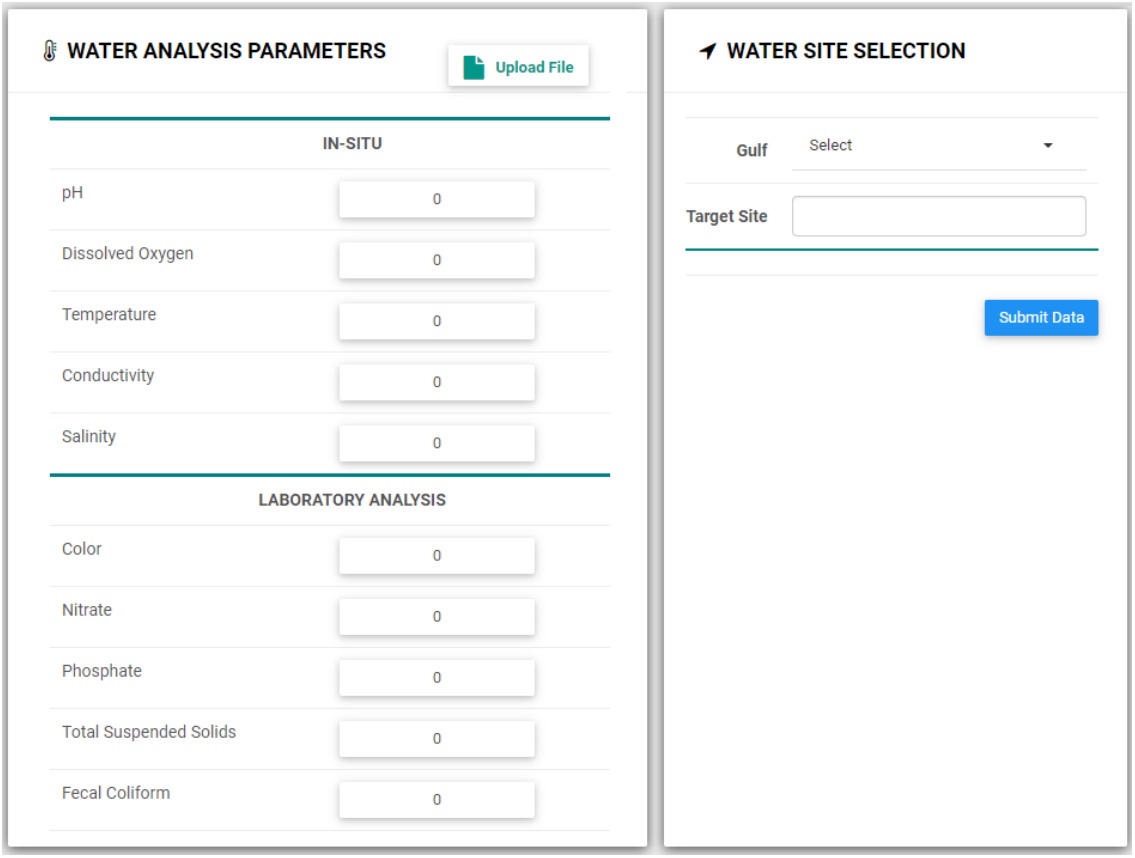


Figure 13. Interface for adding water quality assessment report

Figure 14 shows the interface for updating water quality assessment records. The records can be printed in csv, Excel, and pdf formats. Information details include location, in-situ, and laboratory analysis.

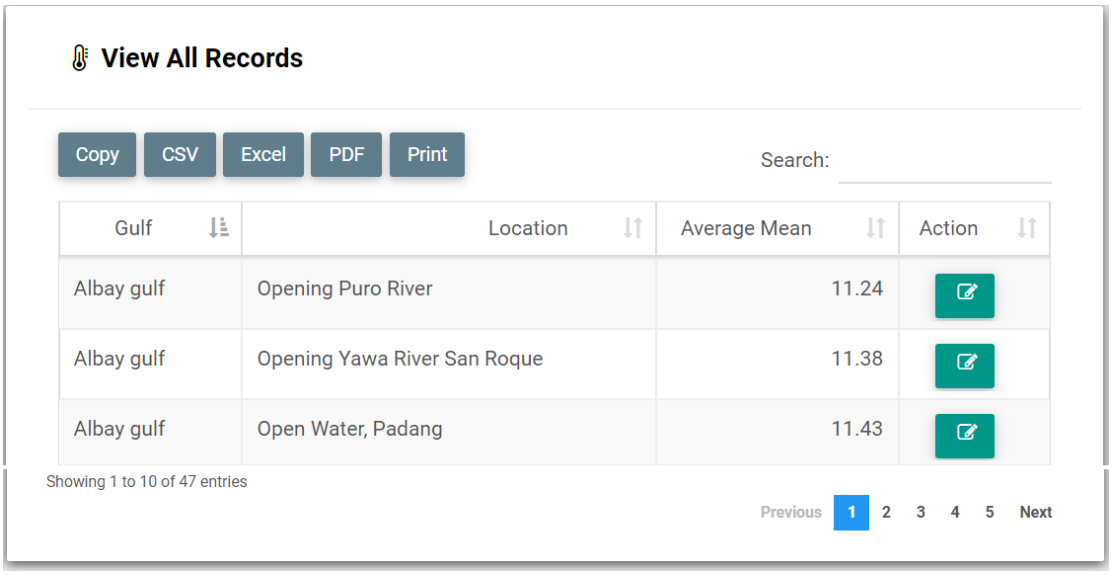
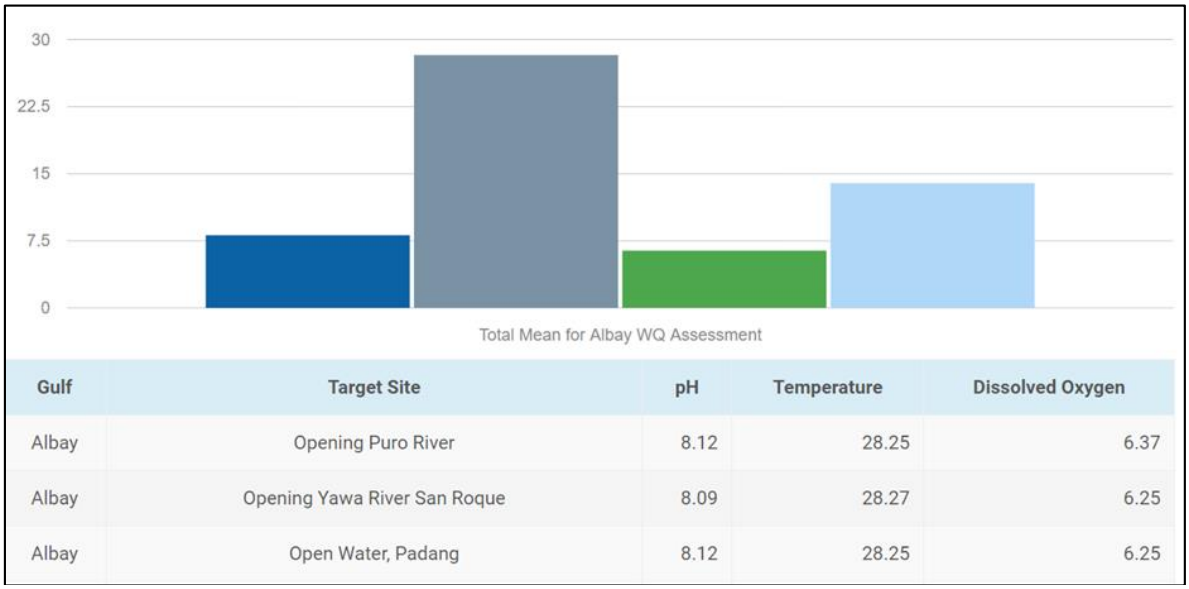


Figure 14. Update interface for water quality

Also, there is a provision to display the results in bar graph (shown in Figure 15). The figure shows the total mean of water quality per parameter. The records shown presented the overall data per location. These data are dependent on database records. The primary key was set to gulf and using the data tables, records are paginated, allowing the user to view the records in ascending and descending order.



Gulf	Target Site	pH	Temperature	Dissolved Oxygen
Albay	Opening Puro River	8.12	28.25	6.37
Albay	Opening Yawa River San Roque	8.09	28.27	6.25
Albay	Open Water, Padang	8.12	28.25	6.25

Figure 15. Graph showing the total mean of Albay gulf Water Quality Assessment

The captured fisheries resource assessment (Project 4) deals with fishing gear inventory, catch and fish landing statistics, catch per unit effort (CPUE) of fishing gears, and fisheries production disaggregated by dominant species, by municipalities, and by fishing gears. To capture the data, an applicable interface shall be provided. Figure 16 shows the interface for adding capture fisheries resource assessment.

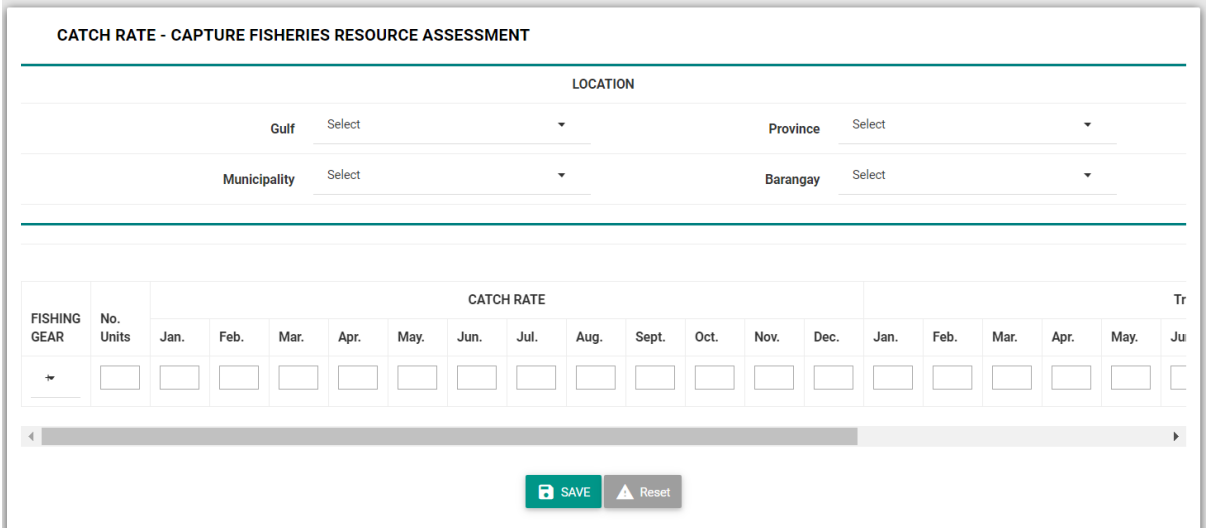
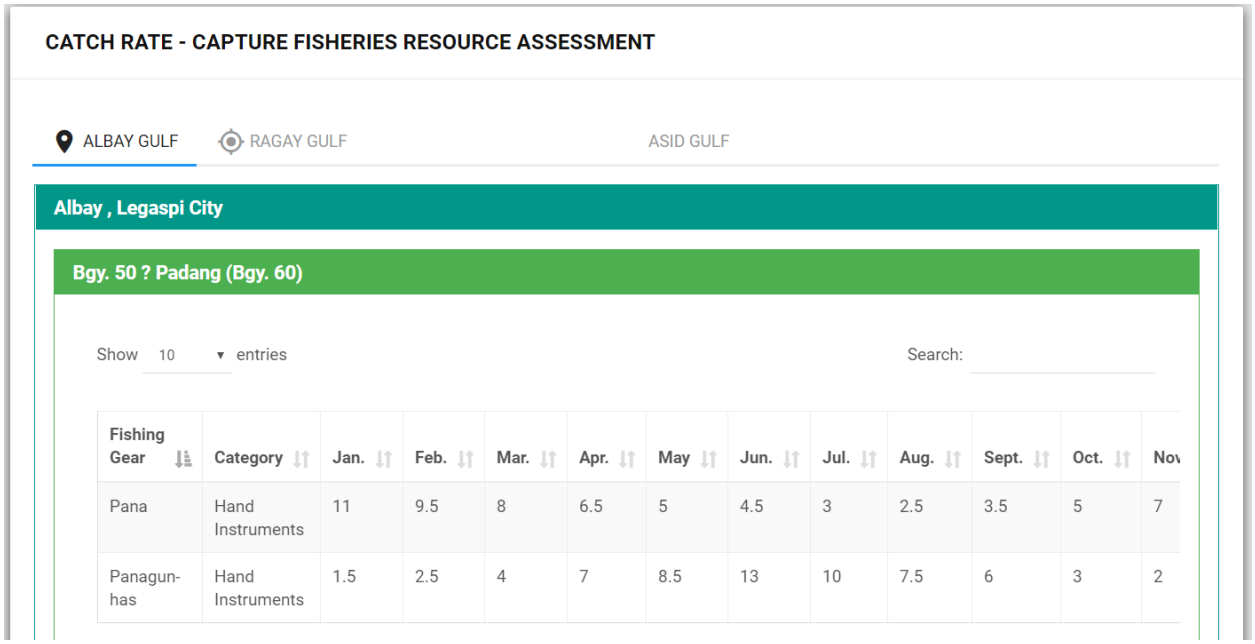


Figure 16. Interface for adding capture fisheries resource assessment report

Similarly, the results to be captured from capture fisheries resource assessment includes a "+" button. But, in the iteration process, the catch rate and trips per month are represented

by month. This allows the system to 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).

Report generation plays an integral role that supports the functional requirements and validates information consistencies of the system. Figure 17 shows the capture fisheries resource assessment report of the different target sites.



Fishing Gear	Category	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov
Pana	Hand Instruments	11	9.5	8	6.5	5	4.5	3	2.5	3.5	5	7
Panagun-has	Hand Instruments	1.5	2.5	4	7	8.5	13	10	7.5	6	3	2

Figure 17. Catch rate of capture fisheries in Albay gulf

The report displays the inventory of fishing gear specific to a target site. Other information includes catch and fish landing statistics, catch per unit effort (CPUE) of fishing gears, and fisheries production disaggregated by dominant species, by municipality, and by fishing gears. Likewise, boat inventory is included as part of the gear inventory, which displays the types of fishing vessel used, gross tonnage, and horsepower per municipality.

System Evaluation

The study used software testing (white/black box) methods to analyze and validate the internal structures and functionalities of the system components, including the full visibility of the logic and code structures. Test cases were constructed based on system program codes and used branching and statement testing for white box testing to validate the specific requirement of the system. Table 1 shows the results of branch testing after evaluating the test cases. The design of test cases was specific 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 system used applicable local and global variables necessary to determine the scope of the variables. These variables, together with other parameters were used as reference to execute the procedure. The identified test cases represented the majority of the processes involved in storing data entries, error message alert, sql queries, collecting data values, and transform these values to graphical representation (Table 2.

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

Results of the Black Box testing showed that the features of the developed system were effective and 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 generate the expected results of each component.

Table 3. Results of Black box testing

Test ID	Description	Actual Results
1	The system provided information for acceptable values	PASSED
2	Values are accepted based on given entry label and in case of unfilled entries an error message displayed	PASSED
3	Only authorized user can add information, but did not limit to view the information of other project components	PASSED
4	When user clicked the Save or Submit button the system responded and prompted an alert message	PASSED
5	Printing of reports are included and available when needed	PASSED

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

IV. CONCLUSIONS AND RECOMMENDATIONS

In order to provide efficiency in handling complex types of data, it is necessary to develop and adapt an information system (IS). This paper discusses the development of a system designed to manage multiple types of data for resource and socio-economic assessment. System access was validated through varying levels of user privileges and provided security procedures for invalid user requests. An interface and discussion for project components were also provided. Each project leader can view the records of the different project components.

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 affect coastal habitats 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.

VI. REFERENCES

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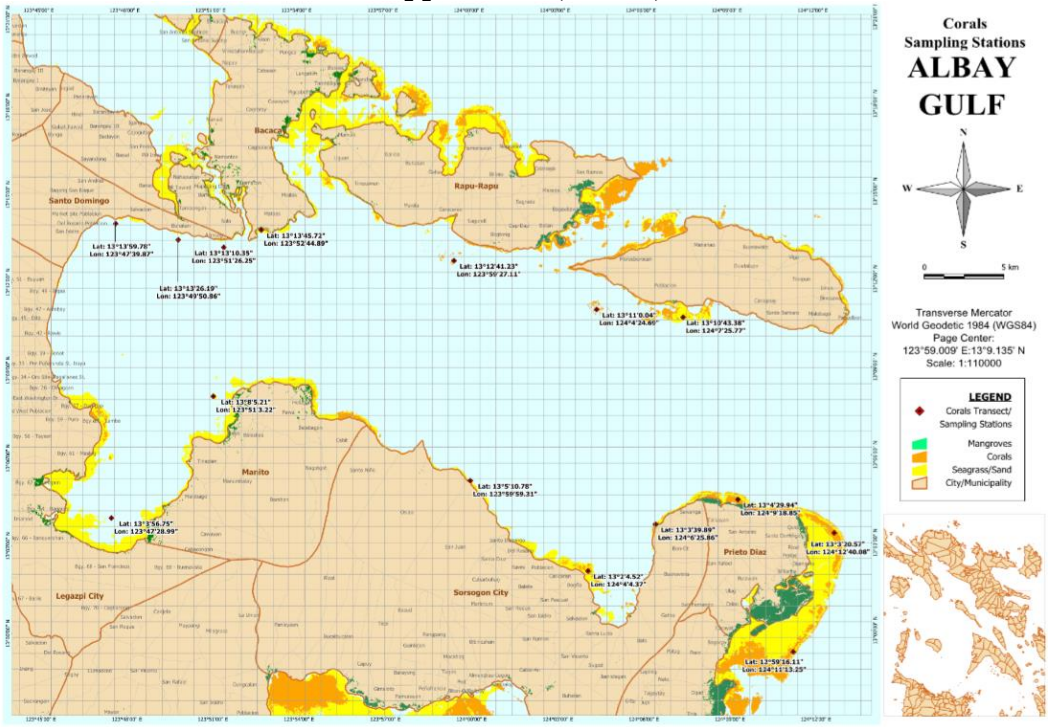
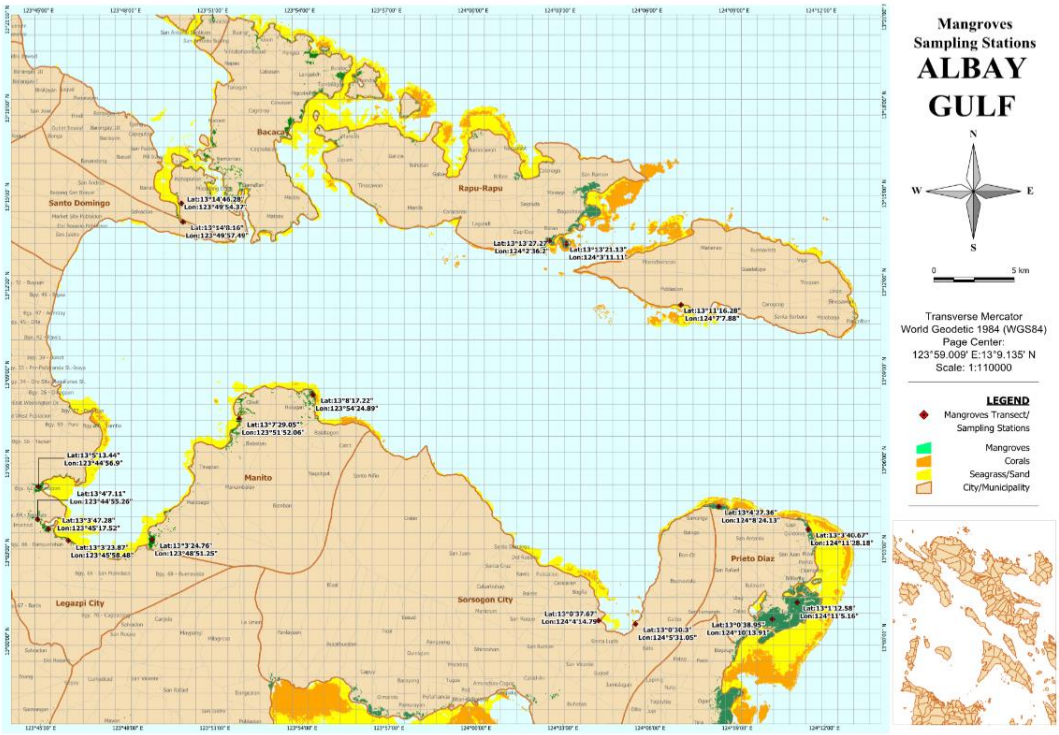
APPENDICES

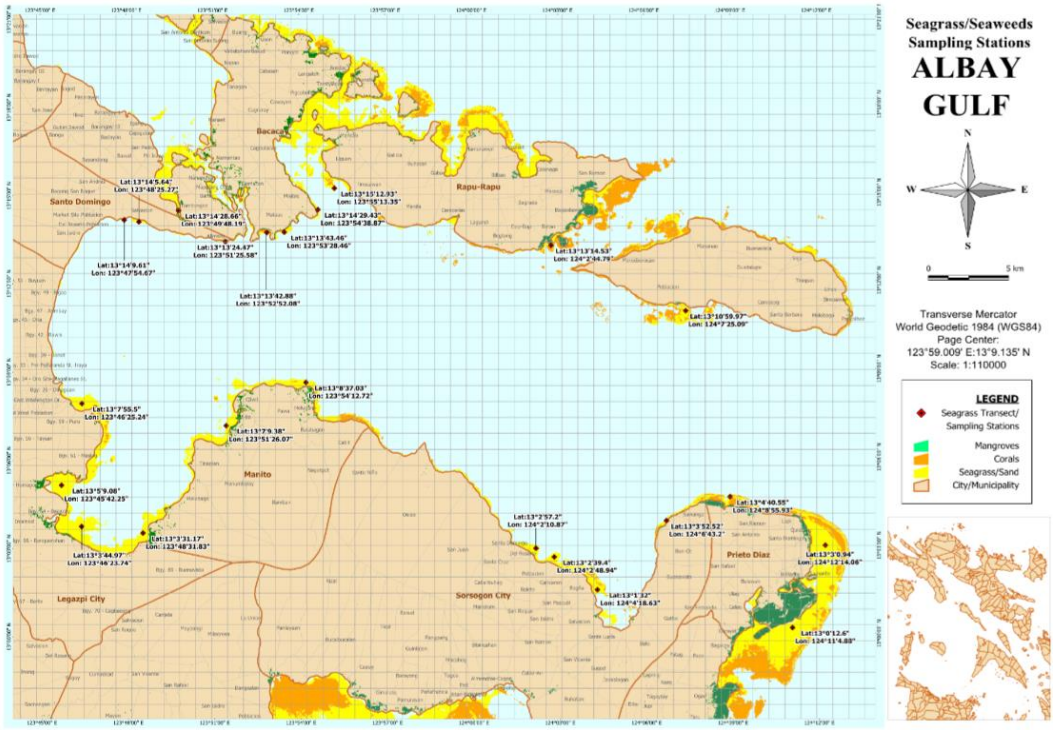
Appendix A (Corals)



Appendix B (Mangrove)



Appendix C (SeaGrass/SeaWeed)



Appendix D (Water Quality)