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Ecosystem services of coastal and fisheries resources: Perspectives of high school students in Municipality of Panukulan, Polillo Island, Quezon, Philippines

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Abstract The study was conducted among three hundred thirty-one (331) high school students (representing 83.59% of the total registered high school students) of Libo National High School in Barangay Libo, Municipality of Panukulan, Polillo Island, Quezon, Philippines, to assess their perception and understanding on the ecosystem functions and services, causes of degradation and destruction, and socio-economic importance of mangroves, seagrasses and coral reefs. Their perception, level of concern, and attitude on local environmental condition, socio-economic, and environmental issues were also determined. Results showed that the students were most knowledgeable on habitat, nursery and breeding ground function of seagrasses and coral reefs, and coastal protection function of mangroves. Majority of the students identified illegal fishing practices, uncontrolled wood harvesting and reclamation as major causes of degradation of coral reefs, mangroves and seagrasses, respectively. However, the students seem to be not familiar or less knowledgeable on the impact of climate change and upland anthropogenic activities to coastal ecosystems. This showed that the students were not able to reflect on the interconnectedness of upland and coastal ecosystems. The study also showed that the students were highly concerned about the quality of water in their traditional drinking wells and springs, degradation of mangroves due to uncontrolled wood cutting, and destruction of coral reef cover due to dynamite fishing. Furthermore, this study showed that the students have a positive environmental attitude, as well as

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awareness on social and environmental responsibility, and that they will likely participate in coastal resources management activities.

Introduction

The ecosystem goods and services of upland forest and marine resources including mangroves, seagrasses and coral reefs are critically important to the livelihood of many isolated island communities, most especially the fishing communities living close to these resources. The coastal environment where mangroves, seagrasses and coral reefs are located is a highly productive and biologically complex ecosystem (Cabili and Cuevas, 2016; Sinfuego and Buot, 2014; Cabili and Cuevas, 2011, 2010). As a productive ecosystem, it sustains many biological communities including many coastal human communities by providing a range of services namely provisioning services (food, fisheries catch, water, timber and fiber), regulating services (regulation of climate, protection from storm, shoreline protection, control of diseases, wastes processing, water and air quality maintenance), cultural services (recreational, aesthetic, and spiritual) and supporting services (soil formation, photosynthesis, nutrient cycling) (UNEP, 2006; UNEP-WCMC, 2006). These benefits that people derive from coastal and marine ecosystems are recognized by the 2005 Millenium Ecosystem Assessment (MEA) as ecosystem goods and services (UNEP, 2006).

Despite their important contributions to human welfare, the coastal ecosystems have suffered from irreversible damage at an alarming rate mainly due to unsustainable anthropogenic activities and previous policies on economic development priorities. The important drivers of coastal ecosystem degradation and loss according to MEA are population growth, land use change and habitat loss, overfishing and destructive fishing methods, illegal fishing, invasive species, climate change, subsidies, eutrophication, pollution, technology change, globalization, increased demand for food, and a shift in food preferences.

On the other hand, while economic development is perceived as beneficial to human well-being, harmonizing economic activities while sustaining ecosystem integrity remains a challenge. Past government economic policy instruments and management interventions failed to balance conservation and development goals but instead created justifications for maximizing economic gains and underestimated environmental preservation. For instance, the Fisheries Act 4003 granted municipal government the authority to grant exclusive privilege of erecting fish corrals, constructing and operating fishponds or oyster culture beds, taking or catching *bangus* fry or fry of other species. Another law which served as the backbone of Philippine fisheries legislation (up to early 1998) is the Fisheries Decree of 1975 which promoted maximum economic utilization of fishery production and strengthened fish products exportation as a national development strategy (Batongbacal, 2002). These fisheries legislation created favorable economic policies to commercial fishing operators and granted subsidies, incentives, tax exemptions and low tariff rates that resulted in more intense fishing pressure using production efficient fishing technologies, overexploitation of nearshore and offshore fisheries resources. All these resulted in the reduction of population of juvenile fish stock and conversion of coastal habitats into aquaculture and fish ponds. The depletion of our fishery resources is exacerbated by inefficient and market driven development strategy and poor post-harvest facilities contributing to intensified poverty among municipal fishermen, social conflict, inequitable distribution of the benefits and further degradation of unexploited fisheries resources (Aliño et al., 2004).

Over the past decades, the upland forest, wetlands, and fisheries resources of Polillo Island have been altered due to population growth, unsustainable resource utilization, and inequitable and inefficient economic policies. For instance, during the late 1960s to the late 1970s, logging companies were allowed to conduct logging operations to harvest hardwood trees in the lowland forests of Polillo Island (Polillo Islands Biodiversity Conservation Foundation Inc., 2012, 2010). In addition, population congestion consequently led to competition for scarce resources such as space for human settlement, agricultural production, and productive fishing grounds. Moreover, because of high resource dependence, seasonality of traditional occupation, and absence of alternative livelihood opportunities, local people are left with no choice but to make fishing and resource harvesting as profitable as possible by using cheap but destructive technology, more frequent resource harvesting, and non-compliance to environmental laws. These unsustainable activities have negative impact to the biodiversity and environmental quality of Polillo Island.

Assessing the resource users' level of ecological knowledge, perception on local environmental condition, concern on local environmental issues, and attitude on socio-economic and environmental issues living adjacent to upland forest, coastal and fisheries resources is imperative because they can act as local environmental stewards or efficient agents of environmental degradation. Moreover, the ecological knowledge and attitudinal characteristics of local resource users, most especially the younger generation, can provide useful information that can be integrated in the current environmental management strategies and in the development of future environmental management strategies. The younger generation (in this study, they were the students in the high school level) who will become adults of the future must be informed, educated and recruited as environmental stewards to instill appreciation of their coastal and marine environment, secure the continuous flow of benefits of the ecosystem goods and services, and to ensure the welfare of future generations. In this study, we hypothesized that the knowledge and familiarity of students to their coastal and fisheries resources were due to their direct experiences and activities such as swimming, boating and gathering of marine organisms in the coastal zone. Furthermore, their guardians and parents, who are mostly fishers, are important source of traditional ecological knowledge.

With this premise, the present study aims to assess the perception of high school students in a school in Panukulan, Polillo Island, Quezon, Philippines, on the ecosystem functions and services of mangroves, seagrasses and coral reefs, the causes of destruction and degradation of the ecosystems, and their socio-economic importance. Another aim of this study is to determine their perception, level of concern, and attitude on local environmental problems and issues affecting the quality of their local environment. To the best of our knowledge this study is one of few to assess the environmental knowledge, perception and environmental attitude of high school students in an isolated island who will become the future citizens and environmental caretakers in the area. The results of this work can be used as input for improving environmental education in remote islands like Polillo Island and other island municipalities in the Philippines. Furthermore, this study can be used as input to develop appropriate mechanisms and management interventions for coastal resource management in the area in the future.

Methodology

Study area

The study was conducted in Libo National High School (LNHS) in Barangay Libo, Municipality of Panukulan, Polillo Island (Fig. 1), Quezon Province on November 6 and 7, 2014. LNHS has the largest high school student population in Municipality of Panukulan. The Municipality of Panukulan is a fifth class coastal municipality in northern Polillo Island. Barangay Libo is a small fishing village located at the northern tip of Polillo Island. It is bounded by Barangay Pag-itan, Barangay Kinalagti and Barangay Pandan. The name *libo* originated from the word *lobo* or balloon which is a favorate toy of *Dumagat*. *Dumagat* refers to a native group of people who were the first occupants of Polillo Island (Barangay Profile of Libo, Panukulan, no date).

Survey questionnaire

A survey using a questionnaire was done to assess the knowledge of students of LNHS on (a) ecosystem functions and services of mangroves, seagrasses and coral reefs, (b) causes of degradation and destruction of mangroves, seagrasses and coral reefs, (c) ecological and socio-economic importance of mangroves, seagrasses and coral reefs, (d) perception on local environmental conditions, (e) level of concern on local environmental issues, and (f) pro-environmentalist attitude. The questionnaire was pre-tested on 420 randomly selected high school students of Manuel G. Araullo High School, Manila, on September 2014 to assess reliability of instrument. Three hundred and thirty-one (331) high school students were present during the survey (representing 83.59% of the total registered high school students of LNHS) enrolled in Grade 7 or first year level (82 students), Grade 8 or second year level (77 students), Grade 9 or third year level (89 students) and Fourth Year (83 students) participated in this study (Fig. 2). At the time of the study, the Philippines' Department of Education implemented Republic Act Number 10533 or the Enhanced Basic Education Act of 2013 wherein the high school students were grouped as Grade 7 (first year level), Grade 8 (second year level), Grade 9 (third year level), and Grade 10 (fourth year level). During the study, the fourth year level was not called Grade 10, but for the purpose of this study, Grade 10 will be used to refer to fourth year students.

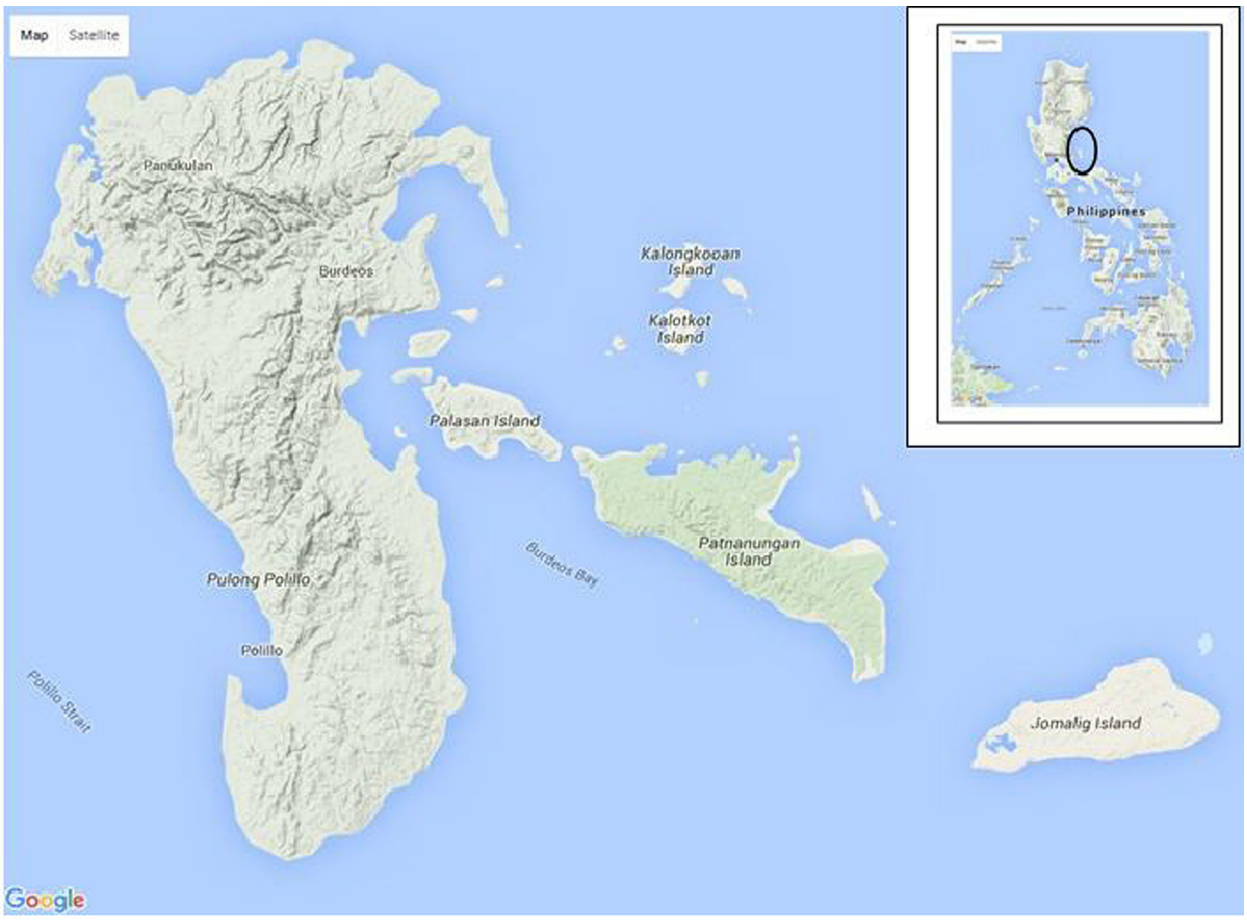
The profile of the students is as follows: the age per grade level was Grade 7 (mean = 12.90), Grade 8 (mean = 14.90), Grade 9 (mean = 15.21), and Grade 10 (mean = 16.58), while the mean age of all students was 14.75 (standard deviation = 1.826). Fifty-seven percent were female and 42% of the students were residents of Barangay Libo. Other students came from Barangay Kinalagti (17.82%), Barangay Pandan (12.08%), Barangay Matangkap (10.57%), Barangay Lipata (3.63%), Barangay Balungay (1.81%), Barangay Pag-itan (10.57%), Barangay Bato (0.60%), Barangay Pinag-agan (0.60%), and Barangay Rizal (0.60%) in Municipality of Burdeos.

For the purpose of this study, knowledge refers to the high school students' understanding of the ecosystem functions and services of mangroves, sea grasses and coral reefs, causes of their degradation and/or destruction, and ecological and socio-economic importance. Awareness is defined as "concern and sensitivity towards the environment and its problems", while attitude is defined as the "acquisition of values, feelings of concerns and motivations towards the participation of environmental improvement and protection" (UNESCO Intergovernmental Conference on Environmental Education, cited by Dela Vega (2004).

The survey questionnaires were answered by Grade 7, Grade 8, Grade 9 and Grade 10 students. The questionnaire consisted of 6 sections. Section A, B and C were answerable with a Yes/No (Agree = 1, Disagree = 2). Section A of the survey questionnaire was on ecosystem functions and services of mangroves, seagrasses and coral reefs while Section B was on the causes of degradation/destruction of mangroves, seagrasses and coral reefs and Section C was on the ecological and socioeconomic importance of mangroves, seagrasses and coral reefs. Section D used a four-point Likert scale response (1 = Much Worse, 2 = Worse, 3 = Better, to 4 = Much Better) to assess their perception to changes in the environmental conditions. Section E used a four-point Likert scale response (1 = Not Concerned at all, 2 = Somewhat Concerned, 3 = Concerned, 4 = Very Concerned) to assess their level of concern on five local environmental problems. This was interpreted as "low" (1.00–1.74), "moderate" (1.75–2.49), "high" (2.50–3.24), and "very high" (3.25–4.00). Finally, Section F used a four-point Likert-type response scale (4 = Strongly Agree, 3 = Agree, 2 = Disagree, 1 = Strongly Disagree) to assess their perception to some local coastal and fisheries issues. This was interpreted as "low" (1.00–1.74), "moderate" (1.75–2.49), "high" (2.50–3.24), and "very high" (3.25–4.00). The students were given a package consisting of a pencil, rubber eraser, pencil sharpener and pocket notebook. The students completed the questionnaire in about 30 min.

Statistical analysis

Data were analyzed using MiniTab version 17. Mean and standard deviation were used to describe students' profile, level of knowledge, awareness and attitude. One-way analysis of variance (ANOVA) and Tukey pairwise comparison was interpreted at $p < 0.05$.



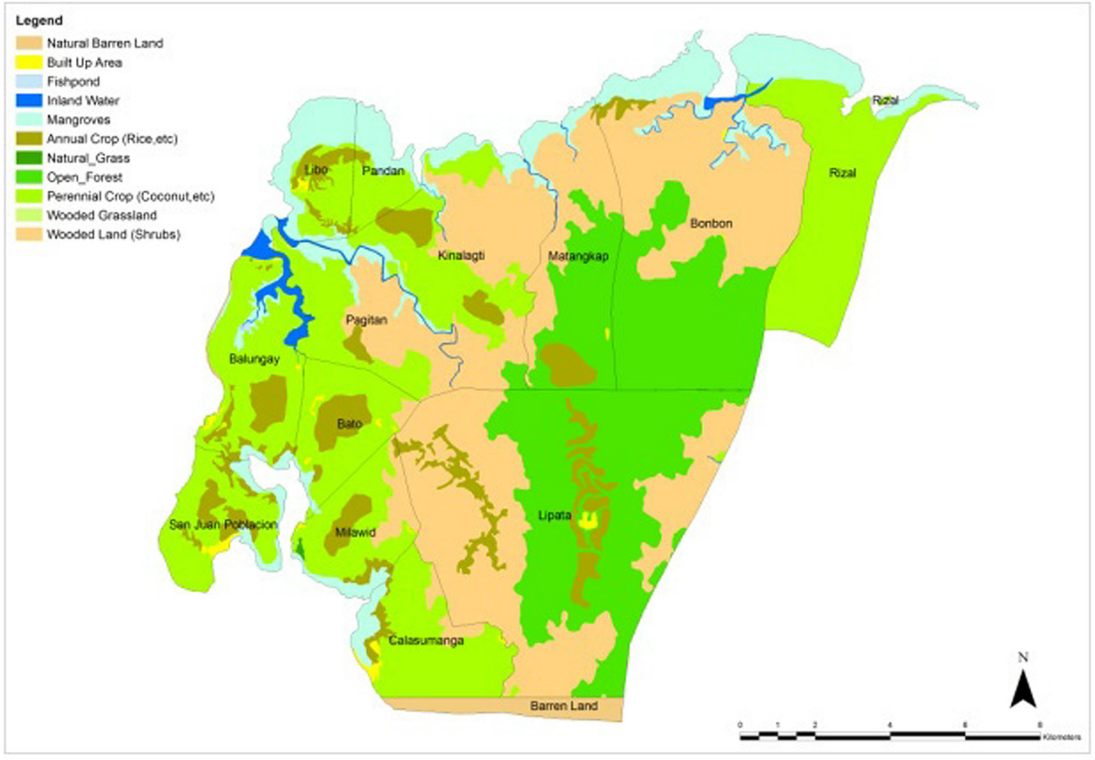


Fig. 1 Location of Polillo Island in the Philippine map (above). Map of Municipality of Panukulan in Polillo Island showing the location of Barangay Balungay, Barangay Bato, Barangay Bonbon, Barangay Calasumanga, Barangay Kinalagti, Barangay Libo (where this study was conducted), Barangay Lipata, Barangay Matangkap, Barangay Milawid, Barangay Pag-itan, Barangay Pandan, and Barangay San Juan. (Note: Barangay is the smallest administrative division in the Philippines) (below).

Fig. 2 The students of Libo National High School while answering the survey questionnaire. (a) Grade 10 students, (b) Grade 9 students, (c) Grade 8 students, and (d) Grade 7 students.

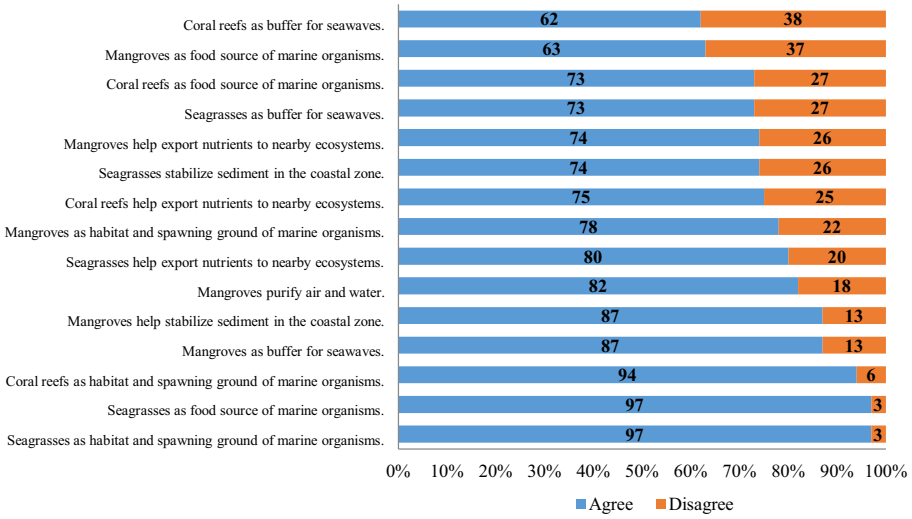


Fig. 3 The response of students (in percentage) when asked to agree or disagree on the different ecosystem function and services of seagrasses, mangroves and coral reefs ($n = 331$).

Results and discussion

Knowledge on ecosystem functions and services of mangroves, seagrasses and coral reefs

As presented in Fig. 3, the students were very familiar with the following ecosystem functions: habitat function (97%) and food source function (97%) of seagrasses, wave protection (87%) and coastal zone stabilization function (87%) of mangroves, and habitat function (94%) of coral reefs. On the other hand, the students were less familiar with the following functions: coastal zone stabilization function (74%) and nutrient export function of seagrasses (73%), food source function of mangroves (63%), and defense function of coral reefs against large and strong sea waves (62%). The possible explanation is that these ecosystem functions are difficult to imagine by the students, not very visible, and are more scientific. In

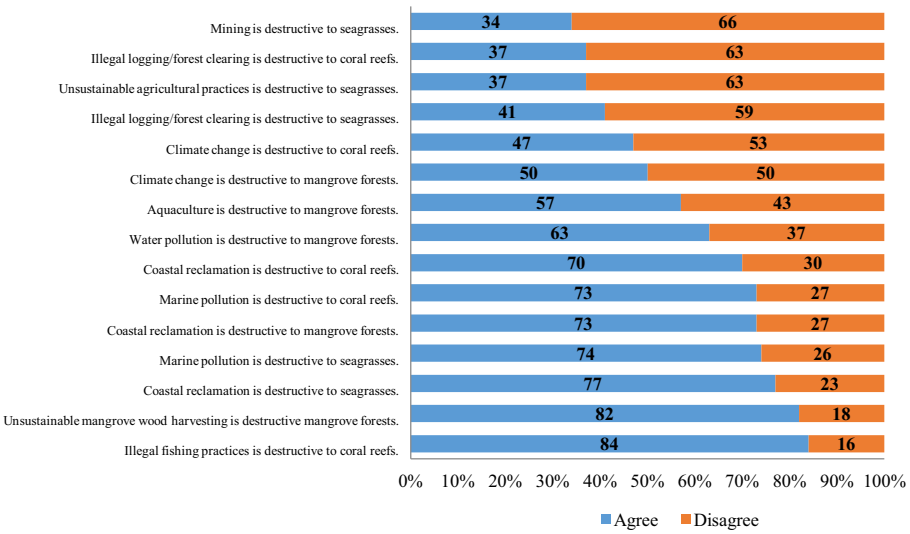


Fig. 4 The response of students (in percentage) when asked to agree or disagree on the causes of degradation or destruction of seagrasses, mangroves, and coral reefs ($n = 331$).

general, the students were highly familiar and have high knowledge on the ecological functions and services of mangroves, seagrasses and coral reefs.

Among the ecosystem services of coastal ecosystems to human society are recreational services (UNEP, 2014; Cruz-Trinidad et al., 2011; Ahmed et al., 2007; Samonte-Tan et al., 2007), habitats for terrestrial and marine fauna (Nagelkerken et al., 2008; Nickerson, 1999), food and nutrition (Baker et al., 2015; Cruz-Trinidad et al., 2011; White et al., 2000), coastal protection from storm surge (Barbier, 2015; Zhang et al., 2012), sea waves (Hashim and Catherine, 2013; Bao, 2011), tsunami (Alongi, 2008; Kathiresan and Rajendran, 2005), sea level rise during high tide, and strong wind (Das and Crepin, 2013), mitigation of coastal erosion (Thampanya et al., 2006), air and water quality maintenance and cleansing services (Sandilyan and Kathiresan, 2014). In addition, a greater understanding of the potential of seagrasses and mangroves (Venturillo, 2016; Gevaña et al., 2008) to sequester atmospheric carbon at a faster rate than terrestrial forests (Beaumont et al., 2014; Macreadie et al., 2014) is gaining global interest for mitigating climate change, creating incentives for coastal resources conservation and restoration efforts. Given these diverse ecosystem services, the coastal environment provides significant inputs which are important for the well-being of human population and economic opportunities to many traditional subsistence economies.

Knowledge on the causes of degradation and destruction of mangroves, seagrasses and coral reefs

As presented in Fig. 4, the students were more familiar on the following causes of destruction and degradation: coastal zone reclamation for seagrasses (77%), excessive wood harvesting for mangroves (82%), and dynamite and cyanide fishing for coral reefs (84%). On the other hand, the students thought that the following anthropogenic activities could not be destructive or less destructive to seagrasses, mangroves and coral reefs: mining (34%), climate change (50%) and illegal logging (37%), respectively. It was also observed that less than

Fig. 5 A former mangrove area was reclaimed for human habitation.

50% of students agreed that illegal logging (41%), mining (34%) and unsustainable agricultural practices (37%) were destructive to seagrasses. Similarly, a low number of students thought that illegal logging (37%) and climate change (47%) were drivers of coral reef destruction, while around 50% of the students thought that aquaculture and climate change were destructive to mangrove forest. This study showed that the students were not familiar or has limited knowledge on the impact of mining, illegal logging, agriculture, and climate change on coastal ecosystems. One possible reason is that the impact of climate change and unsustainable human activities could be less visible in the area. Another possible explanation is that they have limited knowledge on ecosystem structure, dynamics, and interconnectedness of upland forest and mangrove ecosystem to seagrasses and coral reef ecosystems.

Technological improvements in marine transportation, migration, and tourism have transformed Polillo Island from an isolated, low density island community into a populated

Fig. 6 Due to illegal logging activities, the upland became more vulnerable to surface run-off and soil erosion during rainfall event. Soil surface run-off deteriorated the sea water quality and fringing coral reefs.

community. This socio-economic change led to increased demand of land for human habitation, food, freshwater, and increased pressure on upland and coastal resources. Unsustainable human activities directly linked to degradation of seagrasses and coral reefs in Barangay Libo include illegal logging of timber in the upland which has caused sediment overloading of river and sea (Fig. 5), blast and poison fishing, use of destructive fishing device and coastal reclamation (Fig. 6). Substantial decline of mangrove area was stimulated by overharvesting of woods for construction material and charcoal (Sinfuego and Buot, 2014; Walters, 2004; Janssen and Padilla, 1999), reclamation of wetlands (White and de Leon, 1996), aquaculture (Primavera, 2006, 2000; Nickerson, 1999), and reclassification of former mangrove areas into disposable land, making it reasonable for other uses such as human settlement (White and de Leon, 1996).

While the major driver of destruction and degradation of coastal and marine ecosystems are anthropogenic, climate change is becoming the dominant driver (UNEP, 2006). The primary cause of climate change is elevated level of carbon dioxide in the atmosphere (German Advisory Council on Global Change, 2006). The most vulnerable to climate change outcomes which include sea-level rise due to thermal expansion of water and melting of ice, warming of sea surface, seawater acidification, increased intensity of storms, and change in ocean circulation pattern are the tropical coral reefs, coral reef dependent economies and coastal communities.

Mangroves, seagrasses and coral reefs are interconnected ecosystems (Moberg and Folke, 1999). As interconnected ecosystems, the degradation of one ecosystem has an impact on other ecosystems. The mangroves (Fig. 7) being located between the land and sea is the link of seagrasses and coral reefs to the upland forest ecosystem. They act as a bio-filter by trapping soil and sediment, absorb nutrient of surface water originating from land, and recycle nutrient, thus it provides a cleansing service and prevent nutrient enrichment of seawater which is crucial to the growth and survival of seagrasses and coral reefs (Walters et al., 2008; Baran and Hambrey, 1998; Gilbert and Janssen, 1998). The seagrasses being functionally linked between mangroves and coral reefs are more sensitive to changes in the environment thus it can be used as bio-indicator of the health and condition of the entire coastal ecosystem (Fortes, 1999 cited by Aliño et al., 2004). The coral reefs (Fig. 8) being at the forefront of the sea serve as buffer against wave energy during storm surge and natural sea disturbance, thus coral reefs aid the formation of lagoons and sedimentary environments which are favorable habitat for mangrove and seagrasses (Moberg and Folke, 1999).

Anthropogenic activities involving large scale alteration of natural landscape and vegetation cover such as illegal logging, excessive wood harvesting, mining and slash-and-burn agriculture exposes the top soil which makes it more vulnerable to accelerated soil erosion and rapid surface run-off during rainy season. Sediment loads delivered during run-off cause siltation of rivers and decrease water clarity. Suspended sediment in water damages seagrasses and coral reefs (Fig. 9) by smothering their tissues and by limiting light penetration essential for photosynthesis and calcification of coral reefs (Fabricius et al., 2012; Reopanichkul et al., 2009). Coral reefs are sensitive to water quality (Veron et al., 2009) and respond strongly to changes in water quality. Significant correlations between coral reef cover and water quality (Reopanichkul et al., 2009; Fabricius et al., 2012; Liu et al., 2012) and fish abundance (Reopanichkul et al., 2009) have been reported. Reductions in coral cover often results in decline of reef associated fishes, algal feeders and larval recruitment. Sewage inputs from domestic wastes contribute to nutrient enrichment, and with elevated level of nutrient and turbidity, coral reef community progressively shift from those dominated by herbivorous fishes and algal feeders to those consisting of algae dominated with low density herbivorous feeders. Herbivores are instrumental in larval recruitment and in controlling algal growth on coral reefs. The balance between macroalgae and coral reefs will be affected when herbivorous fishes are significantly reduced (Reopanichkul et al., 2009). Thus, economically efficient but unsustainable activities in the upland and mangrove forest can cause detrimental impact to seagrasses and coral reefs ecosystems.

Knowledge on the ecological and socio-economic importance of mangroves, seagrasses and coral reefs

Fig. 10 presents the response of students when asked to agree or disagree on four ecological and socio-economic consequences when mangroves, seagrasses and coral reefs are lost.

Fig. 7 Mangrove forest in Barangay Libo serves as coastal protection against seawaves.

Fig. 8 Fringing coral reefs in Barangay Libo is the habitat of fishes and aquatic organisms.

Around 87% and 89% of the students agreed that there will be less fishes and marine organisms in the absence of coral reefs and seagrasses, respectively. This indicates that the students were familiar on the role of corals and seagrasses as sanctuary of aquatic species. Around 82% and 86% agreed that without seagrasses and mangroves, the coastal zone will be vulnerable to sea waves, which indicate that the students understand the capacity of seagrasses and mangroves to act as buffer against sea waves. Mangroves, being strategically positioned between land and sea, provide protection against damages caused by frequent storm events, prevent coastal erosion, maintain sea water quality, and serve as spawning, nursery and feeding ground for a variety of organisms. The results indicate that the students were knowledgeable on the ecological role and socio-economic importance of mangroves, seagrasses and coral reefs.

The socio-economic value of mangroves, sea grasses and coral reefs in terms of tourism revenue, fisheries output, coastal protection, and other direct and indirect values has been described comprehensively in literature (Failler et al., 2015; Subade and Francisco, 2014; Vo et al., 2012; Cruz-Trinidad et al., 2011; Ahmed et al., 2007; Subade, 2007; UNEP-WCMC, 2006; Ronnback and Primavera, 2000; White et al., 2000; Janssen and Padilla, 1999; Ronnback, 1999). The socio-economic value was estimated from the value of the products and services derived from an ecosystem or the replacement cost of an ecosystem service (UNEP-WCMC, 2006). Economic valuation studies revealed that the value of wetlands and their associated ecosystem services range is estimated at US$14 trillion/year (de Groot et al., 2006), while the mangrove forests (together with tidal marshes) have been estimated at US$1.65 trillion/year (Costanza et al, 1997 cited by

Fig. 9 Live coral surrounded by dead corals due to sediment overload.

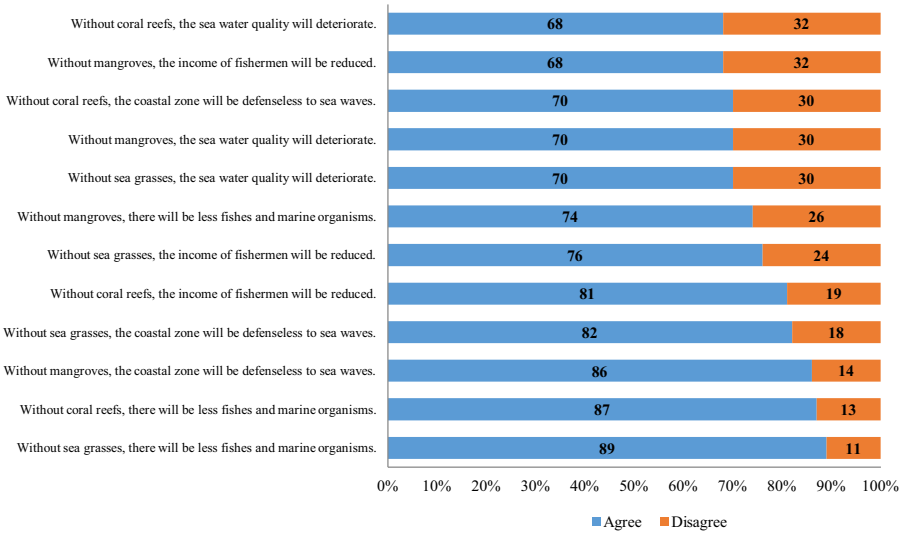


Fig. 10 Response of students (in percentage) when asked to agree or disagree on the possible impacts when seagrasses, mangroves, and coral reefs are lost ($n = 331$).

Primavera, 2006). For coral reefs, US$1.35 billion is the conservative estimated economic contribution of 27,000 km^2 of coral reefs in the Philippines in terms of fisheries, tourism and coastal protection while a one km^2 healthy coral reef with tourism potential produces annual revenues from US$29,400 to US$113,000. On one hand, 140,000 hectares of mangroves provide US$84 million in terms of fisheries output, wood and other values (White and Cruz-Trinidad, 1998 cited by Aliño et al., 2004). Thus, the destruction of mangroves, seagrasses and coral reefs translate into social and environmental cost such as loss of earnings in tourism and fisheries production, unemployment, food insecurity and malnutrition, and greater vulnerability to the impact of climate change.

Perception on local environmental condition

Table 1 shows the perception of Grade 7, Grade 8, Grade 9, and Grade 10 students on four local environmental conditions namely, water quality of the sea, water quality in drinking wells and spring, number of big fishes caught in the sea, and abundance of mangroves and coral reefs using a four point Likert scale (1 = much worse, 2 = worse, 3 = better, 4 = much better). In general, the students thought that the water quality in drinking wells and spring was better at the present time compared to several years ago. Key informant interview revealed that several years ago, the drinking wells in Barangay Libo were unfit for human consumption due to poor maintenance, lack of disinfectants, and microbial contamination (Lagbas and Habito, 2016). The microbial examination and disinfection of drinking wells due to cholera Ogama (El toro) was done several years ago by army medical personnel according to Mr. Evaristo Pestañas (personal communication), a senior resident of Barangay Libo. This could explain why the students perceived that the water quality in their traditional drinking wells was better today compared to several years ago. According to elder residents, large fishes were abundant in their municipal water many years ago and can be easily caught near shore. The average fish catch was about 5 kg per

Table 1 Perception of Grade 7 (G7), Grade 8 (G8), Grade 9 (G9) and Grade 10 (G10) students on four local environmental conditions.

Environmental condition today compared to several years ago	Mean (SD)			
	G7 (n = 82)	G8 (n = 78)	G9 (n = 89)	G10 (n = 83)
Water quality of the sea	2.98[a] (0.67)	2.92[a] (0.89)	2.70[a] (0.84)	2.89[a] (0.80)
Water quality in drinking wells and spring	3.32[a] (0.70)	3.15[b] (0.67)	2.87[b] (0.83)	3.06[a,b] (0.61)
Number of big fishes caught in the sea	3.00[a] (0.85)	3.01[a] (0.82)	2.82[a] (0.85)	2.76[a] (0.71)
Abundance of mangroves and coral reefs	3.18[a] (0.92)	3.17[a,b] (0.89)	2.82[b] (0.92)	2.83[a,b] (0.84)

Note: 1 = much worse, 2 = worse, 3 = better, 4 = much better. Values in parenthesis are standard deviation (SD). Means in the same row that do not share a letter are significantly different ($p < 0.05$) based on Tukey pairwise comparison.

Table 2 Perception of all students on four local environmental conditions.

Environmental condition today compared to several years ago	Mean (SD)
Water quality in drinking wells and spring	3.09[a] (0.73)
Abundance of mangroves and coral reefs	2.99[a,b] (0.91)
Number of big fishes caught in the sea	2.89[b] (0.81)
Water quality of the sea	2.87[b] (0.79)

Note: (1 = much worse, 2 = worse, 3 = better, 4 = much better. Values in parenthesis are standard deviation (SD). Means that do not share a letter are significantly different based on Tukey pairwise comparison ($p < 0.05$).

fishing effort but in the present time the average fish catch was about one kilogram. There was a significant difference among the perceptions of Grade 7, Grade 8, Grade 9 and Grade 10 students on the water quality in drinking wells and spring compared to several years ago ($f = 6.03$, $p = 0.001$), and abundance of mangroves and coral reefs compared to several years ago ($f = 4.23$, $p = 0.006$).

The overall perception of students on the four local environmental conditions is shown in Table 2. Among the four local environmental conditions, water quality in drinking wells and springs was given highest rating (3.09). On the other hand, the students gave lowest rating to water quality of the sea (2.87). A possible explanation is that the students always noticed the impact of sediment in sea water clarity most especially during high tide. There was a significant difference in the perception of students on four local environmental conditions ($f = 5.36$, $p = 0.001$).

Concern on local environmental issues

Table 3 shows the level of concern of students on five local environmental issues namely, contamination of drinking wells and spring, degradation of mangroves and coral reefs, illegal fishing activities such as blast fishing, illegal logging, and solid wastes disposal problem using a 4 point Likert scale (1 = not concern at all, 2 = not concern, 3 = concern, 4 = very concern). Grade 7 had "very high" level of concern on illegal fishing (mean = 3.28) and solid wastes disposal problem (mean = 3.27). For Grade 8, they had "very high" level of concern on contamination of drinking well and spring (mean = 3.28). Both Grade 9 and Grade 10 have "very high" level of concern on all local environmental issues. There was a significant difference among the level of perception of students on contamination of drinking well and spring only ($f = 3.86$, $p = 0.010$).

The overall perception is shown in Table 4. The result showed that the students have "very high" level of concern on the five local environmental issues. The students have expressed highest concern on the water quality in drinking wells and springs (3.33) and degradation of mangroves and coral reefs (3.33) while they were less concerned about solid wastes disposal problem possibly because solid wastes problem is not very visible and not problematic in their area. There was no significant difference on the level of concern of students on the five local environmental issues ($f = 0.49$, $p = 0.740$).

Attitude on issues affecting local fisheries resources, environmental conservation and protection activities

Table 5 shows the attitude of students on issues affecting local fisheries resources and attitude on environmental activities using a four point Likert scale (1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree). Statements 1, 3, 4, 5, and 6 are about coastal and fisheries management problems, while statement 2 is a positive statement about recycling of materials to reduce generation of solid wastes. On the other hand, statements 6, 7, 8, and 9 are negative statements on coastal conservation activities.

On the issue about the disappearance of fisheries resources if not protected in the present time, the students gave a mean rating of 3.35 ("very high" level). When asked if conservation and protection of fisheries resources is the responsibility of government only, the students gave a mean rating of 2.64 ("high" level). This could mean the students think that the government is responsible in the conservation and protection of critical fisheries habitat and fisheries resources.

On the issue if illegal fishing cannot be stopped anymore, the students gave a mean rating of 2.56 ("high" level). This could mean students perceive that the level of current control and regulatory efforts to eliminate dynamite fishing and other forms of illegal fishing activities is insufficient or difficult to

Table 3 Level of concern of Grade 7 (G7), Grade 8 (G8), Grade 9 (G9) and Grade 10 (G10) students on five local environmental issues.

Environmental issues	Mean (SD)			
	G7 (n = 82)	G8 (n = 78)	G9 (n = 89)	G10 (n = 83)
Contamination of drinking well and spring	3.12[b]	3.28[a,b]	3.42[a]	3.44[a]
	(0.81)	(0.70)	(0.65)	(0.57)
Degradation of mangroves, seagrasses and coral reefs	3.21[a]	3.23[a]	3.44[a]	3.37[a]
	(0.80)	(0.87)	(0.54)	(0.62)
Illegal fishing	3.28[a]	3.18[a]	3.42[a]	3.30[a]
	(0.90)	(0.95)	(0.72)	(0.79)
Illegal logging	3.23[a]	3.14[a]	3.38[a]	3.28[a]
	(0.86)	(0.89)	(0.70)	(0.72)
Solid wastes disposal problem	3.27[a]	3.08[a]	3.29[a]	3.39[a]
	(0.90)	(0.89)	(0.76)	(0.58)

Note: Numbers are interpreted as "low" (1.00–1.74), "moderate" (1.75–2.49), "high" (2.50–3.24), and "very high" (3.25–4.00). Values in parenthesis are standard deviation (SD). Means in the same row that do not share a letter are significantly different ($p < 0.05$) based on Tukey pairwise comparison.

Table 4 Level of concern of all students on five local environmental issues.

Local environmental issues	Mean (SD)	Interpretation
Contamination of drinking wells and spring	3.33 (0.67)	Very high
Degradation of mangroves, seagrasses and coral reefs	3.33 (0.69)	Very high
Illegal fishing	3.31 (0.82)	Very high
Illegal logging	3.27 (0.78)	Very high
Solid wastes management problem	3.27 (0.78)	Very high

Note: Numbers are interpreted as "low" (1.00–1.74), "moderate" (1.75–2.49), "high" (2.50–3.24), and "very high" (3.25–4.00). Values in parenthesis are standard deviation (SD).

Table 5 Attitude of students on issues affecting local fisheries resources and environmental conservation/protection activities.

Statements	Mean (SD)
1. Fisheries resources will be lost in the future if not protected today.	3.35 (0.72)
2. I will recycle and reuse things to help reduce solid wastes disposal problem.	3.17 (0.82)
3. The fish supply will be lower in the future due to degradation of fisheries habitat.	3.10 (0.75)
4. The conservation and protection of fisheries resources is the responsibility of the government only and not by local people.	2.64 (0.88)
5. Illegal fishing cannot be stopped anymore.	2.56 (0.85)
6. I am not worried about coral reef degradation because they can be replaced by artificial coral reefs.	2.10 (0.87)
7. I do not want to donate money to sea conservation activity.	2.08 (0.84)
8. I do not want to participate in coastal clean-up activity.	2.07 (0.89)
9. I do not want to participate in mangrove planting activity.	2.02 (0.92)

Note: 1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree. Values in parenthesis are standard deviation (SD).

implement in their community. At the time of the study, a resident said that dynamite fishing is still practiced by some local fishermen in Polillo Island and according to an elder, poachers from Infanta illegally entering their municipal water also practice dynamite fishing.

On the issue about the possibility of low food fish supply in the future due to degradation of fisheries resources, the students gave a mean rating of 3.10 ("high" level). This could mean the students are aware that taking good care of fisheries habitat and environmental stewardship of the coastal and marine resources will ensure sufficient food fish supply in the future.

As for negative statement 6, when the students were asked if they are not worried of coral reef degradation because corals can be replaced by artificial corals, the students gave a mean rating of 2.10. Furthermore, when the students were asked to agree or disagree on three negative statements: 7. I do not want to donate money to sea conservation activities; 8. I do not want to participate in coastal clean-up activity; and 9. I do not want to participate in mangrove planting activity, the students gave a mean rating of 2.08, 2.07, and 2.02, respectively. These are in line with the findings of Bartczak (2015) that both altruistic attitude and environmental concerns significantly affect the willingness to pay of individuals for environmental conservation. The results suggest that the students have positive environmental attitude, awareness of social and environmental responsibility and are likely to participate in coastal resources management activities.

Fisheries resources have been generally viewed as infinite resources and a public property. Property rights issues such as open access, common property, and absence of clearly defined property rights provide no effective mechanism for limiting or excluding new resource users and controlling resource use and exploitation. For these reasons, each resource user tries to maximize his economic opportunity by gaining the largest benefit as much as he can before others do.

In terms of economic contribution, the direct use values of fisheries resources such as fisheries production, tourism and recreation are primarily accounted, but the non-marketable aspects such as coastal protection, water quality control, biological control, maintenance of genetic resources, existence

value, and bequest value, which do not appear in market transactions are often ignored or undervalued in decision making. Since many of the ecosystem functions and services are not traded in market, it is difficult to reflect how human welfare will be affected in the absence of these ecosystem services.

By putting monetary value on ecosystem services, resource users and decision makers will become more conscious that there are opportunity costs involved in using these resources. Resource valuation will also help resource users and decision makers to execute efficient and more informed decisions between options such as preservation costs versus the foregone economic benefits if the resource is to be preserved, formulate appropriate economic instruments, and take into consideration the environmental and societal costs associated with any development activities.

Conclusion

This study has explored the perspectives of high school students in Libo National High School in Polillo Island, in terms of knowledge of ecosystem functions and services of mangroves, seagrasses and coral reefs, causes of their degradation/destruction, and their socio-economic importance. Our study also explored the perceived environmental problems of the students, their level of awareness, concern and altruistic attitude to some local environmental issues and pro-environmental activities. This study showed that the high school students in Barangay Libo, Municipality of Panukulan, Polillo Island, possess high familiarity and understanding of the ecosystem services of mangroves, seagrasses and coral reefs, and possess appreciably high environmental concern and positive attitude to perceived socio-environmental issues.

This study also identified several environmental and social problems in Barangay Libo and adjacent barangays. The increasing human population due to migration, proliferation of unsustainable economic activities, and high enforcement cost of environmental law threaten the health of coastal and marine ecosystems of Polillo Island. Illegal harvesting of hardwood continues, which is a major cause of sediment loading of river and sea. Siltation has deteriorated the water quality of the sea and smothered the fringing coral reefs. Dynamite fishing and cyanide fishing are still practiced by a few local fishers, destroying offshore coral reefs and critical fisheries habitat. Mangrove woods are still harvested for domestic purposes and degraded mangrove areas are reclaimed for human settlements instead of regenerating the area. With the increasing village population, solid wastes including human wastes are indiscriminately dump in the mangrove area and in the future, the disposal of solid wastes will become a problem.

The lack of alternative livelihood opportunities, degraded fishery habitats, and unfair competition with commercial fishers often push some people to engage in unlawful fishing activities and violate environmental laws. Thus, the current socio-economic condition and bad state of the fishery resources exacerbate the already bad condition of the forest, coastal and fisheries resources of Polillo Island, making it more vulnerable to resource depletion.

On the positive side, coastal resources management (CRM) projects would likely succeed in this area. Local peoples' organization (Bantay Kalikasan and Libo Fishers and Farmers Association) are actively involved in environmental stewardship and enforcement of environmental laws. Local fishers, farmers and high school students of LNHS are involved in annual mangrove planting (Ronel Pestañas, personal communication). The community also receives continuing assistance from KALAHI-CIDSS and Institute of Social Order (Evaristo Pestañas and Cesar Quizana, personal communication). The younger generations' perceived environmental crisis, altruism, and positive environmental attitude would provide vigor and interest in the achievement of CRM goals and objectives. In addition, the younger generations' awareness of the worsening state of their coastal and fisheries resources could be taken as a good indication that CRM activities would likely be supported. The existence of a high school in this community and the high school level of education mean that community members can read and understand CRM goals, objectives and contribute and commit to desired outputs and outcomes.

Recommendation

Based on the findings and conclusion, this study recommends to the school administrators and teachers to exert more effort to educate students on relevant topics like biodiversity of Polillo Island, local solid waste management, sustainable thinking (Deniz, 2016), interconnected functions of upland and coastal ecosystems in the natural science and biology subjects, and educate on the impact of upland anthropogenic activities such as illegal logging, mining and unsustainable agricultural practices, and mangrove clearing on the health of seagrasses and coral reefs. Engaging the students on activities such as mangrove planting, wildlife viewing and coastal cleanup activities will bring them closer to nature (Siregar and Quimbo, 2016). The impact of climate change and elevated levels of carbon dioxide in the atmosphere in terms of stronger typhoons, sea-level rise, sea surface thermal expansion, and coral bleaching should be also taught to high school students to better appreciate the existence of mangroves and coral reefs as defense against climate change associated phenomena. Furthermore, environmental education should be initiated and vigorously pursued in the pre-school and elementary levels of education (Siregar and Quimbo, 2016).

To address the heavy reliance of local people on their forest and coastal resources, this study recommends to the local government officials and decision makers to provide a diverse land-based alternative livelihood options to reduce reliance of families on marine resources (Aldon et al., 2011) and encourage fishery exit (Slater et al., 2013). Diversification of land-based livelihood, a shift to nature-based tourism (such as mangrove ecological parks and dive sites), mobilization of women's group through small scale weaving of mats and baskets using indigenous materials like nipa leaves, and livestock raising can provide additional sources of cash income. Without alternative livelihood options, fishers are left with no choice but to make fishing as profitable as possible using cheap and efficient technology but destructive to fisheries resources (Muallil et al., 2014). Furthermore, new and younger fishers, especially those with growing families, should be the primary targets of livelihood programs because they are the ones associated with higher fishing effort and are more open into shifting to non-fishing jobs (Muallil et al., 2013).

Statement of authorship

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