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Biodiversity in the Kuroshio Region: Challenges and Trends in the Upstream

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Abstract

Biodiversity is one of the important tools to consider the richness of natural resources. Unfortunately many of the world's mega diverse areas are experiencing biodiversity loss due to natural and anthropogenic influences. The Kuroshio Region has not escaped from this global phenomenon. Catanduanes Island, which is located at the forefront of Kuroshio Current faces species decline for the past years due to overexploitation accompanied by limited initiatives and directive guidelines. Many species are already threatened in this island from smaller siganid fish to large fishes and birds. The case of marine gastropod for example is biodiversity declining from the last 10 years. Although some gastropod studies in the past have shown a high species richness, a decline is noted in 2013 gastropod diversity at H'= 2.969, a 0.453 lower than 2003 study at H'= 3.422 while it is becoming uneven at J'= 0.88 compared from 2003 study at J'= 0.93. Conservation efforts have started in the island which includes establishments of marine protected areas and forests management plan. More wildlife protection program may be established in the island and rehabilitations of the degraded areas may be closely monitored. Fishing ordinance and regulations in over collection/overfishing is likewise recommended.

Keywords: Upstream, Catanduanes Island, biodiversity, exploitation, biodiversity hotspot, endemism

1. Introduction

Several geographical areas are known to harbor complex number of wildlife and higher degree of endemism. Recently, ecologists have identified these places as mega diverse (countries/regions) where most of the earth's species are more concentrated if combined altogether. However, many of these species centers are becoming widely known as biodiversity hotspot. This means that many of its organisms are on their ways to being endangered and many more are becoming susceptible to brink of extinction while some people across their surroundings unaware of their battling existence. Biodiversity as described by Khrone (2012) which includes species diversity, genetic variation and diversity of ecological interactions is not a constant figure which may immediately fluctuate as more disruptions dominate in a certain time and space.

The Philippines which is also known as a mega diverse country radiated its species richness in the Kuroshio Region, a coastal region which is fed by the Kuroshio Current that starts from tropical Philippines, to subtropical Taiwan and finally to temperate Japan. That Philippine geographical location contributed variety and abundance to Kuroshio' s species stocks. Its tropical setting is an advantage to the region' s biodiversity establishment as most ranges of species are scattered in warm climate and just secondarily disperse to temperate zone through migration. But these bounties have changed and still bound to continue as this Kuroshio's front liner is labeled a biodiversity hotspot (Myers et al., 2000). Human induced activities such as overfishing and coastal forests clearings continue which may have been rendering poor reproduction and development of marine life.

An organism never lives alone nor an ecological process executed isolated from other environmental phenomena. This generally accepted norm scaffolds the fact that Biodiversity in the Kuroshio Region is a shared responsibility among the states on its borders. Now, many would ask why a term upstream is given in one of its portions. What could be its significance? Well, as Kazuo Okuda (2009) remarked, "The

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Philippines is like an upstream of the Kuroshio" and noted that whatever occurs in its place will inevitably spread downstream. In connection, Catanduanes Island in the Philippines' Bicol Region is one of the "Kuroshio' s upstreams" as it is located at the forefront of the current' s origin; its marine species are shaped with the Kuroshio Current and many are destined to follow the current's flow in their migration and breeding. Biodiversity of the Catanduanes Island is therefore an integral part of the Kuroshio, hence this study has been conducted.

2.0. Catanduanes Island Features and Marine Biodiversity

One of the biodiversity rich Philippine provinces is the island of Catanduanes secluded in the Pacific where typhoons closely develop. It is a triangular island at the eastern seaboard of the Philippines and the first landmass of greater Luzon that touches the Pacific Ocean at 13. 5 to 14. 1 degrees North Latitude and extends from 124. 0 to 124. 5 degrees East Longitude (DENR-Catanduanes, 2009b). The island is a part of Bicol Region; the 12th largest island of the Philippines with 1,511.5 km^2 (Department of Science and Technology DOST, 2010) which is separated from the Bicol peninsula by the Maqueda Channel and Lagonoy Gulf. In 2010 census, it is already home to 246, 300 human population (NSO, 2013) which generally inhabit its coastal boundaries.

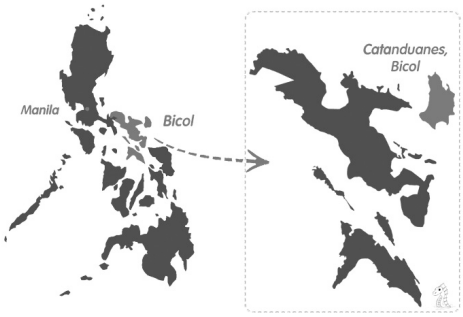

Fig.1. Catanduanes Map. Photo by http:// insights.looloo.com

Catanduanes nestles on the latitude where final waves of North Equatorial Current encounter terrestrial soils for the first time and merge on the waters northwestward and becomes the Kuroshio Current. This location stimulates biological mechanism to many forms of marine fauna in this part of the ocean. Some fishes such as tuna for example follow a path of migration (Catanduanes Tuna Highway) that runs from Southern Philippines which pass through Maqueda Channel and continues to Northern Philippines, Taiwan and Japan drifting with the Kuroshio Current. Pacific squids and octopuses' species are known to frequent on Catanduanes Coasts. Nautiluses and sea turtles are also present in the island evidently shown by their displayed shell in some coastal villages' dwellings. Other pelagic fishes such as sailfish, dolphin fish, shark, sardine and flying fish and many forms of coral reef and littoral fish such as rabbitfish, humphead wrasse and parrotfish flourish in its waters. Coral reefs embrace the coasts and its several islets. Other kinds of mollusks also exist and are used as additional food stocks especially in remote coastal towns. Mollusks diversity has been described by Masagca et al., (2010) which reported higher diversity of mollusks in the island.

The island boosts biodiversity of marine flora as well. Green algae such as the edible *Caulerpa* densely grow especially in eastern coasts where greater turbulence of Kuroshio Current brushes on its shores. Brown and red algae although least studied on its waters are usually seen in the island's reefs and sub littoral regions where depths gradually subdue to continental shelf. Noteworthy to include are the extensive mangrove forests which covers many of the island's muddy and sandy coastal substrata (Masagca et al., 2010). These forests are important refuge of the islands estuarine and juvenile marine species which may eventually migrate to the sea when already grown up. Additionally, an assessment of a Catanduanes marine protected area in Agoho, identified 7 species of seagrass and 10 species of seaweeds with the highest in terms of diversity in the number in all sanctuaries of the Bicol Region (Soliman, as cited by Vargas & Asetre, 2011). Likewise, the highest mean chlorophyll α concentration in the eastern seaboard of the Philippines is found in Catanduanes Island and Samar at 0.47 μg/L (Viron, 2006).

Fig.2. *Cypselurus sp.* Swainson, 1838.
Photo by http://www.livt.net

Fig.3. *Sardinella* sp. Cuvier, 1829.
Photo by http://www.cntresources.com.my

2.1.The Island's Exploitation of Marine Biodiversity

Environmental effort is still limited when it comes to restrictions or total prohibition of juvenile fish excessive fishing. Rabbitfish (*Siganidae*) is one of the most bountiful fish in the island but also one of the heavily exploited fishes which fishing peaks from March to June. Hundreds of sacks of this fish are harvested in coastal areas all over the island in each breeding season. Soliman et al. (2009) indicated that *Siganid* overfishing is a serious problem in Lagonoy Gulf which is a maritime part of Southern Catanduanes, although most coastal part of the island has been heavily fishing it as well.

On the other hand, although dynamite fishing has declined for the past years, the results are still prevailing as damaged coral reefs are not easily recovered in some areas (Catanduanes Tribune, 2013a). Mollusks are not spared of overexploitation as people over glean in remote coastal villages while some parts of mangrove swamps have been cleared. Vargas and Asetre (2011) stated that the sudden decline in the island' s mangrove area coverage in 1995 indicated degradation of coastal resources and the construction of fish ponds and other anthropogenic activities such as uncontrolled gathering or cutting of economically important trees for fuels occurred. Very recently, the Catanduanes Tribune (2014) had reported that the DENR regional office has ordered its provincial and community officers in Catanduanes Island to implement the recommendations of a task force in relation to its findings that at least 8 fishponds in northern towns were illegally built within mangrove forests and swamplands.

Fig.4. Heavily fished "kuyog" *Siganus canaliculatus* Park, 1797.
Photo by http://fishbase.cn

2.2.Connectionism to the Exploitation of Terrestrial and Freshwater Biodiversity

When marine biodiversity is concerned, it is inevitable to describe its relationship to the neighboring terrestrial and freshwater environment because the sea serves as the drainage pool of these systems products and run off and a failure of one system may associate to the loss of one another.

Catanduanes Island has one of the two clumps of rainforests remained in the Bicol region (Fragada, as cited by Arguelles, 2011) and shows high degree of endemism with these bastion of endemic wildlife: Catanduanes bleeding heart pigeon, Catanduanes narrow mouthed frog, Bicol skink, trumpet snail, Philippine deer and macaque, cobra, cloud rat, giant bats, giant lizards, wild pig, rare birds and invertebrates. The island is also home to the critically endangered Philippine cockatoo (Birdlife International, 2014). Although Catanduanes terrestrial biodiversity is still considered least disturbed compared to other Philippine Provinces, environmental disturbance has been accelerated for the last few years. Forest clearing and indiscriminate hunting of forest wildlife may have been the reason why the endemic Catanduanes bleeding heart pigeon is considered nearing to extinction by avian authorities (Hume & Walters, 2012).

In a press briefing, DENR Bicol Executive Director Jocelin Fragada said "Bicol Region has only 155,689 hectares of forested areas remained of which 68,758 hectares or 44% of the regions forest land are in Catanduanes Island" (Arguelles, 2011). However, illegal logging has been a primary problem for the past years and continues to threat forest life and may even harm marine organisms when siltation ran off from denuded mountains to the sea. Illegal and destructive fishing activities in the form of improvised battery operated gadgets, use of cyanide or pesticide that are poisoning the river and creeks and other forms of non- traditional fishing destroy the natural production cycle of fresh water fishes and shrimps throughout the year (DENR-Catanduanes, 2009a). Moreover, freshwater body deterioration may have been adversely affecting migratory marine organisms for many of them use rivers and streams for breeding at sexual maturity.

Fig.5. CBH *Gallicolumba luzonica rubiventris* Gonzales, 1979.
Photo by http://www.gmanetwork. com

Fig.6. Cockatoo *Cacatua haematuropygia* Muller, 1776.
Photo by ecop.pbworks.com

3.0. Conservation Efforts

Many researches have been conducted with recommendations wanting for ecological restrictive policies but few were truly implemented and the need for public awareness and fixed political intervention may be directed. Nevertheless, some of the conservation efforts were effective or potentially successful especially with the involvement of the civic, private stockholders and foreign initiatives.

3.1. The Catanduanes Watershed Forest Reserve

Catanduanes Watershed Forest Reserve (CWFS) was proclaimed in 1987 (DENR-Catanduanes, 2009a) but its conservation is lagged behind. However the DENR has initiated a management program for reviving the Catanduanes Forests, thus the Catanduanes Watershed Forest Reserve 5-year Management Plan (2010 − 2014) was born in 2009. The management plan has mentioned that there is a need of the forests restoration and implementation as it is already widely recognized that climate change is happening and the island province of Catanduanes with its location in the Pacific coast and rough topography, would be very vulnerable to major climate-related hazards and the effects of climate change to flora and fauna would also be likely because the life cycles of many species are closely linked to climatic factors. The management plan has added that CWFR is home to important wildlife species of which some are considered unique to the province but are nearing to extinction or shifting in the distribution and abundance of the species populations due to major climate change.

The management plan has been feuding difficulties in the implementation with the Socio-economic and law enforcement issues exist. Recently however, illegal logging has been gradually decreasing as some local government units started its close monitoring and many cases of logging related confiscations have been reported (DENR-Catanduanes, 2013). This exertion is hard for this time but it reflects new possibilities that it is not too late for the island's forests conservation.

3.2.The Establishment of Agoho Marine Protected Area

The mangrove forests in Agoho, San Andres, Catanduanes was exceptionally still way back to 1960 where 200 ha of forest cover were reported, however due to exploitation, it was reduced down to 31 ha by the end of 1995 (Vargas & Asetre, 2011). The implementation of Agoho MPA in 1993 had led to recovery of the mangrove cover (although it has recorded some loss in the first few years) by the end of 2003 at 147 ha or 166 rebound hectares from 1995. This establishment is one of the most successful environmental initiatives in the island. Civic involvement and private and public stakeholders may have contributed to is progress. Details on the management intervention in Agoho MPA are shown in Table 1 as described by Vargas and Asetre (2011).

Table 1. Selected Management Intervention from the Different Line Agencies in Agoho MPA

Year	*Agency/ Institution*	*Nature of Support*	*Tangible Outputs*
1994	US Embassy and Women's Club and DENR	Technical and financial assistance to the sanctuary	24 hectares of mangrove areas reforested
1999	KR2 Program (RP-Japan Increase Food Production Program)	Funding support of 130,000 pesos	Acquisition of a patrol boat used in surveillance and construction of am watch house
1998-2006	CSC Graduate School, Doctoral Program	Approved and conducted a doctoral research that included/ focused on educational implications for mangrove	Identification of 37 major, minor and associated flora plus macrofaunal elements; published doctoral dissertation that included computer-assisted instruction (CAI) draft and

		conservation in Catanduanes [featuring Agoho Point Marine Protected Area with Agojo Community Mangrove Development Organization (ACOMDO) as the people's organization].	Creation of a Website known as "A View of Mangroves in Catanduanes Island, Philippines) uploaded on trial at De La Salle University-Dasmarinas portal; presented in them International Mangroves 2003 Conference, Bahia, Brazil, International EMECS Conference in Bangkok, Thailand, etc; published in Colombia Journal of Science Education, Southeast Asian Journal of Tropical Biology, etc.
2000	BFAR Regional Office 5	Technical and financial assistance	Reforestation of 5 ha of mangrove areas
2000	BFAR Regional Office 5	Provided 500 kg of seedling materials for the establishment of Seaweed Nursery Project	The nursery provided seaweed seedlings to MFARMC members operating a seaweed farm project
	ACOMDO	Maintenance and production of the Agoho MPA mangrove area	PO awarded the Stewardship Agreement of Agoho Mangrove areas representing MFARMC in the area
	San Andres Vocational School, a public secondary technical vocational school	Spearheads/participated in People's Day Celebration	Advocacy level on coastal cleanup among students improved
	Sea Lion Organization	Mud crab culture	Provided livelihood to 32 members involved in mud culture
	Catanduanes State Colleges (CSC), an Academic institution	Through the NFE project assisted by Asian Development Bank, an Eco- Tour for the NFE Learners at the Sanctuary	Awareness on conservation of MPS among NFE learners
	CSC Laboratory HighSchool	Through the Youth Science Club participation in massive mangrove reforestation initiated by the US Peace Corp Volunteers	Extensive mangrove reforestation in the MPA, Education on the ecology and importance of mangroves, students appreciation of community service, volunteerism and networking with US PCV
2002	CSC	Developed the Agoho Fish Sanctuary & Marine Reserve website through the assistance of CICT students and faculty members	Worldwide advocacy for the conservation and operation of the Agoho Marine Park through the website; education in the socioeconomic and ecological importance of arine park and sanctuary
2003	CSC	Conducted research on *Eucheuma striatum* in Catanduanes in coordination with the R& D Office	Parameters of the coastal waters identified for potential seaweed farming site
2003	CSC College of Arts and Sciences	Conducted research studies of undergraduate BS Biology students and faculty on the topics in population and distribution of mangroves in Agoho	Identification of 17 mangrove species
2005	CSC College of Business and Accountancy	Conducted coastal clean-up in coordination with International Maritime Alliance (IMA)	Students level of awareness on conservation of the Agoho MPA

Source: Vargas & Asetre (2011)

3.3. Other Marine Reserves

The establishment of the fish sanctuary and marine reserve (FSMR) at the Virac coastal barangays of Marilima and Batag as well as at the Takot barrier reef is pursuant to Municipal Ordinance No. 2011-09 (a) enacted by the Local Government Unit in June 2011. Under said measure, no fishing activities of any kind shall be allowed within the 48.2 hectare FSMR in Marilima and Batag and the 79.5 hectare *Takot* reef three kilometers off the coastline (Catanduanes Tribune, 2013b). Included in the report is the BFAR donation of two 10 horsepower engines to be installed in motorized boats (*banca*) to be procured by the municipality for use within the FSMRs as well as a fish aggregating device (*payao*); the World Wildlife Fund also gave a solar panel device for use in the sanctuary. The establishment was implemented to monitor the rich fishing ground which was previously frequented by illegal fishers (Catanduanes Tribune, 2013a).

Another MPA was established in Bato in 2001 imparted with the Fisheries Resource Management Program (FMRP) under Republic Act # 8550- Agriculture & Fisheries Modernization Act (AFMA). However, villagers are considering the site already inactive as reefs experienced significant leaching and siltation caused by natural and human induced activities.

4.0. The Island's Marine Gastropods

Some of the heavily exploited organisms in Catanduanes Island are the marine gastropods. They are gathered to sustain additional food stocks. Its meat forms an essential part of the diet among the people and for those families who cannot afford to buy fish especially during inclement weather (Floren, 2003).

More and more gastropod species are becoming rare for these years. Though no major shell trade is known in Catanduanes Island, coastal ecological problem accompanied by collection by folks may affect gastropod diversity. Garcia (1986) has mentioned that excessive and indiscriminate collection of species of the genus *Cypraea, Strombus, Murex, Oliva* and *Conus* poses serious danger. Some of the mentioned species are already difficult to find today. Several more species are priced expensively in the market which makes them a purposive target for exploitation. In Catanduanes Island, the giant triton *Charonia tritonis,* one of the most important and largest of the world's gastropods is becoming extremely infrequent, - a condition which is also a trend in most coastal parts of the country. Furthermore, recent researchers have found significant breakthrough of some gastropods (especially abalone) in medicine such as being antioxidant, anti-hypertensive, anticoagulant and anti-cancer (Kim et al, 2006; Lee et al., 2010). Although more research have to be considered, this scientific development may even more accelerate organismic exploitation as people eventually learn basis for their medicinal belief that has survived since time immemorial.

4.1. The Case study of "Coastal Marine Ecosystems and Biodiversity of the Kuroshio Region: Intertidal and Mangrove Associated Gastropods in Catanduanes Island, Philippines".

This study of Aldea et al. (2014) was concerned on the gastropods declining biodiversity in the island of Catanduanes where comparative analysis was conducted from the last 10 years. Like most other organisms, this marine life has not spared with over exploitation. In the study, it is emphasized that many factors affect the biodiversity of marine gastropods from human induced activities to other non-anthropogenic influences. While human activities can be easily targeted and may easily be solved through campaign and political implementation, environmental factors are harder to control, therefore a need for ecological mitigation and other devastation related regulation and management be rightfully prepared. Details of the study are shown in Table 2.

The study pointed out that the diversity study for the last 10 years is helpful in order to asses if the gastropod is diversity winning or losing to encourage necessary coastal enforcement for the next years. The basic knowledge on ecology and distribution of the economically important gastropods in the country is essential if we are to preserve and yet make them available in good quantity all the year round (Garcia, 1986). This group deserves a conservation which will include its entire marine habitat. But its conservation effort will not proceed if its real population is not properly investigated. Therefore, its present diversity must be sought to mark the beginning of future studies to it while most of its members last. Some species are critically endangered which if not regulated may escalate into the brink of extinction while most people unaware that they are losing. Their niche's fate would be forever vanished as predicted to many other organisms in this biodiversity hotspot if uncontrolled exploitation prevailed.

Fig. 7. Gleaned gastropods in Catanduanes Island.

Fig. 8 Rare gastropod *Charonia tritonis* Linnaeus, 1758.

Table 2. Summary of the Study "Coastal Marine Ecosystems and Biodiversity of the Kuroshio Region: Intertidal and Mangrove Associated Gastropods in Catanduanes Island, Philippines" (Aldea et al., 2014).

1. Locale, Research Design And Methods Used	A. Catanduanes Island, Philippines coordinates between 13.5 to 14.1^{0}N Lat. & 124° to 124.5^0 E Longitude. B. Located on the eastern most part of Bicol Region; thus the beginning of the Kuroshio Current has direct influence on its coasts. C. Macalanhog Island is just 700 meters away from the main island and only separated by shallow intertidal zone which people used to walk at low tide. There is no pronounced dry season in Catanduanes although highest precipitation is distinct between November-February. D. The various habitats within Macalanhog Intertidal Zones were surveyed with three quadrats established on the same place where biodiversity study was conducted in 2003. The quadrats were assigned to three habitat types: sea grass and mangroves, mudflats and shallow coral reefs. Some nuisance materials such as logs and boat remnants were present but removed in order to validate the establishments of quadrats. E. Measurements of gastropod biodiversity were done using Shannon's Diversity Index, Evenness Index and Simpson's Dominance Index.
Results	
Number of Species and Orders Found	29 species of Gastropods recorded in 2013 belonging to 3 orders, 15 families and 18 genera surveyed in 2013 respectively.
Order Mesogastropoda and its Families	4 families: *Cerithidae, Cypraeacidae, Strombidae* and *Littorinidae*
Order Archaeogastropoda and its Families	5 families: *Acmaeidae, Turbinidae, Haliotidae, Neritidae* and *Trochidae*
Order Neogastropoda and its Families	6 Families: *Conidae, Melonginidae, Mitridae, Muricidae, Thaididae* and *Vasidae* were represented.
Genera	18 genera were found; *Acmaea, Astrea, Cerithium, Conus, Cypraea, Haliotis, Lambis, Littorina, Melongena, Mitra, Murex, Nerita, Nucella, Strombus, Thais, Trochus, Turbo* and *Vasum.*
Species by Genus	Per species, the genus *Conus* had the highest number at 6; *Cypraea* recorded 3; *Lambis* had 3; *Nerita* represented by 2; *Strombus* had also 2 while there was only one species in the following genera: *Acmaea, Astrea, Cerithium, Haliotis, Littorina, Melongena, Mitra, Murex, Nucella, Thais, Trochus, Turbo* and *Vasum*
Difference from the past study *Note: gastropod numbers enclosed with negative values (enclosed in parenthesis) indicate loss of individuals from 2003.*	1. The results are different to the study of Aldea (2004) which found out also 3 orders, but 17 families and 20 genera. Moreover, some genera that have occurred in 2013 such as *Conus* and *Cypraea* are not actually the same to 2003 biodiversity because the two genera are still represented even if some species already disappeared on the site. This is shown by the drop of number of species from 40 in 2003 down to 29 in 2013. 2. There were 12 species of gastropods present in 2003 which were absent during the 2013 study and they are: *Charonia tritonis, Conus carinatus, C. eburneus, C. lithographus, C. lividus, C.minimus, C. musicus, Cypraea felina, C. mauritiana, C.tigris, Murex pectin* and *Natica sagittata.* These organisms were noted with fewer individuals in 2003, thus physical

	changes in their habitat might have caused their populations to dwindle. These gastropods comprised 355 of the 2,814 individuals or 12.6% of the 2003 diversity study. Other gastropods still present on the island but have decreased on their numbers are: *Acmaea fascicularis* 23 (-109), *Astrea calcar* 18 (-20), *Cerithium nodulosum* 43 (-121), *Conus circumactus* 94 (-53), *C. ebraeus* 40 (-35), *C. generalis* 78 (-59), *C. miles* 38 (-86), *C. textile* 1 (-18) *Cypraea annulus* 101 (-92), *C. boivinii* 50 (-41), *C. moneta* 122 (-51), *Haliotis japonica* 5 (88) *Lambis millepeda* 6 (-29), *L. scorpius* 2 (-43), *Littorina littoralis* 40 (-35), *Melongena galeodes* 5 (-47), *Mitra coronata* 5 (-48), *Nerita planospira* 29 (-67), *N. undata* 80 (-51), *Nucella lamellosa* 50 (-8), *Strombus gallus*12 (-36), *S. mutabilis* 14 (-32), *Thais armigera* 35 (-81), *Trochus pyramis* 20 (-48), *Turbo marmoratus* 20 (-70) and *Vasum tubiferum* 10 (-84). 3. Combining all the decreases in number of individuals of the species including the species which are already absent are summed to 1,807 individuals or 64.21% loss from 2003 biodiversity.
Total Difference	1. Two gastropod species which had increased in numbers such as *Conus coronatus* 62 (+ 2) and *Lambis lambis* 28 (+ 22) while new species of *Murex chicoreus* with 1 individual appeared. These 3 species had an increase of 25 individuals altogether or 0.9% increase from the 2003 biodiversity. However, their increases were so minimal compared to the decline of the majority of the species. 2. Combining together (64.21 + -0.9), the results showed a total of 63% decline of the marine gastropods in the island.
Biodiversity Indices	2013: H'= 2.969; J'= 0.88; C = 0.053 2003: H'= 3.422; J'= 0.93; C = 0.038
Discussion of the Biodiversity Indices	The Shannon's Diversity Index (H') shows the value for 2013 diversity at 2.969. This is lower than 3.422 value in 2003. As a rule, higher H' values denotes higher gastropod diversity. The evenness (J') is high indicating that gastropod species are evenly distributed. However, it is also lower than 2003 which implies that it begins to divert from being even to uneven if the trend is not changed in the future. As expected, disturbed communities usually contain uneven distribution of species because unnatural induced changed may be favoring only particular types. The Simpson's Dominance Index (C) at 0.053 indicates that there are very low tendency for a dominating species. However, it is higher from the past study which indicates that dominance may enhance in the future as Diversity Index continue to decline.
Further Discussions	1. The current species richness at 29 of 2013 is lower than 40 of past 2003 study. However, a contrast for the findings appears. Surprisingly, the species richness is higher in several gastropod studies such as 107% higher than 14 species in the study of Dewiyanti and Sofyatuddin (2011), 93% higher than 15 species in the findings of Khade and Mane (2012), Mendoza and Tribiana (1997) and Tabugo et al. (2013) and 7 % higher than 27 species surveyed by Masagca et al. (2010) in selected larger study areas. This may be attributed to fairly good conditions of sea grass (and mangrove) where 90% of species were found at 95 % habitat cover (although minimal areas are now barren) which microhabitat requirement for gastropods (Orth et al., 2006). 2. Road concreting has been widespread since 2008. Coastal clearings, road widening, and other infrastructure establishments are prevailing in the island which may have been contributed to the gastropod decline. 3. The decline of the gastropod diversity is also attributed to over collection accompanied by the increasing Catanduanes population. The giant triton *Charonia tritonis* for example which occurs naturally at low densities (Wells et al, 1981) became even rarer as more and more people collect it for food and souvenir items. As a consequence, the loss of the large gastropod *Charonia tritonis* may also be the reason why some coral colonies are beginning to show disturbance in Macalanhog Island. This gastropod is one of the very few predators of crown-of-thorns *Acanthaster planci* that damages coral reefs (CRCRRC, 2003). 4. The decline may also be attributed to the occurrence of Super typhoons such as Dindo and Yoyong in 2004 and Reming in 2006 as typhoons can adversely affect coasts by sudden siltation (Zhao, 2011). Additionally, although no study is conducted in farmland residues in Catanduanes, farm deposits may have already started to accumulate due to direct run off of farmland sewage to the sea.

	5. The increasing ocean temperatures due to global warming can be also seen as other important factor which increases the impact in gastropod diversity. Worm et al., (2006) have mentioned that changes in marine biodiversity can be indirectly through climate change and related perturbations of ocean biogeochemistry. Increased seawater temperature has resulted in range shifts of intertidal species (Southward et al. 2005; Helmuth et al. 2006; Lima et al., 2006, 2007a, b; Mieskowska et al., 2006, 2007; Herbert et al., 2007; Hawkins et al., 2008). 6. There were some disturbance indications in the area, such as discoloration of few coral colonies. This could be the beginning of bleaching process enhanced by siltation from mountains caused by typhoons (Dou, 2003) and several man-made activities such as road widening/coastal developments (GBRMPA, 2012) and small scale fishing using "tubli/tubri" a poison which is derived from poison plant *Derris elliptica* (Maini & Rejesus, 1993; Star et al.,1999).
Conclusions and Further Concern	Gastropods show decline in their diversity both in species richness and number of individuals. The generally good conditions of their microhabitat explain why their species richness is still higher than many island gastropod studies despite for the fact that it has shown reductions after 10 years. But since a decline is getting pronounced, it is ascertained that some forms of deterioration (human and man-made) of the micro ecosystems have begun. This is characterized by breaking and/or bleaching of some shallow coral reefs and disappearance of negligible areas of sea grass/algal beds. These factors may be critical to generate detrimental changes in the imminent future so there is a need to address regulatory coastal management program to counteract the fluctuating gastropod diversity to be accompanied by mitigations of the possible impact of natural and anthropogenic influences.

This study may serve as a wake- up call for the people and all authorities that at a rapid rate, a loss of gastropods is expected for the next years if the uncontrolled collection is not prevented. Moreover, several marine species can be hypothetically experiencing the same fate. The case of the gastropod diversity may only be the "top of the iceberg" which means many more cases of other threatened species are unreported or not studied.

It is an important addition to note that people and authorities of Catanduanes Island are beginning to cope with the island's challenges in modern times. Gastropods may also be benefited by the implementation of marine protected areas; hence continuous management of the sanctuary is wanted. Although not yet widespread in the island, other coastal areas may follow the establishment of MPA if in the future the benefits of its presence are already transparent to the public. Gastropods are part of the MPA' s as they are important indicators of pollution and their role cannot be disregarded as many of them are placed in the bottom of the marine food chain.

A study of other species biodiversity is a must if the system is to attain high species richness in the region. As biodiversity indices imply, it is not a measure of how one species grow its number solitarily but it is how more species able to thrive in one place supported by the sustainable resources. Like all other ecological dilemmas, biodiversity can be successively retrieved if comprehensively planned and managed by concerned parties.

5.0.Summary, Conclusions and Recommendations

Catanduanes Island as located in the forefront of the Kuroshio Region is teeming with marine and terrestrial life but is presently experiencing biodiversity loss. Some species are highly exploited due to increasing human's need or limited regulation procedures. Gastropods for example have shown biodiversity decline for the past 10 years. On the lighter sides, some environmental initiatives such as ordinance and implementation of the marine protected areas and forest management plan have been conducted. This development are promising in producing more sustainable means in the future although the establishment of MPA is still limited in most coastal towns.

Human induced disturbance such as forests/coastal clearings and overhunting/overfishing are already prevailing in the island. The limited environmental regulation may explain why some species are becoming threatened and results in biodiversity deterioration. Furthermore, environmental phenomena which are naturally occurring may add burden to the status. This can reflect the need of environmental mitigation and disaster related planning for the coastal places which are more affected by the vulnerabilities of this ecological system shift.

More marine protected areas may be established in the island and rehabilitations of the degraded areas may be closely monitored. Fishing ordinance and regulations in over collection/overfishing is likewise recommended. Mitigation on the impacts of climate change and other related risk management campaigns and trainings may be enhanced. Furthermore, studies on the effect of pollutants from

farmlands that leak to the sea may also be conducted and the comparative studies on the biodiversity of other organisms from a disturbance and non-disturbance zones may be considered.

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