

Managing at the 'Root' of Kuroshio

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Abstract

The Kuroshio Current *starts from Bicol and flows with Bicol* but it is not a Filipino term. But does having a sense of owning imply success in managing? It is a hard question in the sense that it would entail asking too many but answers could still be wanting. In this contribution, I tried to provide some answers by outlining key fishery research and development efforts in Lagonoy Gulf. The gulf receives the virgin warmth and productivity of the current after the latter bifurcates from the North Equatorial Current. Vignettes on ecology of tunas (e.g., *bangkulis*, *maguro*, *pundahan*) and siganids (e.g., *kuyog*, *suku*, *bataway*) have been elaborated to highlight ecological changes on and condition of its fishery. Marine protected areas are explicitly the natural protectors in the gulf where the bastion of biodiversity resides. Protecting them should be first priority. Coupled with genuine fishing effort reduction, the gulf's glory years would be back. Through two decades and until recently, the challenge of committing for sustainability remains.

Key words: *Siganus*, yellowfin tuna, San Miguel, assessment, ecological knowledge

Introduction

The Kuroshio Current *starts from Bicol and flows with Bicol*. Eastern Bicol is the first land mass the current approaches after it bifurcates northward from the North Equatorial Current (NEC), strongest during the trade winds (March to May) when it is summer in the Philippines. The mouths of Lagonoy Gulf and Albay Gulf along the Bicol shelf opens into the NEC potentially linking offshore to inshore productivity. The NEC's productivity and warmth are conveyed by Kuroshio to Taiwan, Japan and beyond, together with those from Bicol Pacific coast and the rest of the Philippine's northern regions. The portion of Bicol shelf is bordered by the provinces of Sorsogon to the south, through Albay, Catanduanes, Camarines Sur and Camarines Norte toward the north. We cannot change the Kuroshio's origin but nature can be mediated by our harmonious alliance. This may well remind us that the way we treat nature within our premises can impact us as well as our neighbors.

This contribution elaborates on the challenges and opportunities of pursuing fisheries management in Bicol

with a focus on Lagonoy Gulf, northeastern Philippines. A brief account of the major, multidisciplinary fisheries research and development (R & D) projects implemented in the gulf is provided. Because of the preponderance of tunas, anchovies and siganids in the gulf, cases presented will be on them and their possible ecological interactions that have implications for fisheries management, including connectivity among marine protected areas (MPAs). Sigamid juveniles (*kuyog* in Bicol dialect or *suku* in Japanese) are primarily harvested on the coast of the gulf in summer. Tuna fishers catch the largest volume of tunas and tuna-like fishes in these months. Together with depth and size, the gulf is defined by the dynamics of its tuna, anchovy, sigamid and sardine fisheries.

Natural protection in the gulf

Lagonoy Gulf (Fig. 1) is large (3701 km²) and deep (about three-fourths of its area has depths of 0.7-1.0 km). Biodiversity is concentrated close to shore where coral reefs, seagrass-seaweed complexes and mangroves abound. Seven marine protected areas (MPAs) lie alongside its islands including the island province

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Abbreviations: REA-LG, Resource and Ecological Assessment of Lagonoy Gulf; SEIOS, Socio-economics and Investment Opportunity Studies; SMI-CRMP, San Miguel Island Coastal Resources Management Project; BFBP, Bicol Fish Biodiversity Program; LG Post-RSA, Lagonoy Gulf Post-Resource and Social Assessment; SUMACORE, Sustainable Management of Coastal Resources; CLIMACE, Climate Impact and Adaptation in the Coastal Environment; PPTST, Partnership Program Towards Sustainable Tuna; LG-RMC, Lagonoy Gulf Resource Management Council; BAS, Bureau of Agricultural Statistics; NSAP, National Stock Assessment Program; POs, Peoples, organizations

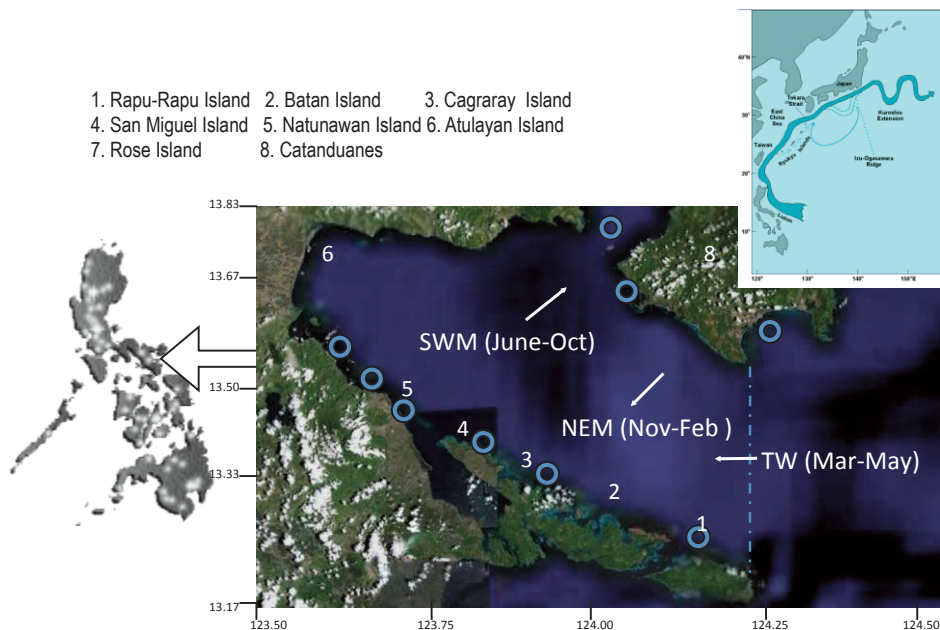


Fig. 1. LG, its MPAs (hollow circles) and islands (1-8); Kuroshio Current path (inset, from Access Science); base map from Google Earth.

Catanduanes. Six MPAs have been declared legally and the seventh one in Gaba was established with a 5-year term ordinance (lapsed by this time) as a dying mother's wish to a local executive son. The latter counts because what would be biologically functional may not necessarily be legal. Caramoan Peninsula's long length facing the gulf has no MPA to interconnect island-hopping larvae along the gulf's coast from Albay to Catanduanes. Fishing in the gulf is monsoon-influenced. Most of Albay's fishing side is sheltered during southwest winds while the shores of Camarines Sur and Catanduanes are better grounds during northeast winds. MPAs and monsoons are similar in the sense that both offer natural protection from fishing. The areas influenced by monsoons are unfishable due to strong winds while law prohibits fishing within MPAs. Additionally, the gulf's depth is unexplored so in some sense depth can be a deterrent to exploitation. These features provide natural protection to maintain ecosystem stability and integrity; natural resources in areas adjacent to these pristine areas are often lost to overfishing.

Exploiting fishes big and small

Close to 500 fish species can be found in the gulf whereas less than 100 species compose the commercial catches (Soliman *et al.*, 2008). Tunas (i.e., mostly skipjack then yellowfin) constitute about 50% of the total fishery production that is recorded between 19,000 and

26,000 t/yr. The tuna fishery, conducted mainly in fish aggregating devices or *Payaos*, is at the forefront of the fisheries. Between 1994 and 2004, there were significant changes (except for tunas presumably recruiting from outside the gulf) in the general composition of commercial fish catches. Throughout this period, for example, the catch of siganids, engraulids and clupeids increased while carangids and istiophorids decreased (Fig. 2). The decrease in larger, high-value fishes seemed to be 'replaced' by smaller, lower value, herbivorous fishes. The prey fishes could be increasing because there are fewer of the former predator fishes feeding on them. It invokes a fundamental predator-prey relation prevailing in highly exploited fisheries resulting from ecosystem overfishing (Murawski, 2000; Pauly *et al.*, 1998).

Ecosystem overfishing or a prelude to it is probably occurring in other Bicol fishing grounds. In San Miguel Bay, there have been substantive changes in the composition of catches (Silvestre and Hilomen, 2004) such as the disappearance of large, long-lived fishes (e.g., sharks and rays) and an increased abundance of squid, shrimps, cardinal and puffer fishes. In Sorsogon Bay, there was the almost total disappearance of the highly valued catfish *Clarias macrocephalus* due to overfishing that were later replaced by shrimps and gobies that have also been eventually overfished. In these fisheries now, when fishers go fishing they no longer look for finfish but instead concentrate on shrimp, clams and other shellfish. Intuitively, there is what may be called a phased overfishing whereby

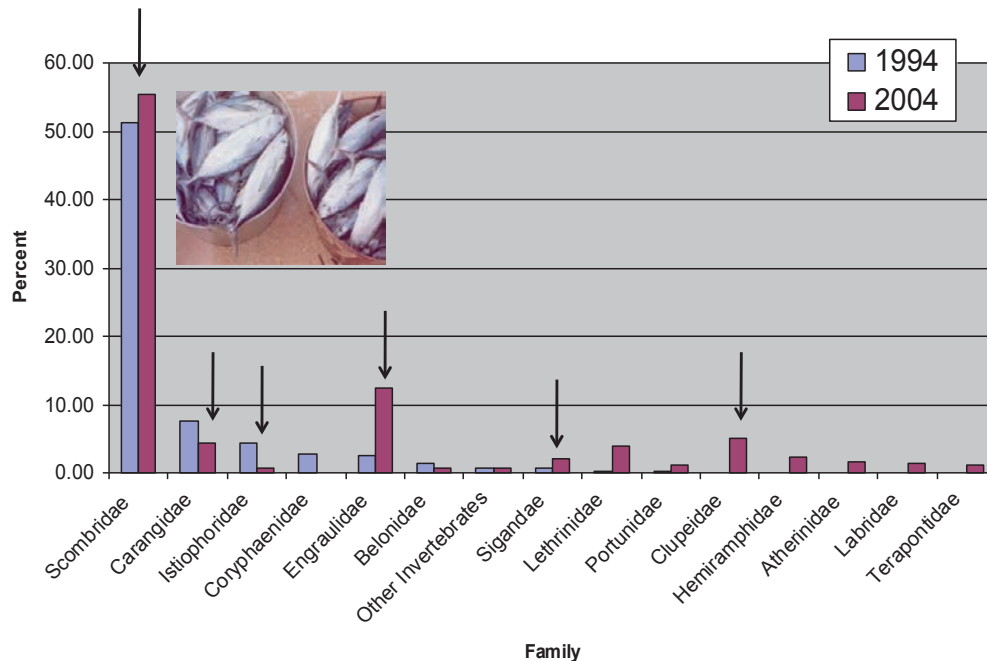


Fig. 2. LG fishery production comparing 1994 and 2004.

overfished species are replaced by other species that later are also overfished. Large predators were almost entirely absent and only small herbivores remained. Viewed in the context of what is occurring in the region, the fishery production data for Bicol from the BAS seems to be showing a different and somewhat implausible trend. The 2002-2012 figures for more than 30 fish and fish groups BAS monitors (<http://www.bas.gov.ph>) showed a continually upward movement (Figs. 3 and 4). Prey and predator fishes had both been increasing. This trend contradicts the species replacement observed resulting from the widespread overfishing of most commercial fish stocks in the region. The widespread overfishing has been evidenced by the findings of the REA, Post-RSA, NSAP and studies by academic and research institutions.

In terms of exploitation by size and volume, the overfishing of siganids in the gulf is a classic example. Exploitation of this resource starts with their smallest (i.e., larvae) and continues to the largest (i.e., sub-adults to mature breeders) individuals (Soliman *et al.*, 2009). For about one week within the new moons of March to May, pre-settled fish and juveniles are caught in large numbers on the Albay east coast by bagnets and seines. A few months after, larger siganids are fished using gillnets, speargun and hook-and-lines. Harvest levels of juveniles have been continually declining by 30-40% every year from early 2000 to 2012 (Soliman *et al.*, 2010; Soliman *et al.*, unpublished data). Exploitation rates of the most dominant species, the seagrass siganid or *Bataway*

Siganus canaliculatus, have generally been increasing from the mid-1990s to 2010 (Soliman *et al.*, unpublished data). Probably there is no better example of overfishing than that of exploiting a fish stock in this extremely wide size spectrum.

The calm trade winds in summer coincide with high fishery production in the gulf highlighted with abundant catches of tunas and tuna-like fishes. The scombrids are also caught outside of the gulf about 120 km or so east of the mouth's gulf. Fishers divulge that the fishing ground outside of the gulf they call *Sirangan* meaning "east" has been a haven (and at times hell) for tuna fishers; a haven because a few hours fishing will often yield for them a very good catch, and hell because winds and waves can bring them there but then suddenly out to sea. For tunas, catches outside the gulf can produce a net income that is about twice that of the net income from catches inside the gulf (Jane *et al.*, 2005). Does this suggest that fishers have to be encouraged to fish outside the gulf or that they need to prefer fishing inside it? Fishing regulation is implied in both cases although admittedly it is more difficult enforcing it outside the gulf. Fishers commonly made the remark "if they fish less outside the gulf they tend to get good catches inside the gulf". What opportunity for fishery management research should be designed to clarify this? How are the tuna stocks inside and outside related? These questions may stir some interest toward innovations worth pursuing.

Siganid juveniles are preyed upon by many fishes

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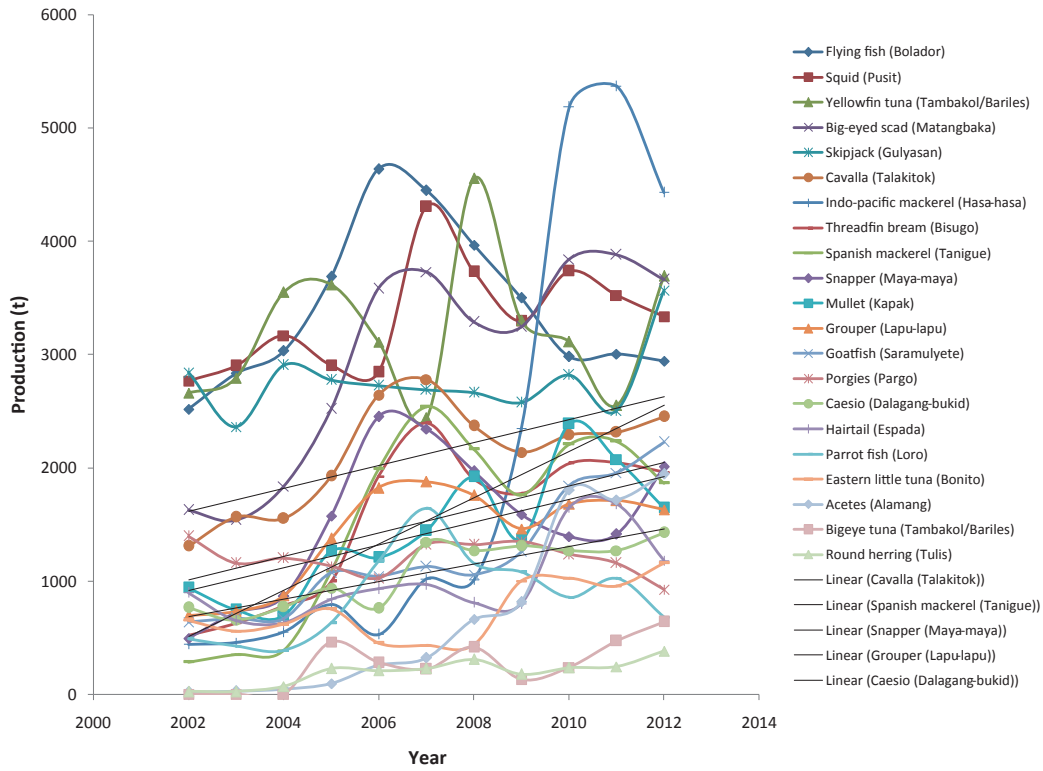


Fig. 3. Top 1st to 21st fish groups monitored by BAS with best fit lines for 5 predators.

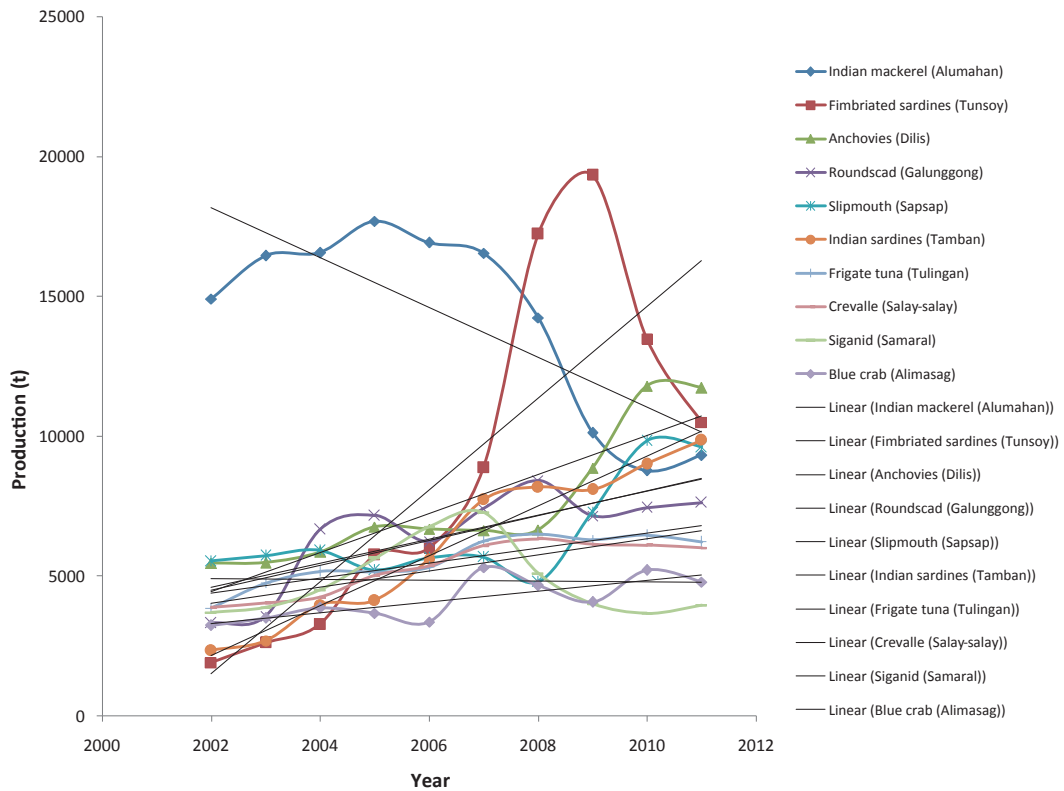


Fig. 4. Top 22nd to 31st prey fish groups monitored by BAS with best fit lines.

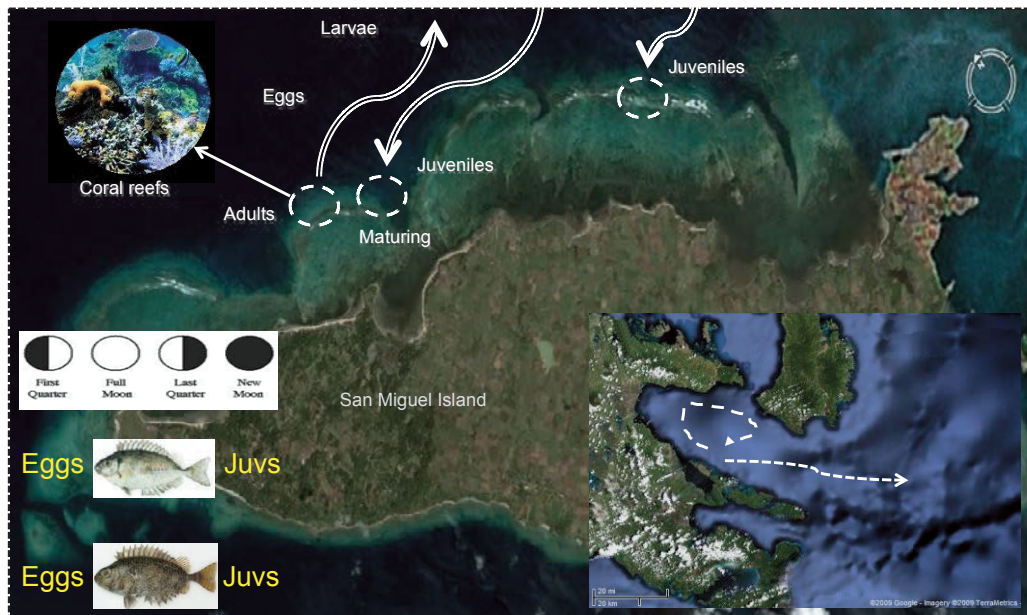


Fig. 5. Migration trajectory of spiny siganid.

along their settlement route and at settlement sites in the coast. Scombrids eat them offshore and almost any fish inshore. Fishers in the gulf notably call this *Sibo* or predation where the larvae and juveniles are at the mercy of any larger fish except siganids. Fishers have common stories about tunas chasing siganid juveniles and tunas caught and hauled on board eject from their mouth siganid larvae when impacted. In September and November, tunas are also caught and fishers say tunas are chasing sardines and anchovies. March to April and August to September are the two peak seasons for catching anchovies in the gulf and Tabaco Bay (Jane, 1985). The trajectory of the migration path of young spiny siganid *Siganus spinus* based on otolith data indicates movement of about 120 km from offshore toward the coast of San Miguel Island for about two ‘otolith’ days (Soliman *et al.*, 2010) (Fig. 5). This indicates movement of 75 km/day or about 2.5 km/hr that is comparable to the swimming record for young fish. *S. spinus* could also be actively swimming and ‘riding along the NEC’. Spiny siganids are also described as the second most distributed siganid next to *S. argenteus* (Woodland, 1998). This evidence indicates that offshore resources are inextricably linked to the coast for which related studies covering the gulf are limited.

MPAs and fisheries

MPAs in the gulf have an area of about 6000 hectares (Soliman and Mendoza, 2000). They are less than

2% of a coastal ecosystem that many of us hope is better protected than the remaining 98%. This very low coverage is inadequate as a management platform. An MPA is a platform, a launching stage for other complementary initiatives. So efforts at reduction should be incorporated into the twin strategy of effort reduction and habitat rehabilitation. Over the long-term, establishment of MPAs in other sites or enlarging existing sites should be considered.

All of the MPAs are either coral reef-MPAs or harbor major habitats that protect corals and coral reefs (Table 1). However, the Agojo MPA in Catanduanes very closely covers roughly equal areas of mangroves and coral reefs. Coral cover in the whole gulf comes to a fair percentage (26-50%) of the area but the gulf as a whole has poor coral cover (<25%). Given the low spatial coverage and poor cover quality of corals, the MPAs alone would not be enough to rehabilitate the stocks. In fact, the entire coastal habitats, in their present condition, may not be large enough to rehabilitate the stocks.

Consider this – why is the legal declaration as an MPA still needed? In the context of our fishery laws the whole area of Philippine municipal waters is a fishery reserve because the use of fine mesh nets, blasting materials and poison fishing are prohibited and the stakeholders can peaceably assemble to form management bodies. Essentially, these regulations are what everyone hopes to be enforced within MPAs throughout the country. Having another ordinance for an MPA is a simple case of double legislation – decreeing what

Table 1. Some essential information on MPAs in LG.

Attributes/ MPA	Agojo, San Andres, Catanduanes	Atulayan Is., Camarines Sur	Sangay, Gaba, Rapu-rapu, Albay	San Miguel Island, Tabaco City	Curangon Shoal, Tiwi, Albay	Pongco-Bunga, Bacacay, Albay	Baybay, Malinao, Albay
1. Year legally declared	1994	1994	1995	1998	2002	2006	2008
2. Management status (i.e., Poor, Fair, Good)	Good	Fair	Fair	Poor	Good	Fair	Fair
3. Organizations involved in management	LGU Bantay-Dagat	LGU Bantay-Dagat PSU Mgt. Council	POs	LGU FARMC Mgt. Council	LGU Bantay-Dagat FARMC Mgt. Council	LGU Bantay-Dagat FARMC Mgt. Council	LGU Bantay-Dagat FARMC Mgt. Council
4. Key coastal habitats							
a. Coral reefs	X	X	X	X	X	X	X
b. Seagrass	X		X	X		X	
c. Seaweeds	X		X	X	X	X	X
d. Mangroves	X		X			X	
5. Human community							
a. Presence	X	X	X	X	X	X	X
b. Participating	X	X	X	X	X	X	X
6. Area (hectares)							
a. Sanctuary	127	72	20	100	686	42.26	180
b. Reserve	1700	386.63	60	125	1574	463.25	270
7. Distance of corals from:							
a. Seagrass/seaweed beds	100 m	300 m	50-250 m	50-300 m	>1 km	100 m	>1 km
b. Mangroves	100 m	>1 km	>2 km	>1 km		>1 km	

is enforceable in the first place. It should be avoided because it creates the impression that people cannot be governed.

The near shore areas including the MPAs are habitats for small pelagic and demersal fishes such as anchovies, sardines, siganids, mackerels and others. These fish are forage fishes for tunas and tuna-like fishes; therefore enhancing coastal habitats is critical to improving and sustaining fisheries. This is a concrete pathway by which ecosystem-based fisheries can be designed. In addition, there should be a confederation of the management councils to complement efforts to enhance the connectivity of the MPAs. To be effective, connecting MPAs should connect people first, although in practice the first can be easier to accomplish than the latter.

Events in the San Miguel Island Marine Fishery Reserve-Sanctuary, one of the seven MPAs in the gulf, showed realities of the social dynamics that can be expected managing an MPA. The MPA was legally established in 1998 together with the management council by the Tabaco local government. It is a coral reef MPA that consists of a core or sanctuary (100 hectares) and a reserve/buffer area (125 hectares). Ecological indicators were initially poor in 1998 but they improved to a large degree after 3-4 years of full enforcement, but were back to poor again 3-4 years later. Good coral cover was obtained from early 2000 to 2003 and fish catch rates within the sanctuary increased about 3-5 times during this period compared with 1994 data. The MPA was adjudged to be the second best-managed MPA in the

Philippines in 2002. In November 2006, a super typhoon devastated a significant part of Albay and its coastal areas suffered the greatest damage. The greatest blow occurred when the MPA was opened for economic fishing to the community a few weeks after the typhoon. According to the accounts of fishers we interviewed, in less than two weeks after relaxing the sanctuary ordinance, the fish stocks in the MPA were fished to depletion, leaving almost nothing. The events showed that with functional management people can appreciably enhance fish stocks, but without it, the same resources can be depleted much faster than they can be rebuilt.

R & D timeline

Major research and development projects in the gulf can be divided into three time periods, namely those of (i) initiation, (ii) growth, and (iii) sustaining (Fig. 6). A period describes only the time origin of initiatives and the phases of activities that prevailed. It is not exclusive in the sense that periods may have had beginnings of growth and sustainability. Most of them were implemented beginning in the mid-1990s. R & D initiatives before this period had not been multidisciplinary, in order to cover both natural sciences and socio-economics in one particular program. Research and development in this context means a planned effort to link R & D within a program that invokes a continuum whereby scientific findings have been aimed leading to a development platform. A development platform is a project or outcome

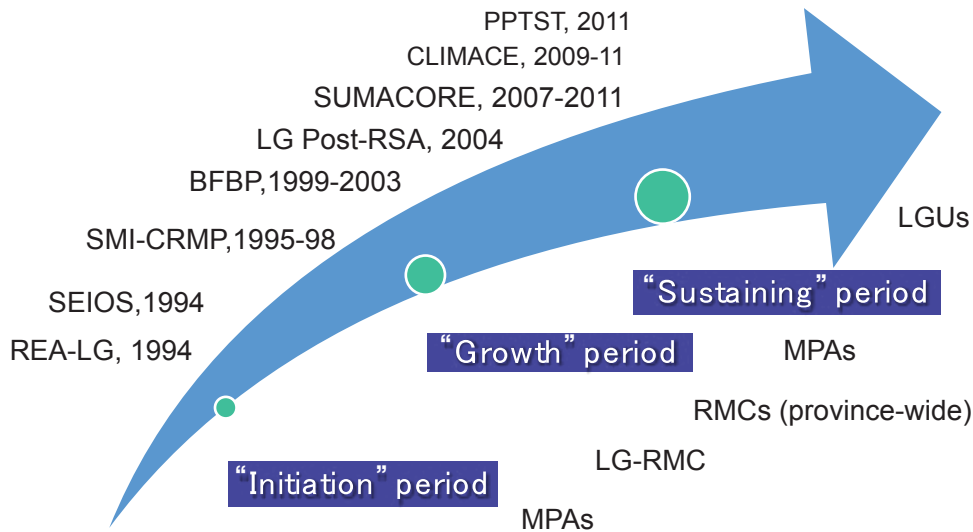


Fig. 6. Timeline of major R & D projects in LG.

that enables other initiatives to be launched. For instance, the assessment of coastal habitats provided a technical basis for establishing MPAs. Research monitoring of MPAs strengthened management effectiveness.

The 'initiation' years provided an impetus for 'growth' that eventually moved towards facing challenges in 'sustaining' the initiatives. During the initiation years, the REA carried out the most comprehensive fisheries research in the gulf. The REA generated baseline data on fisheries and coastal habitats, in particular estimates of annual total catch (ca. 22,000 t/yr) and exploitation rates of commercial fishes, coverage and status of coral reefs, mangroves and seaweed-seagrass beds, and general water quality condition. Through the management component of the REA, the gulf management council was organized and a management plan was drafted. The plan evaluated establishment of MPAs and prohibition of commercial fishing as options for managing the gulf. The gulf-wide council later disaggregated into province-wide councils because putting into operation a gulf-wide body had been a huge logistical operation.

Ten years later, the LG Post-RSA was implemented to evaluate changes in the fisheries and coastal environment of the gulf. In summary, it looked into a basic paradigm made up of the three components of the fishery, namely fish stocks, coastal habitats, and peoples' economic status. The results can be summarized as follows: a continual overfishing of fish stocks and declining catches; the maintenance of the status of habitats in fair to good condition; and a continuing low incomes for people and poor economic conditions for fishers (Soliman *et al.*, 2005). During these years, MPAs have

been established and some of them have been set up by direct LGU initiatives. In terms of significant improvements, there have only been a few noted upon evaluation by comparing REA and Post-RSA findings. However, during this period, there may not have been any real fishery management in the sense of actively reducing fishing efforts within sustained levels except in the context of the gulf's natural protection as explained above. Fishing gear units have increased significantly in number and consequently catch rates have declined. There has been more improvement in the so-called "growth" years to carry-over to the sustaining years. The sense of sustaining years could relevantly refer mostly to management of MPAs that are in various levels of effectiveness.

Learning from fishers

Fishery managers should be required to have functional understanding of natural science including knowledge of actual fishing experiences by fishers. The wealth of fishers' ecological knowledge (FEK) in the gulf includes aspects of siganid reproductive behavior, settlement and migration. We documented the knowledge from interviews with 30 of the oldest, most experienced siganid fishers in San Miguel Island and we found an interesting richness of experience in relation to the fishery. This was a formal study but it was also enriched by our long years of association with fishermen that have been equally informative. The respondents were identified using a simple referral system whereby the fishers themselves refer each other to us and those with the largest number of referrals (i.e., at least 3) were chosen. Science-based management can be complemented and

even provided solely by actual fishers observations that can be equivalent to a long time series (i.e., life long in some cases).

Therefore it is necessary that a mechanism should be created in order that FEK becomes incorporated into the management process. To avoid the mechanism from becoming self-serving for fishers, the FEK should be documented, validated and acknowledged. The mechanism should allow a fishers group to be organized and funds enabling them to regularly participate should be allocated. They may not be within the FARMC because most of them may be of an advanced age such that their meetings have to be scheduled close to their residences and held at times most convenient for them. As many of these FEK are not well documented, they may be forgotten and the practices lost in time when the wise individuals bearing them are gone.

There are many such FEK that have withstood scientific scrutiny. We may well realize that fishers have experienced and distilled these events within themselves through many years of fishing and allowed them to become essential practices in their livelihoods. In the gulf, many aspects of coastal migration of siganid pre-juveniles and their eventual settlement on and near new moon are well known examples. We have confirmed these from our own experiences with them. It is also true that some of them were prepared to blast 'schools of siganids' during our search for siganid spawning aggregations. Furthermore, findings of siganid otolith studies provided basis to formulate closed season for siganids in the gulf. Closed season dates were determined through back-counting the otolith age of settling fish and adding few days for egg development. Fish samples used were collected during the settlement dates that they amazingly predicted when and where to occur in the islands.

Conclusion

Over the last 20 years, fisheries research and development efforts in the gulf have provided a stimulus for establishing MPAs. Does this mean the MPAs are all the gulf got within the last couple of decades? To a large extent, yes, plus the equally important raised awareness among stakeholders for the need for environmental protection. But it is evident through examination of these years that the MPAs and the awareness level are not enough. More MPAs areas and educating schemes are necessary if stocks and habitats are to be significantly rehabilitated.

I would like to coin the phrase *managing over-fishing* to describe fisheries management in the gulf. If

you consider 20 years experience to be historical then this is historical overfishing that has not been adequately addressed. Well, it is not rare in Bicol fisheries. As early as 1981, the fish stocks of San Miguel Bay were declared to be biologically and economically overfished (Pauly, 1982). Current conditions are not any better. It was also in 1979 when the fishery for *Sinarapan Mistichthys luzonensis*, the "world's smallest edible fish," totally collapsed when the fish almost disappeared in Bicol major lakes due to overfishing. There are indicators of over-exploited conditions in other fishing grounds (e.g., Asid Gulf, Albay Gulf). 'Managing overfishing' can mean not doing enough to consistently resolve it until resources are gone, or equivalently a management body may just be 'maintaining overfishing'. Is it bad? Yes, because it tends to persist. We may consider a 3-stage process to graduate from it. First, we need to acknowledge that overfishing exists; second, allocate resources to address it; finally, complement measures to eradicate it.

On the gulf's frontline fishery, the scombrids appear to endure overfishing because they are not local stocks. They recruit from outside the gulf and have been moving along the Philippine Pacific borders and across countries. An important point is that they are migratory, hence a temporary resource within the gulf whose availability and thus sustainability depends on others' exercise of responsible fishing. The gulf can lose them especially when what these fishes look for is no longer around – forage fishes for their food that depend on 'good management' of suitable coastal habitats including the MPAs. So MPAs are a key ecological link to the tunas that are the gulf's key fishery.

The expanse of the gulf has always been a logistical challenge given that management has always been fund-limited. But managing the gulf is a small challenge, only a tip of a 'whale shark' issue, compared to managing the Bicol 'root' of Kuroshio that is the larger challenge. Quite simply, what is happening at the 'root' and close to it is that resources have been continually exploited unsustainably. We may fear that the Kuroshio will not anymore be bringing the rest of its blessings beyond the origin. Is this the end of it? I certainly think not. Given the opportunities for consultation and collaboration, there are many benefits to tap soon so that optimism does not wane.

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Letter from GSKS Alumni 2

Importance of Kuroshio-related Joint Studies via a Cross-Sectorial Approach

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Life in Kochi and Kochi University

My first time to visit any foreign country was Japan. As a result of receiving a Japanese Government Fellowship to study in the Master's and Ph. D. course in Japan, I chose Kochi and Kochi University. This was the beginning of my five and half years (from 2003 to 2008) of life in Kochi. Every time I think of the time I have spent in Kochi, I feel a certain kind of happiness in my heart. I feel that I was really lucky to have received such an opportunity. For me, when I first arrived in Japan and in Kochi, everything was new: the surroundings, the lan-

guage, the culture, the faces, people and food. Generally such sudden exposure can be sometimes stressful, but for me it was as if I was getting more and more interested in this new thing that had happened to me. Everything, from learning the language, to getting adjusted to the food, was challenging, but at the end it was fine. I was able to learn Japanese within six months of my arrival and also could become adjusted to the food within one year.

Both my Master's and Ph.D. courses were at the agricultural campus of Kochi University. It is a very nice campus with serenity in the air and is full of flora and fauna. I was able to meet students from many different countries and hence, was introduced to different cultures and traditions resulting in a deeper understanding of people with different ideas and ways of living. I also made some many friendships with students from countries such as Papua New Guinea, Samoa, Vietnam, the Philippines and Thailand. People in Kochi are very kind and I have been lucky enough to have very nice people around me including my supervisor, language teachers,

and volunteers at the international association. Within no time I started liking everything in Kochi and this was good because I was supposed to stay for a long time.

I was able to take part in cultural activities in Kochi as well as conduct my studies related to coral reef science. Since my research topic was coral reefs, I was introduced to the members of the Biological Institute on Kuroshio, which is situated in the south of Kochi Prefecture in a town called Otsuki. I have been able to learn a lot during the time I spent in this Institute and I still continue to do so through collaborative research with the Institute.

My current work

After graduating from the Graduate School of Kuroshio Science, Kochi University, I started my job as a postdoctoral research fellow at the Biodiversity Research Center (Dr. Allen Chen's Laboratory), Academia Sinica in Taiwan. My present work involves understanding the physiological response in different corals, e.g., *Symbiodinium* associations. Because of recent climate change and increases in seawater temperature, it is necessary to understand how corals and coral reefs can adjust and survive into the future. By conducting physiological experiments and molecular analysis, I hope to answer some questions related to the adaptation, acclimation and adjustment to local and regional environmental conditions as a result of climate change.

Apart from my main research on the physiological aspects of corals, I am also involved in studies related to coral molecular taxonomy, molecular ecology of coral

and *Symbiodinium* associations and diversity in corals with respect to the local and regional environment in the Pacific and Indian Oceans.

My views on Kuroshio-related studies

In my opinion, establishing the Graduate School of Kuroshio Studies in Kochi University was very significant development. I have always believed that presence of researchers from different specialties under one roof is very important for the advancement of science. In this Graduate School, one can find work being carried out related to coral reef ecology, fish ecology, macro- and microalgae ecology, medical science, human interaction with the environment, and how the Kuroshio current influences the life of people. I believe that this kind of arrangement is very much ideal for conducting comprehensive research. I have the utmost hopes for the future of Kuroshio-related studies at Kochi University and beyond, which involves not only Kochi, but also Taiwan, the Philippines and recently Indonesia, as part of the extended Kuroshio triangle research network.

After joining Academia Sinica, I co-wrote a 3-year project entitled, "Impact of Environmental Change on Coral Reef Biodiversity in the Kuroshio and the surrounding waters of Taiwan" and my work deals with physiological aspects of coral response to climate change. As part of this project, I was able to collaborate with many researchers in Kochi as well as in the Philippines. I am following the basic idea of the Kuroshio triangle and will continue to work with researchers in this region.