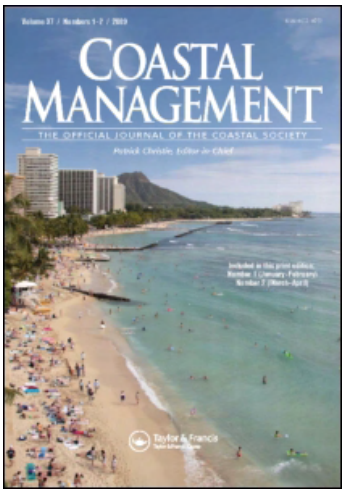

Coastal Management
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713626371

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First Published on: 01 May 2009

To cite this Article Armada, Nygiel, White, Alan T. and Christie, Patrick(2009)'Managing Fisheries Resources in Danajon Bank, Bohol, Philippines: An Ecosystem-Based Approach',Coastal Management,37:3,308 — 330
To link to this Article: DOI: 10.1080/08920750902851609
URL: http://dx.doi.org/10.1080/08920750902851609

Coastal Management, 37:308–330, 2009

ISSN: 0892-0753 print / 1521-0421 online
DOI: 10.1080/08920750902851609

Managing Fisheries Resources in Danajon Bank, Bohol, Philippines: An Ecosystem-Based Approach

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The Danajon Bank double barrier reef, located off northern Bohol Island of central Philippines, is the focus of this case study on ecosystem-based management (EBM). Fisheries management is relatively new in the area, particularly the aspect of managing fish stocks with wide distribution patterns crossing jurisdictional boundaries. Nevertheless, stakeholders are taking bold steps toward improving fisheries management. The impetus to take action comes from the realization that coastal habitats can no longer sustain the level of exploitation to which they have been exposed. The initiative is facilitated by the USAID-funded Fisheries Improved for Sustainable Harvests (FISH) Project in collaboration with various partners. The EBM approach of the FISH Project is incremental and builds on existing management systems and utilizes existing legal and institutional frameworks while encouraging progress toward ecosystem-wide management. Fisheries management tools include coastal management, marine protected areas, limitations on fishing effort and gear, control of extraction of specific life stages of important species, licensing, zoning, and coastal law enforcement. One FISH Project goal is to increase fish biomass by at least 10% in 2010 over the 2004 baseline. Monitoring data collected in 2006 and 2008 to quantify changes against baseline data for key indicators have generally shown incremental improvements based on fisheries-independent surveys and MPA assessments. The Danajon Bank experience shows that there are three major components in working toward EBM: (1) fisheries management interventions should always consider a defined ecosystem boundary as resource management unit; (2) there is a need to understand the dynamics of marine ecosystems and how they respond to human-induced changes, particularly to changes resulting from fisheries; and (3), there is a need for a governance system that supports limits to fisheries resource exploitation activities. The match between the spatial range of the ecosystem and the governance system is the most important consideration and will play an important role in scaling up of fisheries management initiatives.

Keywords ecosystem-based management, fisheries monitoring, governance

Background: Danajon Bank Resources and Management Context

The Danajon Bank (Figure 1), located off northern Bohol Island, central Philippines, is the only double barrier reef in the Philippines and one of only three such double barrier

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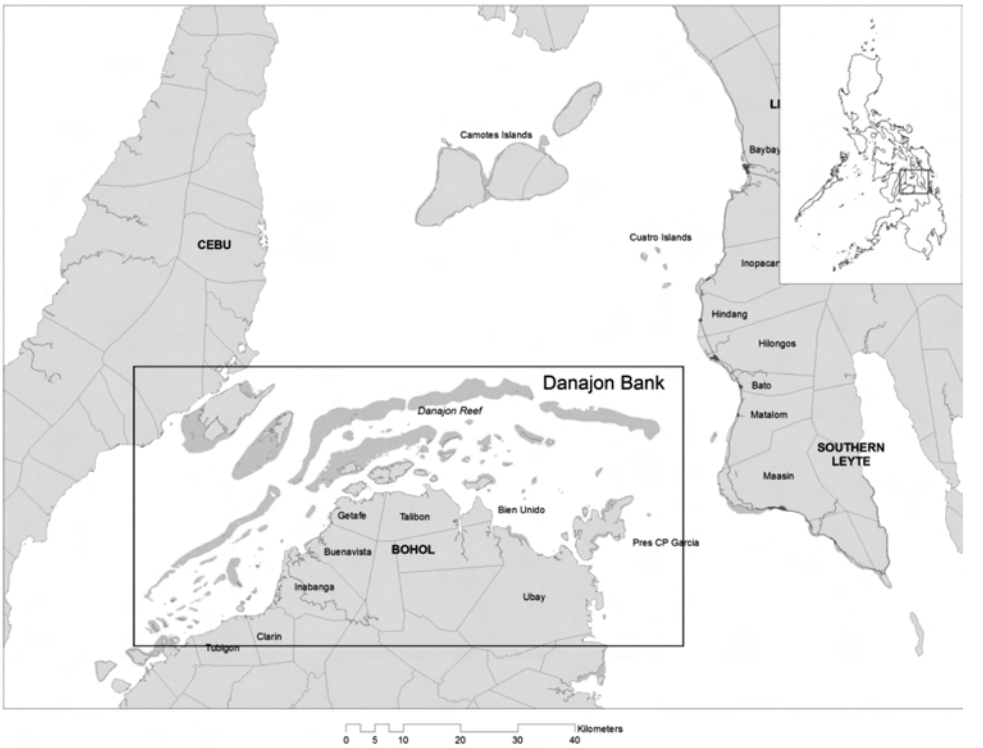

Figure 1. Danajon Bank Double Barrier Reef, northern Bohol, and neighboring bodies of water and islands.

reefs in the Indo-Pacific (Pichon, 1977). The double barrier reef system covers an estimated 272 km^2 and consists of three large reefs spread across 130 kilometers, many clusters of small reefs, and about 40 small islands (FISH, 2004a). This reef area and its associated habitats and fisheries, inshore and offshore, comprise a complex management area that is the focus of this case study on ecosystem-based fisheries management in the Philippines.

Seventeen municipalities, belonging to 4 provinces and 2 regions, each have an exclusive area of political jurisdiction over in Danajon Bank. In Region 7, 10 municipalities belong to Bohol Province and 2 to Cebu Province while 4 belong to Leyte and 1 to Southern Leyte in Region 8 (Table 1). Forty-three percent of the villages (*barangays*) are located in the coastal area and islands, covering 699 kilometers of shoreline. An estimated 28,240 fishers reside in these coastal and island villages, supported by 16,100 motorized and non-motorized fishing boats in their fishing activities. Ten National Integrated Protected Area System (NIPAS) sites have been established within these boundaries, specifically, 7 strict nature reserves and 3 protected seascapes (Green et al., 2002). More than 30 community and municipal-based marine protected areas (MPAs) have been set up and are in various stages of implementation. The Fisheries Improved for Sustainable Harvests (FISH) Project[1] activities in the area focuses on four Bohol municipalities with jurisdiction on the Danajon Bank referred to as the "focal area" of the FISH Project (Figure 2). The municipality of Trinidad, with its coastal river system, was also recently included as part of the FISH Project focal area.

Table 1
Basic descriptive data on the municipalities around Danajon Bank

Province	Municipality	Land area (hectares)	Population	Number of *barangays*	Coastal *barangays*	Length of coastline (km)	Number of fishers	Non-motorized boats	Motorized boats
Bohol	Tubigon	7, 556	44, 434	34	17	28	1, 670	261	620
	Clarin	6, 279	18, 871	24	7	29	335	150	84
	Inabanga	13, 166	43, 331	50	20	62	2, 281	874	629
	Buenavista	8, 730	26, 443	35	11	32	1, 000	492	159
	Getafe	9, 980	27, 852	24	19	77	2, 170	700	664
	Talibon*	17, 704	59, 274	25	19	86	3, 476	750	1, 490
	Trinidad	9, 472	27, 580	20	4	8	83	93	34
	Bien Unido*	4, 482	23, 412	15	15	45	3, 176	840	940
	Ubay*	20, 755	65, 900	44	11	61	1, 492	406	380
	C.P. Garcia*	6, 528	25, 118	23	14	76	2, 093	610	591
Cebu	Lapu-lapu	5, 190	292, 530	30	28	112	3, 825	1, 142	545
	Cordova	780	45, 066	13	11	21	2, 641	1, 498	213
Leyte	Hindang	12, 740	19, 927	20	10	7	502	156	245
	Hilongos	18, 914	53, 911	51	11	12	532	169	260
	Bato	7, 240	33, 930	32	7	4	189	50	79
	Matalom	11, 090	31, 055	30	11	14	620	375	185
S. Leyte	Maasin	21, 170	79, 737	70	19	25	2, 153	200	220
Total		**181, 776**	**918, 371**	**540**	**234**	**699**	**28, 238**	**8, 766**	**7, 338**

Sources: NSO (2000, 2007); Green et al. (2004); Armada et al. (2004), various provincial and municipal profiles.
*Municipalities included in the focal area of the FISH Project.

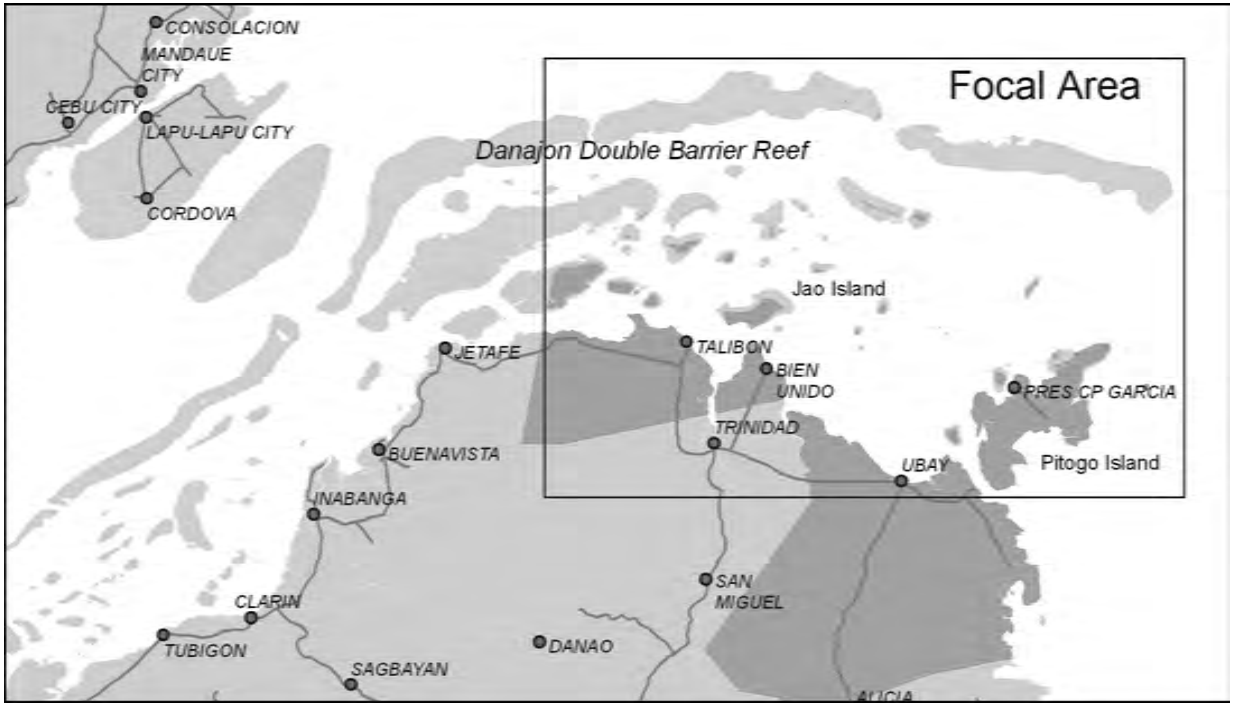

Figure 2. Target area of the FISH Project in the Danajon Bank area.

The Danajon Bank barrier coral reef system provides habitat for associated reef and offshore small pelagic and demersal fisheries. There are many small islands surrounded by reefs, seagrass, and mud flat habitats. The rich diversity of corals (Calumpong et al., 1997) and associated fish and marine life has attracted a growing population of fishers and other marine resource–dependent communities. Thus, the densely populated islands in the Danajon Bank mostly contain people dependent on fisheries and aquaculture as there are few economic development alternatives in the area. Consequently, there exist pervasive impacts on the ecosystem from overuse, habitat destruction, and pollution, all creating significant challenges for resource management efforts (Christie et al., 2006).

Threats to Coastal Resources

The Danajon Bank marine ecosystem, with its high density of fishers (Christie et al., 2006), has been subjected to extremely high fishing pressure and largely through unsustainable, destructive, and illegal fishing methods. The use of dynamite and cyanide for fishing has been widespread and they are among the top three issues identified by fishers in a survey conducted in 2003 (Armada et al., 2004; Green et al., 2004). Collection of fish for the aquarium trade, through the use of cyanide, has taken its toll and has resulted in further reef degradation. Fisheries outside of the shallow reef areas are also heavily exploited by a combination of small-scale, locally based fishers and commercial fishing boats that fish illegally inside of the municipal boundaries of 15 km from the shore (Christie et al., 2006)

In addition to fishing-related disturbances, the overall reef condition is threatened by human population growth. The coastal land areas adjacent to the Danajon Bank have an average of 505 persons/km^2 compared to 282 persons/km^2 for the Province of Bohol (ADB et al., 2003). This dense population leads to conversion of land for settlement, agriculture, and landfills for waste, which all adds to the pollution in the Danajon Bank. Mangroves are also being removed and the area converted to other uses, thus contributing to increased runoff from inland areas and to a reduction in critical nursery habitat and shoreline resilience to erosion and storms.

The final threat to the area is the poverty of northern Bohol and surrounding provinces. Over 60% of the coastal inhabitants of northwestern Bohol live below the poverty line of US$120 per month (Green et al., 2002). This low income drives fishers to catch smaller fish and use more efficient but destructive methods. Such poverty significantly lowers the capacity of people to change their behavior and switch to alternative, sustainable livelihoods.

Demographic and Socioeconomic Context

Historic and contemporary human interactions with the rich natural resources in Danajon Bank are complex. A challenge to developing resource management options is to gain a full understanding of these interactions. The average monthly family income is less than US$100 a month of which about 51% was spent on food while less than 1% was spent on medical care (NSO, 2001). The high incidence of poverty limits options available to FISH Project, government officials, and resource users and suggests that the stakes are high. As environmental degradation continues, the poorest sectors tend to suffer the most.

With the Philippine population of about 90 million people projected at current growth rates to double in 30 years, infrastructure, services, and environmental conditions will be stretched to the limits. Since 1990, the coastal population in Region 7 has increased 24.7% and Bohol's population has grown by 19.5% (NSO, 2001). Although the growth rate in northern Bohol is lower than other areas within Region 7 (Green et al., 2000), partly due to limited economic opportunities, the population densities on outlying islands on Danajon Bank are unusually high with most people dependent on coastal resources.

While there are encouraging trends, the overall educational infrastructure in Bohol is in a chronic state of need, and considerable financial barriers frequently prevent children from attending school. Despite these limitations, literacy remains high in Bohol—according to the Department of Education between 82% and 98%—a condition that broadens the suite of available tools for education campaigns to engage the public.

Coastal Economic Activities

About 43% of the 540 villages of Municipalities surrounding Danajon Bank are coastal or island villages and about 5% of the population are fishers. Calumpong et al. (1997) reported that approximately 50% of the population the Northwest Bohol coast is directly or indirectly engaged in fishing and only 5% of coastal inhabitants own agricultural land. With a rapidly growing population and limited marine resources, economic diversification is a key dimension for sustainable development. Sustainable coastal tourism is one opportunity. The double barrier reef represents a potential global attraction for divers and eco-tourists, potentially providing jobs and stable tax revenue, but only if the ecological condition is significantly improved.

Seaweed culture is another alternative to resource extraction. Thousands of families on the outlying islands depend on *Euchema spp.* culture to either supplement or provide a main source of income. While potentially vulnerable to disease and fluctuations in price, seaweed culture can provide needed income. Culture of fish and shrimp is also a lucrative source of income. However, this is capital intensive and limited to few families who have established rights to the available aquaculture sites. While aquaculture is an important livelihood, its impacts on mangroves, seagrass beds, and coral reefs reduce ecosystem services from these habitats.

The State of Coastal Planning and Governance

The level of experience with and progress toward coastal planning and management vary around the Danajon Bank—-primarily because previous coastal management projects did not cover all municipalities. The Coastal Resource Management Project (CRMP, 2004) developed benchmark indicators of progress toward coastal management. Several of the municipalities, especially those in the northwest portion of the Danajon Bank, are further along in reaching these benchmarks (Christie et al., 2006). It is by design that the FISH Project selected the four municipalities in the northern portion of Danajon Bank as the focal area because these are the municipalities that did not receive direct assistance from CRMP.

The coordination of various government and nongovernment entities is a critical step toward effective coastal management. A wide variety of institutional partners in the area have a role to play. The lead institutions to plan and sustain management are the municipal governments with support from the Provincial Government. Supporting organizations include a variety of nongovernmental organizations (NGOs), small academic colleges, and a number of community-level organizations, all of which are critical in building local support. Finally, the FISH Project is currently the main catalyst for management planning and works together with the government and community partners in this process.

Context Summary

The resource-rich Danajon Bank area has socioeconomic, demographic, and institutional conditions that make fisheries management difficult. The large population is generally poor and highly reliant on fishery resources. Yet, many partners in the area are aware of or have

been involved to some degree in coastal resource management initiatives to improve habitat management as well as planning the use of the marine resources within the jurisdiction of each municipality. However, fisheries resource management per se is relatively new in the FISH Project target municipalities, and even in neighboring municipalities, particularly the aspect of managing fish stocks with wider distribution patterns and migrating from one jurisdiction to another. Nevertheless, leaders are taking bold steps toward improving fisheries management. The impetus to take action comes from the realization that coastal habitats can no longer sustain the level of exploitation they have been exposed to. The situation has serious consequences for food security, biodiversity conservation, and economic growth. The need to develop management within an ecosystem framework that makes all the necessary connections is now seen as the way forward in this complex management area. And, it also appears that the ecosystem tenet from a logical perspective is easily understood by many and what is lacking are the "how to's," which the project, together with the partners, develop and provide.

Definition Used for Ecosystem-Based Approach in Danajon

The FISH Project is utilizing an ecosystem approach to fisheries management in its four Philippine project areas including Danajon Bank. In a broad sense, this considers geographically specified fisheries boundaries and management. It takes account of current knowledge and uncertainties about, and among, biotic, abiotic, and human components of coastal and marine ecosystems as they pertain to fisheries, and strives to balance diverse societal objectives. The approach addresses human activities and environmental factors that affect these ecosystems, the response of the ecosystems, and the outcomes in terms of benefits and impacts on humans. The approach places an emphasis on protecting the productive potential of the marine and coastal ecosystems and sees humans as being integral to the ecosystems of concern. To the extent that an ecosystem is already degraded, the goal is to rebuild and restore the ecosystem or just simply move toward sustainable use.

The ecosystem-based fisheries management approach of the FISH Project is incremental and builds on existing management systems that are already proven and functioning in the Philippines and within its project areas (FISH, 2004; Christie et al., 2007). It utilizes the existing legal and institutional framework while it encourages working toward ecosystem-wide management. It assumes that functioning integrated coastal management (ICM) or coastal resource management (CRM) units at the *barangay*, municipal/city, and provincial levels, that include fisheries management tools, are the foundation of effective ecosystem-based fisheries management. Fisheries management tools include the fundamentals of sound CRM as well as more focused tools such as marine protected areas, limitations on effort and gear, control of extraction of specific life stages of important species, and coastal law enforcement, among others. It also recognizes that the various factors, both human and environmental, that affect coastal resource and fisheries management, must be dealt with in an integrated framework based on the most workable and acceptable models functioning in the country.

The FISH Project in its incremental approach is initially focusing on a local (focal area) scale with a gradual scaling up to medium- and larger-scale fisheries management. Early management thrusts in near shore areas that include coral reef, mangrove, and related demersal fisheries will expand to include offshore pelagic fisheries as feasible. Scaling up of coastal and fisheries management will be determined by increasing availability of relevant information for planning and the improved institutional capability for implementation and

enforcement as well as willingness to work with other neighboring local government units, whose fish stocks and other marine resources they share.

Characteristics that Make this Example Ecosystem-Based Management (EBM)

Coastal resource management began formally in 1996 in Bohol Province when the CRMP commenced operations. Although this project did not work in all the municipalities covering the Danajon Bank area, the CRMP, through the provincial government, set in place a foundation for planning at the municipal level throughout the province. The FISH Project took off from this, commenced the EBM process in 2004, concentrating on the four municipalities as focal area, and gradually expanded to cover the rest of the municipalities that constitute the Danajon Bank ecosystem (target area).

The Danajon Bank management area has several characteristics that make it opportune for EBM. The area and its resources are affected by multiple forces and threats that dictate the need for integrated and holistic management. The approach used considers both the needs of the ecosystem parameters as well as the needs of the resource users, their limitations and abilities in management. Distinctive aspects of the management approach being used include:

- Management boundaries are primarily determined by the important fisheries and habitats of the area with some adjustments for political jurisdictions
- Habitats and other ecological subsystems that support fisheries are prioritized for protection
- The interface between the ecosystem (fisheries) and human uses for management is studied and analyzed to determine management interventions that are feasible and that can achieve optimal success in relation to social, economic, and political forces
- There is a focus on maintaining and augmenting productive potential of the ecosystem and important fish stocks while addressing biodiversity conservation
- The approach utilizes an integrated management framework that addresses multiple issues from both ecological and societal perspectives
- The need to scale up from smaller to larger geographical areas and fisheries with wider distribution is determined by relative sizes of fisheries ecosystems interfaced with political jurisdictions and ability of management entities to implement
- Scaling up moves at a pace that the human community can comprehend, adapt to, and support

Coastal Resource Management and EBM Tools being Used

The development of EBM to address the multitude of issues in the area is integrated and participatory and engages as many of the important stakeholders in the process as possible. This participatory planning process is conducted on a parallel track with scientifically based planning that guides, as possible, the overall outcome of the planning process. Scientific studies, baseline assessment and monitoring that are feeding into plan development include:

- Biophysical status and extent of coral reefs, mangroves, and seagrass habitats
- Identification of important fisheries, their status, productivity, and management concerns
- Monitoring of changes in the condition of critical habitats and fisheries as project indicators

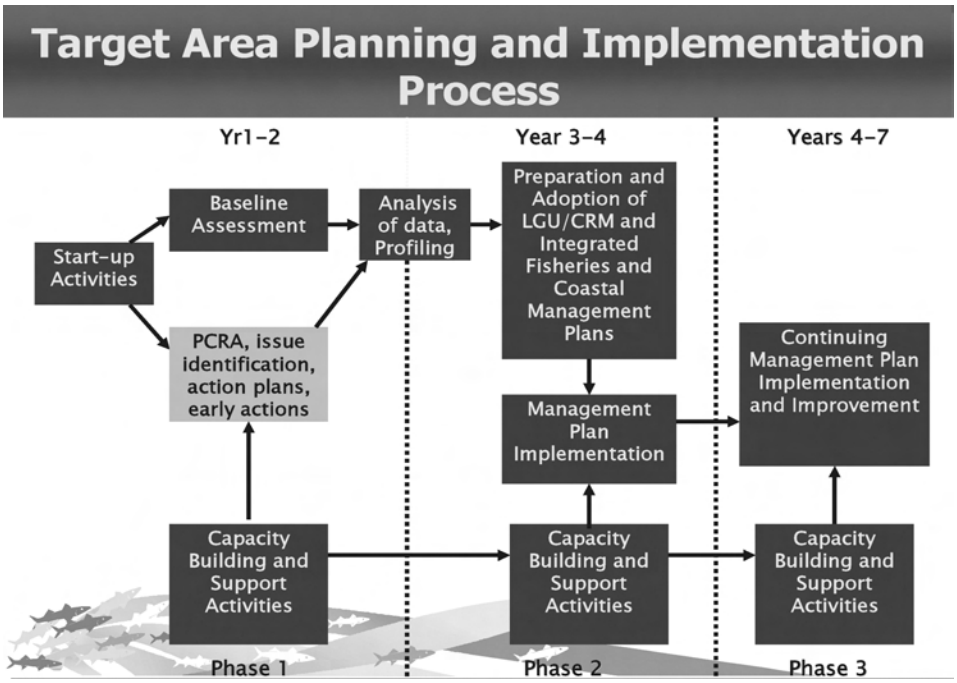

Figure 3. Target area planning and implementation process for FISH EBM process.

- Determination of current movement patterns that may affect larval dispersal and provide basis for selection of sites for MPAs
- Baseline studies on the socialeconomic, demographic, and population conditions
- Detailed observation and analysis of resource use methods, patterns, and catch rates
- Institutional and capacity baselines to inform management planning and capacity building

The planning and implementation process (Figure 3) runs parallel with initial field implementation of interventions that are critical to demonstrate early gains focusing on interventions that are most likely to deliver early results and management response to very obvious issues. This is necessary to engage the stakeholders and to make inroads into the issues they are facing. Examples include improving the enforcement of existing MPAs, strengthening enforcement to curb illegal and destructive fishing practices, making and supporting local action plans, initiating municipal ordinances to address key policy issues on fisheries management that are compatible and complementary to neighboring municipalities, and ongoing education with fisher communities, the youth, and other stakeholders.

The management tools being planned and implemented over the long term are tailored to improve fisheries management and productivity and thus to improve the well being of the stakeholders. The strategies are mostly focused on reducing fishing effort, stopping illegal fishing, and reducing incidence of fishing techniques that cause overfishing and/or habitat destruction. At the same time strategies are aimed at raising awareness about the need for coastal resource and fisheries management and to develop economic development alternatives that are not dependent on natural resource extraction. The workshop on the

formulation of the Danajon Bank Fisheries Management Plan (Christie et al., 2006) conducted in June 2005 and the participants identified the following initial strategies:

1. Strengthen planning and enforcement through education, training, and capacity building.
2. Ratify an agreement among municipal governments to protect Danajon Bank, coordinate interventions, share information and expertise, and harmonize municipal fishery ordinances.
3. Implement Danajon-wide registration and licensing of municipal fishers, vessels, and gears.
4. Delineate jurisdictional boundaries for municipal waters.
5. Intensify education campaign on the importance of Danajon Bank and the effects of destructive fishing gears and overfishing.
6. Conduct socioeconomic monitoring of fishing communities, including research relevant to illegal and destructive fishing practices.
7. Strengthen People's Organizations and Fisheries and Aquatic Resources Management Councils—multi-sector groups that oversee and implement policy.
8. Improve management of existing MPAs and establish a functional network of MPAs.
9. Develop alternative and supplemental livelihoods for the poor affected by regulations.
10. Increase municipal and provincial budget allocations for coastal and fisheries management.

As the FISH Project has evolved, strategies have been refined as each local government unit (LGU) does its share to contribute to a Danajon-wide management effort. In this regard, each municipality has generated its own plans and actions and some components were formalized through enactment of municipal ordinance. The plans and ordinances are coordinated through the Danajon-wide management council to ensure that there is consistency in the policies and their implementation by each local government unit. More particular fisheries management tools being endorsed are species- and gear-specific management interventions that include:

- Close season during the spawning period of rabbit fish (*Siganus canaliculatus*)
- Ban on catching blue crab (*Portunus pelagicus*) smaller than 12 cm carapace length
- Ban on catching and selling berried blue crab (*Portunus pelagicus*)
- Mesh size limit of 12 cm for crab gillnets
- Ban on use of beach seine in the entire Danajon Bank
- Strict implementation of 3 cm minimum mesh size limit for fish corrals
- Limits on the deployment of stationary fishing gears

Species-specific interventions were initially focused on fish and invertebrates that comprise the large portion of the trophic system that are utilized by fishers in Danajon Bank. Other species will likewise be dealt with as the necessity arises, especially when the initiative comes from the stakeholders themselves. Similarly, gear-specific management initiatives focused on fishing gears that have immediate impacts on the abundant and common stocks. At the same time inter-LGU initiatives like zoning areas for fisheries use, integrated law enforcement activities, and the establishment of a network of MPAs were recently initiated.

Table 2
FISH Project objectives and their means of measurement

Objectives	Measurement
• Increase in abundance of selected fisheries resources in focal areas	• Percent change in catch per unit effort compared to baseline via fishery-independent methods
• Increase catch rate of selected fisheries in focal areas	• Percent change in catch per unit effort compared to baseline via fishery-dependent methods
• Increase in reef fish biomass inside and adjacent to selected MPAs in focal areas	• Percent change in abundance (tons/km^2) compared to baseline
• Increase in reef fish species richness inside and adjacent to selected MPAs in focal areas	• Percent increase in number of species/ 500 m^2 compared to baseline
• Improve benthic condition inside and adjacent to selected MPAs in focal areas	• Percent change of living coral cover compared to baseline

Goals and Objectives (and Indicators) of the Program

The FISH Project has an overall goal: *Marine fish stocks increased by 10% (over 2004 baseline levels) in focal areas by the year 2010.* This goal is considered to be an objectively verifiable goal that can be quantified over the life of the project. In addition, the Project has five primary objectives that are measurable with specified targets and provide the basis for determining to what extent the project is progressing toward it overall 2010 goal. The objectives and their means of measurement are given in Table 2.

The process indicators of the FISH Project are termed as "intermediate results" or IRs. The IRs were carefully selected to help guide the activities of the project so that the processes necessary to achieve the primary objectives and goal are clear and also measurable. The relevant IRs related to fisheries resources management and their means of quantification are listed in Table 3.

The Project goal, objectives, and indicators provide a useful guide to project implementation. USAID normally requires a rigorous results framework to be developed in the first year of project implementation. The framework for FISH has served more than just monitoring project progress. It also provides a guide to the local governments who, in essence, need to replicate mini-versions of the project within their own jurisdictions. Thus, the project results framework is to some degree being replicated in the management plans developed by each municipality.

How are Ecosystem Governance Arrangements Designed and Implemented?

The legal framework for the Philippines applies in the Danajon Bank area and guides the development of the EBM framework. In general, the municipal governments have jurisdiction of their municipal waters to 15 km offshore, which for the most part, covers the management area.[2] A key aspect of management is supporting the governance authorities with incentives to improve their ability to enforce the law and to engage the coastal communities. In this way the FISH project serves as a catalyst to educate and to bring the municipal government authorities together to plan for an EBM scheme that goes beyond

Table 3
Fisheries management related intermediate results of the FISH Project

	Intermediate results	Means of quantification
1	Municipal fishers and fishing crafts registered and fishing gears licensed in focal areas	• Number of municipal fishers and crafts registered and gears licensed compared to baseline
2	Law enforcement units, prosecutors, and judiciary trained and/or assisted in fisheries law enforcement in target areas	• Number of coastal law enforcement units established, and/or improved and functional
3	Effort restrictions introduced in focal areas	• Number of effort restrictions introduced
4	MPAs established, improved, and functional in focal areas	• Number of MPAs and hectares attained MPA rating level 2*
5	Local government units in focal areas adopting CRM	• Number of municipalities achieving basic requirements of CRM level 1 benchmarks
6	Inter-LGU and interagency collaborative agreements and ecosystem-based fisheries management initiatives in target area	• Number of agreements/plans signed or adopted among government units, agencies, and relevant stakeholders
7	Reproductive health and population programs implemented and/or improved in focal areas	• Number of *barangays* integrating reproductive health/population management
8	National fisheries policies supporting sustainable fisheries	• Number of national policy instruments developed, reviewed, or revised.

*MPA rating defined by a system adopted for MPA evaluation in the Philippines (White et al., 2006).

their own areas of jurisdiction. The national Bureau of Fisheries and Aquatic Resources (BFAR) has the mandate to support but, due to the large budget and manpower requirement of the initiatives, does not play an active role in developing the management framework for local government units and limits its responsibility to licensing and regulating fishing of all commercial fishing boats, development of fisheries livelihood activities, and management of migratory and shared fish stocks. Thus, the authority is largely devolved to local governments. In whole, institutions that have roles in the management of fisheries and other marine resources of Danajon Bank include the following:

- Local *barangay* and municipal governments and Provinces of Bohol, Leyte, and Cebu
- Fisheries and Aquatic Resources Management Councils (FARMCs) at *barangay* and municipal level
- National Bureau of Fisheries and Aquatic Resources (BFAR)
- Municipal, provincial, and national coastal law enforcement units
- National Department of Environment and Natural Resources (DENR)
- Fisheries Improved for Sustainable Harvests Project of USAID
- Bohol-based NGOs

- Local fisher organizations
- Private sector fishing companies
- Municipal- and *barangay*-level managers supported by government

Given the legal and institutional framework within which Danajon Bank management operates, the following describes how the ecosystem governance arrangements are designed and implemented.

Access to Resources

The national and local laws of the Philippines dictate the access to resources in the Danajon Bank. Generally, all resources within the 15 km boundary of a municipality or city can be limited to the access of residents of the government unit. Equally, fishing boats that are 3 gross tons or more are required to fish outside of the 15 km boundary including all fishing boats using active fishing gear regardless of tonnage. In practice, the exclusive access by resident fishers to their own municipality is not applied, with a few exceptions. On the other hand, the limit of boats to 3 gross tons is increasingly enforced by municipalities that have the capacity and will. Access to resources is also being limited by establishment of no-take marine reserves (sanctuaries). In most cases, these are authorized by the local government units and enforced by local governments and community organizations working together. Christie et al. (2009) and Eisma-Osorio et al. (2009) discuss the importance of enforcement efforts to improve resource conditions and the conditions and processes supporting successful MPA and fisheries rule enforcement in this context.

Resource Appropriation

Generally, appropriation of resources is guided by the resource access laws described earlier. But given the discretion allowed by municipalities in managing their own resources, rules developed through management planning limit the use of particular fishing gear and, in some instances, the size of fish caught. In addition, use of certain areas for fish cages, seaweed farms, stationary gears, and fish ponds are appropriated under license arrangements with lessees that pay license fees to the local government. Decisions on matters of fishing gear are made through a highly participatory planning process informed by scientific research and facilitated by the FISH Project working together with the local governments and fishing communities. Activities often include planning and education workshops to develop management interventions for specific species, fishing gear, and area in relation to the broader Danajon Bank area. The process includes: (a) engaging stakeholders and resource users in a focus group discussion on exploitation issues; (b) biological and technical inputs from resource persons; (c) agreement on appropriate action steps; (d) field validation and resource user consultation; (e) drafting of ordinances; (f) public hearing; and (g) coordination meetings to harmonize activities with law enforcement as well as fund appropriation. These focus group discussions provide direct input to the municipal regulatory and ordinance forming processes. Over 1 to 2 years, as guidelines are translated into municipal ordinances for enforcement, the legal basis for improved management is put in place.

Resource Depletion/Degradation

Given the overexploited nature of fisheries resources in Danajon Bank, most management efforts are directed at protecting and restoring degraded coastal ecosystems. The primary

tools used are improved law enforcement and implementation of effective MPAs that are no-take fisheries reserves. Also, early fisheries management, primarily gear- and species-specific interventions, that are obvious and do not require large data collection efforts were immediately put in place. An equally important tool to support these efforts is education of stakeholders about the consequences of continued depletion and degradation. One major compelling factor that hastened the engagement and response of partners with immediate actions for the management of the fisheries of Danajon Bank is the grim results of the baseline assessment. Fishery-independent surveys indicated very low catch rates (FISH, 2005), and in particular, the independent trawl survey showed that demersal fish stocks was just about 0.45 tons/km^2, far below similar stocks estimated by Vakily (1982) in San Miguel Bay (2.13 tons/km^2), Villoso and Aprieto (1983) in Lingayen Gulf (1.33 tons/km^2), Armada and Silvestre (1981) in Carigara Bay (2.00 tons/km^2), and comparable to the most overfished demersal stock in the country estimated by Armada (1994) in Manila Bay (0.44 tons/km^2). Many of the partners, stake holders, and resource users, particularly the older ones, are very aware that Danajon Bank has a much better potential than the current state and agree that this can only be achieved through improved resource management.

Monitoring Compliance and Sanctions for Non-Compliance

Monitoring compliance with management regulations is multifaceted and involves resource users and law enforcers. Monitoring for prevention of illegal fishing operations is mostly conducted by local government law enforcers trained for such operations. Much of the legal monitoring is intended to prevent illegal actions and to serve as an effective deterrent. The most difficult aspect is to ensure that prosecutions are carried out and that offenders pay fines or serve time in jail. This is the only way that a serious message is sent to the community of known offenders. In addition to monitoring and sanctions by police or village officials, community monitoring also ensures the implementation of agreed-on regulations. In the case of no-fishing MPAs, most monitoring is by community volunteers that ensure that fishing does not occur inside the MPA boundaries. Sanctions for offenders range from a verbal warning at the site, to public reprimands, to occasional arrest and court case for repeated offenders. The community buy-in and educational process is critical in building effective monitoring and compliance systems at the local level. Survey interview research supports the FISH field experience. Effective enforcement is correlated with community support for an MPA and the effectiveness of local community enforcement groups is a statistically significant predictor of improved coral reef conditions (Christie et al., 2009).

Funding

The substantial costs of planning and implementing an EBM program in the Danajon Bank area are shouldered by both external and internal entities of the system. The recurring budgets for management and law enforcement are largely from municipal governments and to some extent from the Province. The FISH Project supported by USAID provides catalytic support through its on-site staff for training, technical support, and several subcontracts to local NGOs to provide social services related to MPA implementation and education. The FISH Project only provides technical support so that the local governments do not become dependent on funding for operations. Thus, most of the financial burden falls on the local governments. Although still in the minority, a few municipalities in Danajon Bank have realized the economic benefits from managing the resources not just from the fines from apprehensions and fees from licenses and permits but also from calculated increase in catch

rates due to fisheries management. The data on catch rates provided through the FISH Project as well as revenues from fines and fees encourages the municipal council to allocate funds for coastal and fisheries management activities in those municipalities. Typically, municipalities in the Danajon Bank are poorly funded; nevertheless, each municipality allocates a portion of its budget for CRM, fisheries management, and law enforcement. Annual amounts being made available vary from about US$10,000 to $50,000 depending on the local government unit.

Coordination

Clusters of Municipalities have aligned their management plans for consistency and to complement each other's management efforts. Thus, management coordination depends on each municipal government adopting management actions through municipal ordinances that in turn can be enforced through locally coordinated enforcement actions. The overall coordination to link the municipal governments in planning and decision-making is through a Municipal Cluster Council for Danajon in which the Provincial government plays an active role. The clusters of municipalities were formed as Coastal Law Enforcement Councils (CLEC), which has overall coordination at the provincial level. FISH Project initially engaged the council (CLEC 2 for Danajon Bank) as the immediate partner for the establishment of local law enforcement units and implementation of municipal law enforcement initiatives. The council, however, later on also proved itself to be the appropriate coordination body for the introduction and harmonization of fisheries management initiatives. Member municipalities of each council provided the peer pressure to erring and non-complying members. And member municipalities who are way ahead with their fisheries resource management initiatives served as mentors to others. Other means of coordination include sharing of expertise of technical staff of the province and member municipalities and the regular operation planning for the Danajon Bank wide fisheries law enforcement activities. Recently, FISH Project provided technical support in determining appropriate MPA sites for the network of MPAs in Danajon Bank as well as training of local partners in the bio-physical monitoring of their respective MPAs. People's organizations managing these MPAs have formed an alliance to coordinate their efforts and share lessons and best practices with one another. They are formalizing this alliance so that they will become eligible to apply for financial and technical support from other organizations and institutions. Such coordination, at multiple governance levels, is clearly related to improved MPA success (Christie et al., 2009).

Monitoring Resource Conditions

Monitoring of the resource conditions of Danajon Bank serves as a measure of project results and provides a basis for implementing activities to capacitate municipalities or clusters in making monitoring part of their regular coastal resources management activities. By design, the FISH Project generated baseline data in 2004 and conducts subsequent monitoring every two years until 2010 to determine project results or impacts. The baseline data were collected, processed, and analyzed, and they also became the basis for management interventions as well as information materials for engaging community, resource users, and government officials in the coastal and fisheries resources management initiatives. On separate occasions, partners from the local governments, communities, and people's organizations were involved in the project's training programs in MPA and fisheries catch and effort monitoring for them to perform basic fisheries data collection and analysis. Local

MPA and catch monitoring teams were involved in the FISH Project's third monitoring event in 2008 and will also be involved in the final monitoring event in 2010. This provides a venue for establishing and refining habitat and fisheries resource monitoring protocols that can readily be performed by the local partners beyond the life of the project. Pietri et al. (2009) further explore the relationship between habitat and MPA monitoring with the success of educational programs.

Learning/Management Adaptation

Development of coastal and fisheries regulations initially took the form of issues and were aired in meetings in the community and during public hearings. The process is facilitated by the FISH Project. Issues are usually raised during dialogues with various sectors. Management initiatives normally start with identification and spatial mapping of issues. Whenever possible, FISH Project staff provide technical inputs by showing and explaining the status of the fisheries in question; biology, life cycle, and fisheries of species involved; and characteristics and operations of fishing gears used. Then resource users in the group enhance the inputs by confirming or refuting the information based on their experience. The group then agrees and prioritizes recommended actions and laws. They form the main component of the next step of activities, which include, among others, data collection in support of ordinances, drafting of ordinances, information dissemination, public hearings, and training of personnel on actions required to support the implementation of the ordinance.

Conflict Resolution and Transparency of Management

The transparency of the governance process varies among municipal governments. Some municipal governments are more favorable to the fisheries management process than others because large-scale commercial fishing interests exert political influence in some. But the evolution of integrated coastal management, and now EBM in the Philippines, in general, is moving toward increased transparency in planning and implementation. The level of transparency depends largely on locally elected mayors and municipal councils together with the provincial governor and the provincial legislative board. In the Danajon Bank management area, the processes described earlier for planning and coordination are the primary means for maintaining transparency of management and also for conflict resolution among the larger stakeholders. At the very local level, where conflicts arise because some fishers do not agree to follow the new rules, the *barangay* captain and council perform conflict resolution as feasible. Considering the complexity of the context and inherent linkages between rule enforcement and conflict, managers and local officials should be prepared with well-designed conflict resolution strategies (Christie et al., 2009). Ultimately, however, strict rule enforcement is necessary for success because the management rules are developed in a participatory manner, agreed on by the local officials and majority of resource users, and are encoded in local law. If rule infractions are recurrent, law enforcement officials are engaged and cases may be brought to court.

Impact on Resource and Ecosystem Conditions as Shown by Key Indicators

With five years gone and two years of implementation remaining, the project and its partners have attained the intermediate objectives of managing Danajon Bank as an ecosystem. The four municipalities in the FISH Project's focal area have each adopted a 5-year coastal

Table 4
Results of fisheries independent surveys during the 2004 baseline assessment and the 2006 and 2008 monitoring events in Danajon Bank

	2004			2006			2008		
Gear	Mean (kg/haul)	s.d.	*n*	Mean (kg/haul)	s.d.	*n*	Mean (kg/haul)	s.d.	*n*
Bottom-set gillnet	2.06	1.44	32	1.83	1.67	32	3.88	4.32	32
Bottom-set longline	4.77	3.03	30	2.62	2.20	32	1.32	1.16	35
Fish trap	1.06	0.68	30	1.34	0.83	30	1.17	0.67	38
Bottom trawl	1.41	1.63	18	2.91	3.87	19	2.89	3.86	19

fishery resources management plan and coordinated in the enactment of fishery ordinances on closed season for siganids, minimum size limit for blue crab, total ban on the use of beach seine, and registration of fishers and fishing boats. They have also coordinated the enactment of ordinances on the creation of enforcement teams for the municipality and special enforcement teams (SET) to directly guard MPAs supported by the project. The four municipalities have also completed the process of legitimizing the establishment of MPAs and are in the process of establishing a network of about 20 MPAs, designed to contribute to a combined effect that enhances the process of habitat protection and fisheries replenishment. To gradually expand and cover the rest of the municipalities that constitute the Danajon Bank ecosystem (target area), initiatives like registration and licensing, closed season for siganids, and minimum size limit for blue crab are being replicated in the rest of the target area. A technical working group (TWG) from the nine municipalities of the Danajon Bank in Bohol Province was created as an initial step to scale up the activities to the entire Danajon Bank ecosystem. This TWG has recently launched an initiative to declare Danajon Bank as a natural heritage site to increase public and local government awareness on Danajon Bank as a unique and productive ecosystem.

The expected result of the FISH Project interventions is the increase of fish biomass by at least 10% in 2010 over the 2004 baseline. This is based on an elaborate computation incorporating fisheries-independent and fisheries-dependent surveys and MPA assessment methods. The results to date in Danajon are showing progress toward the objectives of the project per the results framework. Monitoring data collected in 2006 and 2008 to quantify changes against baseline data (2004) for key indicators have generally shown incremental improvements. Fisheries independent surveys (Table 4) have shown declines in the bottom set longline test fishing gear but increases in all other three test fishing gears (bottom-set gillnet, fish trap and bottom trawl). The catch rates of trawl and bottom-set gillnet has practically doubled between those periods. Fisheries-dependent surveys (Table 5) revealed mixed results but evidently showed higher values for catch rates that have increased and much lower magnitude for those that declined. The aggregated weighted mean for this is about 16%.[3] Unfortunately, even illegal fishing activity has benefited from this, as in the case of an active fishing gear, the Danish seine, whose catch rate has more than doubled in 2008 from its 2004 level.

Assessment of MPAs results are given in Figure 4. Two of the three MPAs surveyed still showed slight decline in reef fish biomass while one MPA (Hingutanan East Island) showed a remarkable increment (Figure 4a). The number of species observed in all three

Table 5
Results of fisheries dependent surveys during the 2004 baseline assessment and the 2006 and 2008 monitoring events in Danajon Bank

	2004			2006			2008			
Gear	Mean (kg/day)	s.d.	*n*	Mean (kg/day)	s.d.	*n*	Mean (kg/day)	s.d.	*n*	% change (2004–2008)
Stationary liftnet	13.48	8.99	66	17.38	9.87	6	62.10	107.45	87	360.70
Drift gillnet	7.37	6.86	458	11.65	15.50	610	24.33	216.12	561	230.12
Danish seine	24.75	15.21	413	79.06	42.90	234	56.80	39.65	268	129.48
Fish pot	9.50	8.27	59	19.90	8.43	72	15.02	9.33	89	58.07
Encircling gillnet	42.67	73.15	21	45.84	70.57	55	66.90	48.66	57	56.77
Fish corral	5.30	4.44	127	4.41	10.42	82	6.29	7.09	168	18.64
Set gillnet	10.29	6.61	250	13.59	7.85	232	11.61	7.74	319	12.81
Hook and line	2.50	1.82	382	2.68	3.10	457	2.78	2.79	301	11.19
Squid jig (troll)	1.53	0.91	73	1.73	1.45	84	1.50	1.08	159	−2.14
Otter trawl	13.57	6.52	174	6.38	4.90	6	13.01	5.54	22	−4.10
Crab liftnet	3.37	1.60	735	2.40	1.47	787	3.20	1.30	551	−5.03
Multiple handline	3.60	3.17	93	4.00	3.55	121	3.35	4.03	72	−7.05
Drive-in gillnet	14.77	10.01	220	12.31	8.29	516	12.57	10.50	653	−14.90
Trammel net	5.73	5.01	81	6.09	3.37	167	4.48	2.72	186	−21.78
Spear gun, harpoon	2.92	1.53	15	1.68	1.18	167	1.60	0.93	91	−45.35
Bottomset gillnet	15.81	20.39	168	7.66	8.86	424	8.62	8.82	616	−45.50
Spear w/compressor	29.05	15.54	65	23.22	7.98	75	14.57	6.99	72	−49.84
Bottom-set longline	4.59	3.22	222	3.29	2.73	302	2.29	1.80	264	−50.14
Crab gillnet	3.40	2.25	789	2.04	1.21	625	1.65	1.18	659	−51.51
Crab pot	6.65	2.47	457	3.66	1.79	364	2.93	3.46	472	−55.92
Scoopnets	36.23	11.45	57	21.70	15.25	81	9.57	16.81	82	−73.58

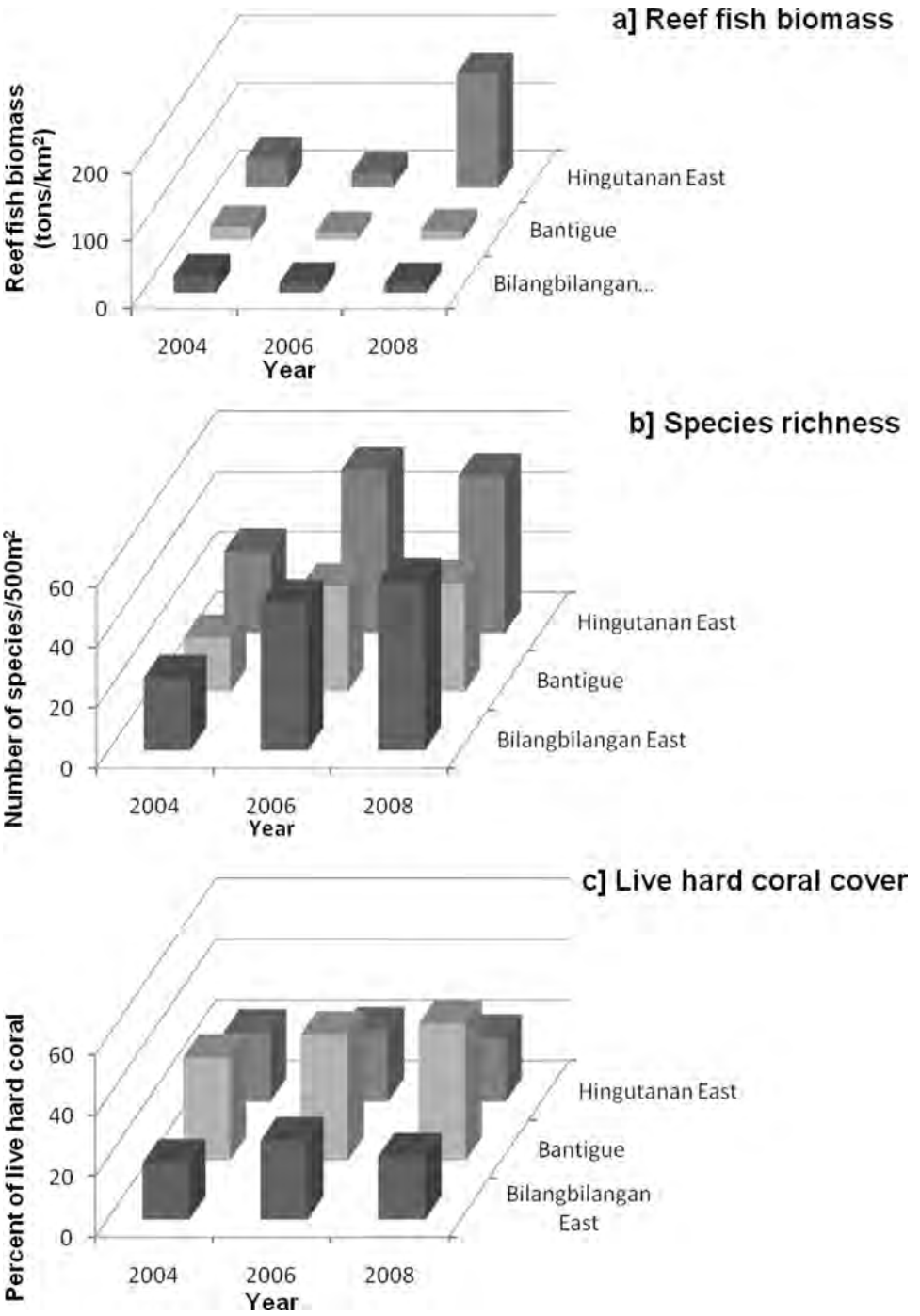

Figure 4. Results of MPA survey during the 2004 baseline assessment and 2006 and 2008 monitoring events in Danajon Bank.

MPAs has increased significantly, indicating increasing species richness in those protected areas (Figure 4b). Protection has likewise brought a slight increase in live hard coral cover (Figure 4c).

Evolution of the EBM Regime and Overall Results

The development of an EBM regime in the Danajon Bank area is a slow and incremental process. The lessons being learned point to the need for patience as the system evolves and expands to become more inclusive and holistic. The process of scaling up to management on ecological scales requires that difficult issues such as overfishing are addressed. EBM necessitates higher levels of coordination, which is challenging. The context demands that managers focus on feasible solutions that will create tangible benefits. The benefits need to be measurable and apparent to the resource users as well as those more aware of ecological parameters and needs. An adaptive planning and management process is essential to slowly build a workable system that achieves the objectives of EBM. What can be accomplished in the short term and what can be planned for expansion in the future that will be feasible and sustainable, is a recurring dilemma that tasks the scientists and local resource managers alike (Lowry et al., 2009). Key governance challenges in Danajon are:

1. How to eliminate non-compliance for fundamental laws on illegal fishing?
2. How to streamline the planning and implementation process involving numerous stakeholders?
3. How to effectively divide up the resource base so that resource user groups have a stronger vested interest in maintaining the productivity of their resource use area?
4. How to scale up to levels that address larger fisheries systems, and/or scale down to empower community management at smaller geographical and ecological scales?
5. What indicators are most effective within the context of the management area/regime that contributes to sustainability of management?
6. How to complete the management cycle by instituting monitoring system to form part of the fisheries management activities?
7. What levels of education and types of incentives are important to further management?

Carefully designed assessments, as related in this theme issue, are related to the aforementioned dilemmas and helping to provide guidance to managers (Christie, 2005; Pollnac & Pomeroy, 2005). Danajon Bank is moving toward an EBM regime that can substantially improve conditions of the area. The sustainability of this progress is not certain and will only be tested once the FISH Project ends in 2010. The capacity of the local governments and other stakeholders has been improved immensely but whether this will guarantee a functional and lasting EBM regime remains to be seen.

The need to manage Danajon Bank as an ecosystem is recognized at various levels of the community and governance system. It is clear to most stakeholders that managing the Danajon Bank's resources at the municipal level will not be enough because the spatial distribution of most harvestable fish and invertebrate stocks is beyond the political boundaries of the municipalities and therefore requires inter-LGU cooperation.

Furthermore, the success of an inter-LGU management initiative is dependent on the cooperation of all local executives. A failure of one is a threat to the success of the entire initiative. Figure 5 shows the fishing area of operation of Danish seines during the start of the project in 2004 and during the monitoring event in 2006. The relatively effective fishery law enforcement activities of the neighboring municipalities turned out to be less

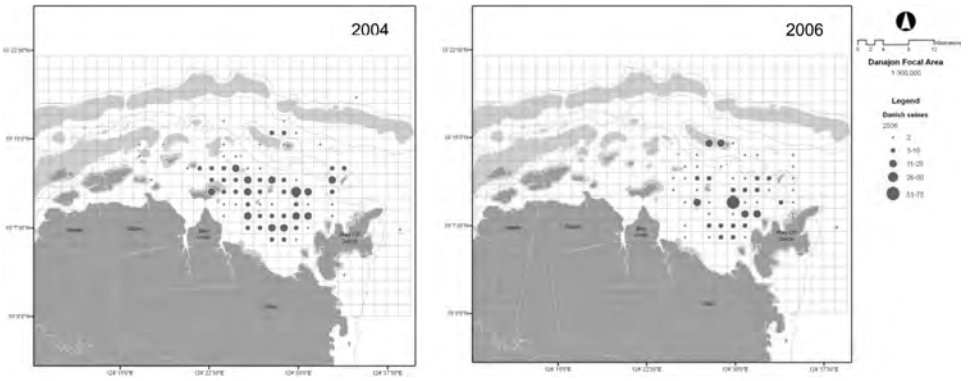

Figure 5. Observed fishing area of Danish seine during the 2004 fisheries baseline assessment and 2006 fisheries monitoring event.

successful because it just actually pushed the problem somewhere else, and in this case, toward the municipal water of the municipality that is less effective. This shows that an ecosystem-based management initiative is only strongest at its weakest link.

The interplay between the benefit to be derived from appropriately managing the resources and the effort and investment put forth in implementing management interventions will be critical. Monitoring of results will play a very important role to inform stakeholders, managers, and donors. Additional fisheries management interventions in the pipeline include fisheries use zoning and establishment of an appropriate fishing gear and fishing effort configuration for the entire Danajon Bank ecosystem. Both initiatives will be developed together with resource users and local governments. A fisheries use zoning plan and a cap on numbers of fishing gear will be included in the framework plan, which will be one of the major documents to be crafted by the stakeholders toward the culmination of the project to guide fisheries managers going forward.

The Danajon Bank experience shows that there are three major components in working toward ecosystem based management: (1) fisheries management interventions should always consider a defined ecosystem boundary as resource management unit; (2) there is a need to understand the dynamics of marine ecosystems and how they respond to human-induced changes, particularly to changes resulting from fisheries; and (3) there is a need for a governance system that is responsive to ecosystems approach to controls and limits in fisheries resource exploitation activities. The Danajon Bank ecosystem-based fisheries management was initiated with 4 municipalities as focus, gradually expanded to 9 municipalities in Bohol province, and currently being further expanded to cover the rest of the 17 municipalities constituting the Danajon Bank Double Barrier reef system. Scaling up the initiatives that constitute the EBM approach to the entire reef system is not just a challenge but also an opportunity to find out at what scale EBM will still be effective. It is quite obvious that the match between the spatial range of the ecosystem and the governance system is the most important consideration.

Notes

1. The FISH Project is supported by USAID Philippines (2003–2010) and provides the basis for this case study on ecosystem-based management with most data and examples for analysis derived from the “focal” area of FISH.

2. For a detailed explanation of the legal and institutional framework, see Eisma-Osorio (2005) and Green et al. (2004).

3. The aggregated weighted mean refers to a computation of all fisheries data collected by the FISH project to determine the change over baseline of the biomass of fish because the FISH project overall indicator of progress is based on increase in biomass of fish in the area of the project.

References

ADB, GEF, DENR, TTEMI and PRIMEX (Asian Development Bank, Global Environment Facility, Department of Environment and Natural Resources, Tetra Tech EM Inc. and Pacific Rim Innovation and Management Exponents, Inc.). 2003. *Integrated Coastal Resource Management Project, Philippines*. Final report, Volume 3: Appendix 2: GEF eligibility requirements. TTEMI and PRIMEX, Mandaluyong City, Philippines. 100 p.

Armada, N. B. 1994. *Resource and Ecological Assessment of Manila Bay, Philippines: Capture Fisheries*. Report submitted to the Fisheries Sectoral Program (FSP) of the Department of Agriculture. 50 p.

Armada, N. B., and G. T. Silvestre. 1981. *Results of the Demersal Fishery Resource Survey in Samar Sea and Carigara Bay*. Project report submitted to the National Science Development Board (NSDB). Department of Marine Fisheries, College of Fisheries, UP Diliman, Quezon City. 45 p.

Armada, N. B., J. N. Fragillano, R. T. M. Bacalso, R. I. Crusio, and R. T. Martinez. 2004. *Municipal Capture Fisheries Profile of Central Visayas, 2003*. Final report. University of the Philippines in the Visayas Foundation, Inc. and Coastal Resource Management Project, Philippines. 264 p.

Calumpong, H. P., J. S. Estacion, and C. Acedo. Eds. 1997. *Status of the Coastal Resources of the Bohol Learning Site (Jetafe to Calape)*. Marine Laboratory and Center of Excellence in Coastal Resources Management, Silliman University, Dumaguete City, Philippines. 150 p.

Christie, P. 2005. Is integrated coastal management sustainable? *Ocean and Coastal Management* 48:208–232.

Christie, P., N. Armada, A. T. White, A. Gulayan, and H. Dios. 2006. *Coastal Environmental and Fisheries Profile, Danajon Bank, Bohol, Philippines*. Project Fisheries for Improved Harvest. Cebu City, Philippines and USAID. Available at http://www.oneocean.org.

Christie, P., D. L. Fluharty, A. T. White, R. L. Eisma-Osorio, and W. Jatulan. 2007. Assessing the feasibility of ecosystem-based fisheries management in tropical contexts. *Marine Policy* 31:239–250.

Christie, P., R. B. Pollnac, E. G. Oracion, A. Sabonsolin, R. Diaz, and D. Pietri. 2009. Back to basics: An empirical study demonstrating the importance of local-level dynamics for the success of tropical marine ecosystem-based management. *Coastal Management* 37:349–373.

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

Eisma-Osorio, R. L., R. C. Amolo, A. P. Maypa, A. T. White, and P. Christie. 2009. Scaling up local government initiatives toward ecosystem-based fisheries management in Southeast Cebu Island, Philippines. *Coastal Management* 37:291–307.

Eisma-Osorio, R. L. 2005. The current legal landscape for EBFM in the Philippines. Coastal Conservation Education Foundation, Cebu City, Philippines. (Unpublished).

FISH (Fisheries Improved for Sustainable Harvest) Project. 2004. *FISH Document 04-FISH/2004. Target Area Profiles*. Tetra Tech EM, Inc., Mandaluyong City, Philippines. 28 p.

FISH Project. 2005. FISH Document 17-FISH/2005. *Consolidated Report: Baseline Assessment of the Capture Fisheries and Marine Protected Areas in the FISH Project's Focal Areas: Coron Bay, Danajon Bank, Lanuza Bay and Tawi-Tawi Bay*. Tetra Tech EM, Inc., Mandaluyong City, Philippines. 94 p.

Green S. J., R. P. Monreal, A. T. White, and T. G. Bayer, Eds. 2000. *Coastal Environmental Profile of Northwestern Bohol*. Coastal Resource Management Project, Cebu City, Philippines.

Green, S. J., R. D. Alexander, A. M. Gulayan, C. C.Migriño III, J. Jarantilla-Paler, and C. A. Courtney. 2002. *Bohol Island: Its Coastal Environmental Profile*. Bohol Environment Management Office and Coastal Resource Management Project, Cebu City, Philippines, 174 p.

Green, S. J., J. O. Flores, J. Q. Dizon-Corrales, R. T. Martinez, D. R. Nunal, N. B. Armada, and A. T. White. 2004. *The Fisheries of Central Visayas, Philippines: Status and Trends*. Coastal Resource Management Project of the Department of Environment and Natural Resources and the Bureau Fisheries and Aquatic Resources of the Department of Agriculture, Cebu City, Philippines. 159 p.

Lowry, G. K., A. T. White, and P. Christie. 2009. Scaling up to networks of marine protected areas in the Philippines: Biophysical, legal, institutional and social considerations. *Coastal Management* 37:274–290.

NSO (National Statistics Office). 2001. Census 2000. Philippine population by barangay. CD-rom. Version 3.0. NSO, Manila, Philippines.

NSO. 2007. http://www.census.gov.ph/data/census2007/index.html

Pollnac, R. B., and R. S. Pomeroy. 2005. Factors influencing the sustainability of integrated coastal management projects in the Philippines and Indonesia. *Ocean and Coastal Management* 48:233–251.

Pichon, M. 1977. Physiography, morphology and ecology of the double barrier reef of north Bohol (Philippines). In *Proceedings of the Third International Coral Reef Symposium, Miami, USA*. 261–267.

Pietri, D., P. Christie, R. B. Pollnac, R. Diaz, and A. Sabonsolin. 2009. Information diffusion in two marine protected area networks in the Central Visayas Region, Philippines. *Coastal Management* 37:331–348.

Vakily, J. M. 1982. Catch and effort in the trawl fishery. In *Small-scale fisheries of San Miguel Bay, Philippines: Biology and Stock Assessment*, eds. D. Pauly and A. N. Mines, 65–94. ICLARM Technical Reports 7, IFDR, College of Fisheries, University of the Philippines, Quezon City, Philippines; ICLARM, Manila, Philippines; and the United Nations University, Tokyo, Japan.

Villoso, E. P., and V. L. Aprieto. 1983. On the Relative Abundance and Distribution of Slipmouths (Pisces: Leiognathidae) in Lingayen Gulf, Philippines. *Philippines Fisheries Research Journal* 8(1):26–43.

White, A. T., P. M Alino, and A. T. Meneses. 2006. *Creating and Managing Marine Protected Areas in the Philippines*. Fisheries for Sustainable Harvest Project, Coastal Conservaton and Education Foundation, Inc. and University of the Philippines Marine Science Institute, Cebu City, Philippines. 83 p.