Marine Reserves as Tools of Fishery Management and Conservation of Biodiversity in the Philippines

By Emily Layos

Dr. Angel C. Alcala's major contribution to biological science is his pioneering research work on no-take marine reserves, which are now recognized as tools of fishery management and marine biodiversity conservation throughout the world. Dr. Alcala started his research on marine reserves in 1974 as the major program of the Silliman University Marine Laboratory (renamed Dr. A.C. Alcala Environment and Marine Science Laboratories), which he founded in the same year. Initially established on two small islands off southern Cebu (Sumilon Island) in 1974 and off southeastern Negros Oriental (Apo Island) in 1982, marine reserves have been established throughout the Philippines. There are by now more than 564 no-take marine reserves in the Visayas and probably no less than 1,000 in the whole country. No-take marine reserves have also been established in the Caribbean and Indonesia following the Philippine model.

To understand the background of Alcala's contribution, it is necessary to point out the nature of the Philippine marine environment and the various factors causing environmental destruction and resource depletion. The Philippines is an archipelago of some 7,000 islands and islets with about 25,000 square kilometers of coral reefs. It is surrounded by water bodies on all sides. It has a long coastline of approximately 36,300 kilometers. It is part of the Coral Triangle region, known as the world's center for marine biodiversity, rich in marine resources like coral reefs, seagrasses, mangroves and marine fishes on which 300 million people, including Filipinos, depend for food, livelihood, and economy.

According to D.R. Stoddart, coral reefs are "complex biological systems of high productivity." A coral reef is like a city with different buildings and different people. Instead of buildings, there are colorful corals of different sizes and shapes. And instead of people, there are different kinds of fish, sharks, turtles, crabs, octopuses, shells, squids, and other organisms. Coral reef organisms provide chemicals used for medicine and the industry. Coral reefs also help moderate the climate by absorbing carbon dioxide from sea water and air for use in building their calcareous skeletons. Perhaps the most important role of coral reefs is serving as habitats for many marine organisms, particularly fish, crustaceans and shells that serve as source of food for people. Every 100 hectares of healthy coral reefs produce 15-30 tons of fishery products annually. It is therefore important that coral reefs are kept healthy.

Fish, as well as rice, are the staple food of Asians, including Filipinos. About 50% of the protein diet of Filipinos is fish. A good supply of fish and other fishery products must be assured always to achieve good human health. Coral reefs, mangroves, seagrass beds and marine waters must therefore be protected from pollution and destructive human activities and managed so they can provide food for human populations.

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Figure 1. Coral reefs serve as habitats of fish and other marine species, and source of food for the 300 million people of the Coral Triangle area.

However, humans tend to over-exploit their natural resources. This is especially true in the case of the Philippines, where most of forest and marine resources have been used up fast since the mid 20th century.

The tendency of fishermen to take too much of our natural resources without thought of future needs of the coming generations is a well known fact. For example, three marine species have been known to be locally extinct in southern Philippines because of heavy exploitation. The chambered nautilus (*Nautilus pompilius*) in the Tañon Strait has been locally extinct since the 1980s, and a cone shell (*Conus*) and a cowry shell (*Cypraea*) have become locally depleted around the island of Aliguay in the Bohol (Mindanao) Sea within a short time of two years (1999-2000). Overexploitation is made worse by the use of resource-destructive fishing gears. Both are the major causes of the depletion of fishery stocks and destruction of fish habitats, including coral reefs. Some destructive fishing methods used include trawl fishing, *muro-ami* or drive-in net fishing, blast fishing, and cyanide fishing.

The use of these fishing gears depleted coastal fisheries and destroyed fishery habitats in the late 1940s. By 1949, the negative effects of trawl fishing on fishery stocks became evident. A 1982 survey showed that blast fishing was the culprit for the devastation of almost all 632 coral reef sites, leaving 70% in bad condition. It has gotten worse at present. Muro-ami has also produced destructive results on coral reefs. It took a long while before significant action and effective implementation of laws against this fishing method by government took place. By that time the destructive fishing methods had reduced the nation's vast expanse of coral reefs into monotonous, barren beds of coral rubble. There is little chance that these reefs will recover into high-diversity, productive coral reefs at any time soon.

To worsen the situation, the widespread denudation of Philippine primary forests, including mangroves, since the mid 20th century has reduced forest cover from 17 million hectares (57% of land area) to 1.87 million hectares (about 6%) in the mid 1990s, causing not only dramatic changes in the landscape of the country but also resulting in massive soil erosion. The sediments from this erosion found their way to coastal areas, silting or burying—and killing—coral reefs, seagrass beds, and mangrove swamps. The conversion of mangroves to fishponds has led to the destruction of 80% of primary mangrove forests. Mangroves are nursery and habitat areas of many marine species and are sources of organic nutrients that maintain the productivity of shallow coastal areas.

All of the destructive factors discussed above have combined to reduce the fish biomass of coastal areas by 90% in most parts to the country, as compared to those in the 1930s and 1940's.

The depressing state of the Philippine marine environment is what made world-renown marine biologist, Dr. Angel C. Alcala, conceptualize the idea of community-based no-take marine reserves. It was his fascination for marine organisms (especially coral reefs and reef fishes), advocacy for the environment, and concern for sustained fishery production that inspired him to pursue his goal of sustainable management and protection of the marine environment and marine resources through the establishment of marine reserves.

The first marine reserves in the world include the Fort Jefferson National Monument in Florida, U.S.A. (1935) and the Hundred Islands National Park in the Philippines (1940). The

Figure 2. Aerial photographs of Sumilon (left) and Apo (right) islands in the central Philippines. The reserve at Sumilon Island extends 750 m along the western side the island while the Apo reserve Apo is 450 m long on the southeastern side of the island.

main reason for putting them up was to protect and conserve the marine organisms living in them, thus the term "marine conservation." It was Dr. Alcala who thought that no-take marine reserves could significantly help fishery species recover their depleted status as well as increase their species richness, biomass and abundance. This in turn would provide more fish for fishers to catch, thus leading to enhanced food fish production. His predictions proved to be correct.

Marine reserves or more correctly, no-take marine reserves (NTMR) are defined as areas of the marine environment protected from various forms of extractive exploitation, particularly fishing. It is also sometimes used interchangeably with terms like *marine protected areas* and *marine sanctuaries*. As conceptualized originally, a marine reserve occupies 20-30% of the total area of an ecosystem (e.g. a coral reef); the remaining 70-80% (non-reserve) is the area where fishermen are allowed to fish using traditional, non-destructive fishing gears. Non-reserves are also protected to some extent by not allowing the use of destructive fishing methods (e.g. explosives, *muro-ami*, and cyanide). Putting up marine reserves this way achieves two purposes: (1) to allow fishers to continue to fish in the non-reserve area and (2) to allow the fishery species and the rest of the biodiversity to recover in the no-take marine reserve area. The expectation is that after some time, the species richness, the biomass and the abundance of fishes will increase in the marine reserve and some of them will move out (spill over) towards the non-reserve for fishers to catch. The maintenance of protective management of both reserve and non-reserve areas, as Dr. Alcala stresses, should be done by organized local communities and local government units. This makes sense because the local communities reside near the sites of marine reserves and fishing areas. This type of management is called community-based management.

Dr. Alcala and his Australian colleague, Dr. Garry R. Russ, and some members of the Silliman University Marine Laboratory set up two marine reserves in central Philippines—one on Sumilon Island in 1974, and another on Apo Island in 1982. The reserve and non-reserve areas were monitored almost every year to determine the species richness, the fish biomass, the fish abundance, the coral cover, and periodically, the total fish catch in the fished areas of both Sumilon and Apo islands. These two reserves are discussed here as models for marine reserves.

Sumilon Island is a low, flat coralline island about three kilometers from the island of Cebu. It has a land area of 23 hectares with a 50-ha coral reef. A 0.75 km long marine reserve was established on its western side, a reserve approximately 25% of the total coral reef area. Apo Island, on the other hand, is a high island, about 8 km. off the coast of mainland Negros. Its land area is 70 hectares and has a coral reef area of 111-ha. Its marine reserve is 0.45 km long on its southeastern side, which is approximately 10% of the whole coral reef area (The area is being enlarged).

Dr. Alcala and his team initiated the establishment of marine reserves on both islands, conducted biological studies and, together with social workers, helped organize local communities to support and ultimately manage the reserves. Organized local communities and local government units usually cooperated to manage and protect marine reserves. The Sumilon Reserve has had a complex history of management while the Apo Reserve has been protected from fishing effectively since its establishment in 1982.

The Sumilon Reserve illustrates the difficulty of maintaining marine reserves. Because of conflicting interests of stakeholders, the Sumilon Reserve experienced full protection during the first 10 years but suffered a setback some years later when a politician violated the no-fishing rule pertaining to the reserve. When the reserve was protected and managed from 1974-1984, the fish caught in the non-reserve (75% of reef area) increased in tons per km^2 per year from 9.7 in 1976 to 14.0 in 1977, 15.0 in 1978, until 16.8 in 1983-1984. But when protective management was no longer enforced and fishing occurred in both reserve and non-reserve (100% of reef area) in 1984-1985, fish yield was reduced to about 11.2 tons/km2/year; or a 54% decline from the catch in 1983-1984. However, when

protection was restored, fish abundance increased again.

The abundance and species richness (variety) were much higher in the reserve than in the non-reserve (fished area) during periods of protective management. A resort was also established on the island, but went out of business quickly. In the end, the objectives for putting up the reserve were only partially achieved, and the benefits it received were only short-term. Dr. Alcala and Dr. Russ then concluded that in order for benefits to last a long time, marine reserves must be protected, managed, and functional on a time frame of at least 10 years or more.

Nevertheless, the Sumilon Reserve (together with Apo Reserve) influenced marine resource policy and still contributed important scientific findings. It continues as a reserve and serves as a control site for marine reserve studies. Dr. Alcala continues his research in this reserve and in other established marine reserves through the Silliman University Angelo King Center for Research and Environmental Management (SUAKCREM).

The Apo Reserve has been a continuous success compared to the Sumilon Reserve. At first, its establishment was opposed by the Apo community. The community of about 500 residents who relied greatly on fishing as livelihood did not agree to set aside a portion of their fishing grounds as a reserve, where fishing was not allowed. Moreover, these fishermen used destructive fishing methods like *muro-ami*. But since their fishery stocks were low, they decided to give it a try. They formed a Marine Management Committee, which was advised and supported by Silliman University and the municipality of Dauin, where Apo Island belongs, geographically. The community observed strict compliance with the marine reserve rules. And sure enough, after a few years of the establishment of the reserve, the community saw the effects. The fishermen's catch from the non-reserve areas doubled. Other economic activities began to flourish, such as catering and selling of island souvenirs. The Apo Island residents also experienced a continuous flow of scuba-diving tourists, which created a need to have tourist resorts. Dr. Alcala says that at present, the total earnings from the more than 20,000 visitors per year and the fish catch of 15-20 tons per year taken from the non-reserve fishing area amounts to about 5-6 million Philippine Pesos annually.

Figure 3. The Apo Marine Reserve benefits to the Apo community in terms of (left) increased fish yields and (right) livelihood as well as tourism receipts.

This substantial income can be attributed to almost three decades of protective management by the community members who have developed a sense of stewardship towards their marine resources and continue to protect the reserve to this day.

The effects of marine reserves may be summarized as follows: The species richness, biomass, and abundance of fish species inside marine reserves are greater than those outside. The fishes inside marine reserves are also much bigger in size. Finally, there is a net movement of adult fishes to the fished area (called spillover), enhancing the catch of fishers. The total fish catches from the fished areas (not the reserve) has remained stable at 15-20 metric tons per year. About 10% of this fish catch volume is the result of spillover from the reserve. Marine reserves enable fishers to fish not too far away because fish is available nearby (and thus not requiring motorized boats), usually 100 meters from the shoreline. The increased reproductive capacity of fish enables them to live longer and they become "larger." Adult fish are able to produce exponentially more offspring. Therefore, both adults and offspring have the potential to "spill over"

the boundaries of a reserve. The improved biodiversity in marine reserves attract tourists, and coastal communities earn income through user fees. In summary, marine reserves serve as tools for fishery management and biodiversity conservation and improve the quality of life of the coastal communities both on Apo Island and Negros Oriental.

Marine reserves are the central feature of coastal and marine resource management (CRM). The model that Dr. Alcala promoted is one where the primary stakeholders are given the responsibility to manage and protect their marine resources. These stakeholders consist of local communities, their organizations and NGOs, and the local government units at the barangay and municipal levels. In the case of the Apo Reserve, these are the members of the Marine Management Committee, the rest of the island residents, and the local government units of Apo Island and the municipality of Dauin.

The role of Dr. Alcala as a scientist was to initiate the management program and be their technical adviser in addition to conducting research. The national government agencies are seen as supporters and enablers of local management and protective initiatives. Dr. Alcala hopes that at least 20-30% of coral reefs, mangroves and seagrass beds in the whole Philippines will acquire protective management in the near future, as marine reserves are the only viable options left for the Philippines to save its marine biodiversity and prevent the total collapse of marine capture fisheries. He also believes that as more marine reserves are established, they should also be networked.

Networking involves bringing together managers of marine reserves in a sea area characterized by common oceanographic and certain physico-chemical features such as directions and nature of ocean currents. Networking will ensure efficient implementation of regulations and sustainability in of reserves in terms of fish larval recruits. Fish larvae are distributed by ocean currents, and some reserves serve as source of recruits while others serve as recipients or sinks (Fig.4). In Figure 4, the currents flow fromthe northeast to the southwest direction. Larvae are carried from upstream sites, near the Pacific Ocean, to downstream sites toward the Sulu Sea.

Dr. Alcala applied this principle when he helped establish and/or strengthen about 50 marine reserves in the Bohol (Mindanao) Sea, covering the Visayan islands of Cebu, Negros, and Bohol, and the coastal areas of the provinces of Zamboanga del Norte, Misamis Occidental and Surigao del Norte on Mindanao.

Many studies have revealed that resource-destructive fishing and even logging activities have not only destroyed fish habitats but depleted fishery resources. Also, protective management is not simply legal protection or support of local government. Management requires a commitment to implement legislations. Governments at the local and national levels have time and again showed that they are relatively quick in legislation but are slow in intervention and implementation. Truly, a top-down management is not effective in most cases. Perhaps a down-top scheme or one where the community has the greatest or most influential role of accomplishing a certain task is more viable. Several community-based projects for terrestrial environments have already proven themselves effective and sustainable.

The outstanding characteristic of communities is their tendency to directly and actively act as stewards towards common goals. It is in this light that Dr. Alcala considers marine reserves as an effective tool for community-based fisheries management (CBFM) in sustaining coastal fisheries. A CBFM then is a combination of the full participation of local communities and local government units, and the support of

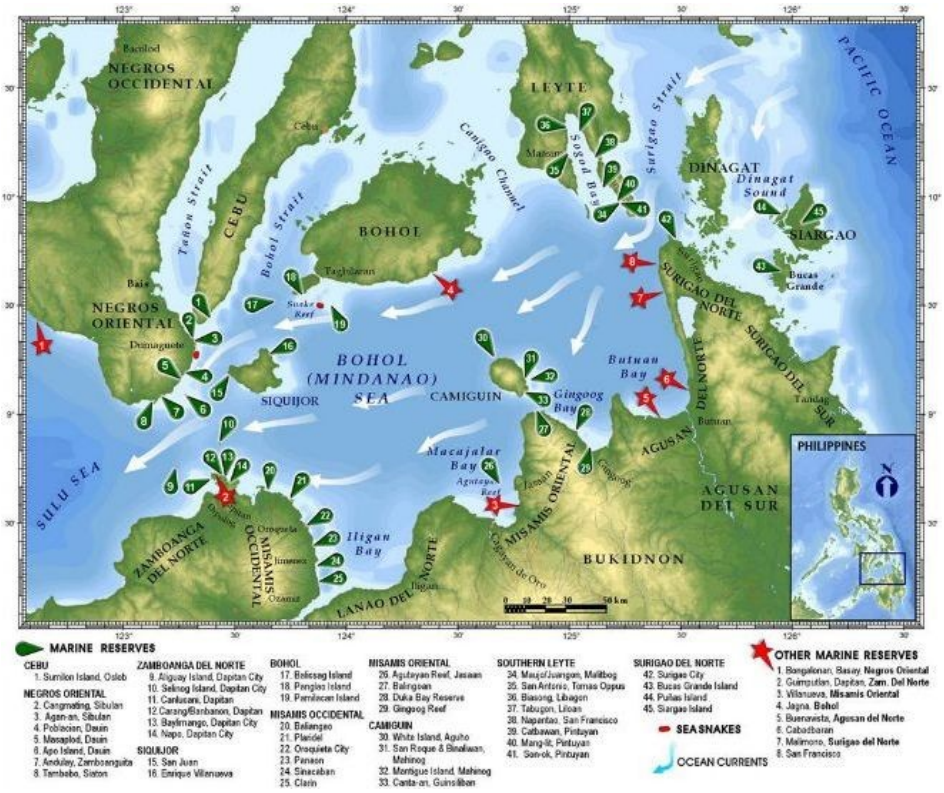

Figure 4. Marine reserves established within the Bohol (Mindanao) Sea, as part of more than 564 marine reserves in the whole of the Visayas.

academe and non-government agencies. Dr Alcala believes that a good example of a highly sustainable CBFM would have (1) a workable organization/s in the community; (2) a functional marine reserve protected by the community; (3) existence of other forms of livelihood based on coastal resources; (4) collaboration with local, national, and or international organizations and agencies; and (5) a capacity-building plan.

In order to achieve this, communities need assistance in community development, finance, legislation, and other technical arrangements which social workers, non-government organizations, and academic institutions can provide. They can achieve this through a step-by-step process. First is social preparation and community organizing. This is followed by environmental education and capacity building. The third step is resource management planning and protective management. The next step would be to support activities for livelihood and generate finance resources. Research and monitoring comes next, and lastly, networking activities.

The first step is the most crucial as it allows the community to identify their needs and appropriate solutions for community well-being. It is also in this step that communities start to form viable organizations that will lead to planning and implementation. These organizations would either make or break a developing marine reserve especially if they will let certain political interests get in the way or be disunited in times of important decision-making. Also, as the benefits of marine reserves do not manifest until about a period of 5-10 years, communities need to seek other sources of livelihood that do not conflict with their primary interest as well as establish networking with other communities or organizations for support and assistance.

Dr. Alcala's 38-year work on marine reserves in the Philippines is documented in publications by himself and his colleagues at SUAKCREM in international and refereed journals with more than 175 papers, 50% of which he is either the sole author or first author.

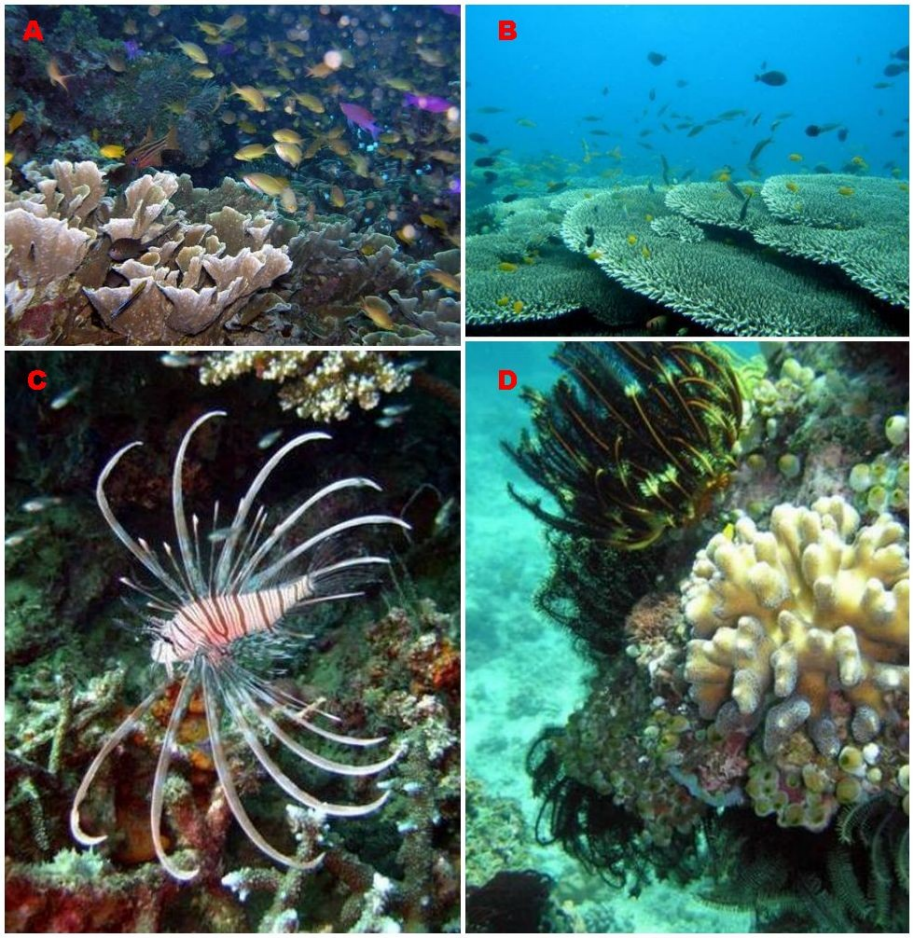

Figure 5. Views of marine reserves in the Bohol Sea and Tañon Strait, (a) Balicasag in Bohol and the municipalities of (b) Dauin, (c) Amlan, and (d) Malatapay all in Negros Oriental. Note the diversity of corals and fish.

He is also currently the Chairman of the Advisory Board of SUAKCREM, where he and his fellow researchers have produced around 60 papers from 1999 to 2012, or a rate of 4.6 papers per year for 6 researchers. This record does not include popular articles written for publication in newspapers and speeches and lectures in workshops and seminars and upcoming researches still in publication. Aside from the papers published, some of the Center's findings have been translated into policies such as those in the Fisheries Code of 1998, requiring the establishment of marine protected areas as part of coastal resource management of local government units.

Dr. Alcala's concept of Community-based Coastal and Marine Resource Management (CRM) has not only been adopted by the Fisheries Code of 1998, as mentioned above, but also by some groups in the Caribbean and in Indonesia. The famous Shedd Aquarium in Chicago, USA, has showcased the Apo Marine Reserve as a model of a successful CRM project.

In the Philippines, a recent review of marine reserves has given a total of 564+ marine reserves in the whole Visayas, and

for the whole Philippines, probably more than 1,000. All of these were no doubt influenced to varying degrees by his pioneering efforts at establishing the Sumilon and Apo Marine Reserves in 1974 and 1982, respectively.

BIOGRAPHY

Dr. Angel C. Alcala is the chief Filipino scientist with outstanding contributions in the biological sciences that comprises studies on land vertebrates and marine biodiversity and conservation in the Philippines. His studies deal with ecology, taxonomy, and conservation biology based in Silliman University, Dumaguete City, from 1955 up to the present (2012).

He is the first Filipino to make a comprehensive study on Philippine amphibians and reptiles, with minor contributions on birds and mammals. His fieldwork from 1954 to 1999 resulted in the addition of 50 new species of amphibians and reptiles out of the now 1100 known species. Conservationists now have a more reliable basis for establishing conservation programs on Philippine amphibians and reptiles because of the works of Dr. Alcala and others on ecology and taxonomy of these two vertebrate groups.

He founded the Silliman University Marine Laboratory in 1974. In the same year, he pioneered the use of the concept or tool of no-take marine reserves to conserve marine biodiversity as well as improve fisheries yield, with the collaboration of local communities, local people's organizations, and local government units. This concept was first applied to Sumilon Island followed by Apo Island in 1982. Presently, the Apo Marine Sanctuary is recognized both as a model for about 1000 marine community-based protected areas in the Philippines and as a model for marine resource conservation in the world, as showcased at the famous Shedd Aquarium in Chicago. He also established a dozen more marine reserves in the central Philippines and strengthened the management of about 60 more. Some of these marine reserves have been highly successful in preserving marine biodiversity, promoting marine biological and oceanographic research, and encouraging environment-friendly tourism related activities that have improved incomes of local communities.

His research, including collaborative research programs with scientists from the USA and Australia, has resulted in a substantial publication output of more than 170 scientific papers and books, of which he is author or co-author of half. He also served as consultant to several marine and development projects including the Coastal and Marine Biodiversity Component of the Mindanao Rural Development Projected supported by the World Bank and the Global Environment facility (GEF) from 2002-2005 and the Integrated Coastal Resource Management Program of the Department of Environment and Natural Resources (DENR) since 2009.

Dr. Alcala is recipient of numerous awards, including the Biodiversity Award from the Field Museum, Chicago, USA; Ramon Magsaysay Award for Public Service in 1992; Distinguished Ecologist from the Fulbright Program; Pew Fellowship in Marine Conservation; and as one of the 50 Men and Women of Science in the Philippines for the period 1958-2008 by the Department of Science and Technology (DOST), among others. He is Fellow of the American Society of Ichthyologists and Herpetologists, Honorary Fellow of the California Academy of Sciences, and Academician of the National Academy of Science and Technology, Philippines.

Dr. Alcala taught Biology at Silliman University from 1952-1989, retiring as Professor of Biology. He also served as Deputy Executive Director of the Philippine Council for Aquatic and Marine Research and Development of the DOST from 1989-1991. He became President of Silliman University in 1991-1992 when he was also called to serve the Philippine government as Secretary of the DENR in 1992-1995, and then as the first Chairman of the Commission on Higher Education (CHED) from 1995-1999. He came back to Silliman University to continue teaching graduate courses at Silliman's Institute of Environmental & Marine Sciences, and conducting research at

Figure 6. Community building for cooperation in fisheries management.

the Silliman University Angelo King Center for Research and Environmental Management (SUAKCREM), as well as serving as the Director (1999-2011) of the Silliman University-Commission on Higher Education Zonal Research Center (SU-CHED ZRC) at Silliman University.

Dr. Alcala obtained his B.S. in Biology *magna cum laude* from Silliman University, Dumaguete City in 1951, and went on to finish his M.A. (1960) and Ph.D. (1966) in Biological Sciences at Stanford University, California, U.S.A. Presently a Professor Emeritus of Biological Sciences and the Chairman, Advisory Board of the Silliman University Angelo King Center for Research and Environmental Management (SUAKCREM), he continues to promote research and use of research data for publication and for practical application in development projects. At the same time, Alcala travels nationally and internationally to work with different LGUs, NGOs, POs, and academic institutions in programs and projects on research and coastal and marine resource management. He also teaches graduate students in the marine sciences and gives lectures on subjects like biodiversity, conservation, resource management, and climate change; and attends board meetings or research and development organizations of which he is either member, President, or chairman. These organizations include Haribon Foundation, Wildlife Conservation Society of the Philippines, Foundation for the Philippine Environment, World Wide Fund for Nature (WWF) Philippines, Philippine Appropriate Technology and Health (PATH) Foundation, as well as various government agencies such as the Protected Areas and Wildlife Bureau of the DENR, the Philippine Institute for Traditional and Alternative Health Care of the Department of Health, and several research programs and accreditation committees of the Commission on Higher Education.

He has been married to Naomi L. Alcala for 60 years and together they have six children, 17 grandchildren, and 5 great grandchildren. **PSL**