ECOSYSTEM-BASED MANAGEMENT TOOLKIT FOR PHILIPPINE COASTAL RESOURCE MANAGEMENT:

FISH-DA

FISHING INDUSTRIES' SUPPORT IN HANDLING DECISION APPLICATIONS DEMONSTRATION GUIDE

Fishing Industries' Support in Handling Decision Applications (FISHDA) Tool Demonstration Guide

Reniel B. Cabral, Rollan C. Geronimo and Porfirio M. Aliño

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Fishing Industries' Support in Handling Decision Applications (FISHDA) Tool Demonstration Guide

Reniel B. Cabral[1,2], Rollan C. Geronimo[1,3], Porfirio M. Aliño[1,3]

[1] Marine Environment and Resources Foundation, Inc.,
c/o The Marine Science Institute, University of the Philippines
Diliman, Quezon City 1101
[2] National Institute of Physics, University of the Philippines
Diliman, Quezon City 1101
[3] The Marine Science Institute, University of the Philippines
Diliman, Quezon City 1101

I. INTRODUCTION

The country has been experiencing widespread overfishing as fishing effort continues to increase while total fish catch declines. In an attempt to determine the maximum carrying capacity for fishing grounds, models that estimate the maximum sustainable yield (MSY) were developed and applied since the 1970s (Lachica-Aliño *et al.* 2006). However, many of these models require large amounts of systematically collected fisheries and fish stock assessment information. Unfortunately, there is a paucity of well-established fisheries monitoring data in the Philippines based at the municipal level despite the current devolution of coastal resource management (CRM) to local governments. Despite the data gaps, providing information on carrying capacities and, recently, guidance on marine protected area (MPA) size requirements remain critical questions for local governments and coastal resource managers.

The Fisheries Information for Sustainable Harvest Bio-Economic Model or FISH-BE was developed to help synthesize basic fisheries information at the municipal level and provide estimates and scenario testing on fisheries' carrying capacities and MPA size (Licuanan *et al.* 2006, 2008). Applications on different bays and municipal waters proved it to be a useful communication and discussion tool on the status of fishery resources (Licuanan *et al.* 2007). However, FISH-BE requires the use of an expensive commercial modeling software called Stella®[2] to run. It may also be too complicated to operate for local governments and non-scientists. However, the use

[1] FISHDA was created by M. De Castro, S. Go Ho, J.C. Kiac, and A. Lao of the De La Salle University. The authors of this Guide aim to present only an overview of the tool. For further details on FISHDA and FISH-BE, please refer to the USAID-Philippine Environmental Governance (EcoGov 2) Project (2007) that contains manuals on both tools.

[2] A free Stella® player can be downloaded from: http://www.iseesystems.com/softwares/player/iseeplayer.aspx to run FISH-BE but you cannot save files. FISHDA is recommended for public use.

of Stella® provides greater flexibility in refining or changing the model dynamics.

The demand from resource managers to use the tool eventually led to the development of a stand-alone and freely distributable version which is the Fishing Industries' Support in Handling Decision Applications or FISHDA. Developed by Melangeline De Castro, Sellena Go Ho, John Christopher Kiac, and Alvin Lao as a software technology thesis at De La Salle University-Manila, FISHDA has a much simpler interface than FISH-BE.

FISH-BE and FISHDA are both used as management and communication tools to assess, test, and demonstrate various management scenarios in the fishery. Some of the scenarios that can be tested using the tool are:

1. Projection of the future of fishery under current fishery status.
2. Estimation of the extraction rate capacity or number of fishers that can be supported by the fishery (i.e., "fishery carrying capacity").
3. Estimation of the area needed to be under full protection (or "no-take" zone) to make fisheries sustainable.
4. Effect of poaching and entry of commercial fishers.

Throughout this publication, we will be referring more to FISHDA than the FISH-BE model. The FISH-BE model publication and software produced by the USAID-funded project, the Philippine Environmental Governance Project Phase 2 (EcoGov2) are included in the accompanying CD of this Ecosystem-based management (EBM) Toolkit for Philippine CRM.

NOTE!

This booklet presents only an overview of FISHDA, its application in the EBM Tools Demonstration Project in the Philippines, and practical tips on application, feedback of results, and use in discussions. References in the accompanying CD provide an in-depth discussion and user's manual on both FISH-BE and FISHDA.

II. TARGET PARTICIPANTS

FISHDA is intended to help local government units (LGUs), coastal resource managers, and other stakeholders in making decisions related to fisheries management. It helps fisheries management in three ways: (1) by compiling the minimum and basic fisheries and resource information needed to effectively assess the state of their fishery resources; (2) determining critical knowledge / data gaps on fisheries; and (3) demonstrating the effect of various fishing and MPA size scenarios. Although it is much simpler than most available ecosystem-based management modeling and scenario-testing tools, the use of FISHDA is still intended for people with strong fisheries background. Running the model is as easy as putting in numbers and clicking the "Run" button. But the results and reliability of model outputs will depend on the reliability and accuracy of the input values.

More than a predictive and scenario-testing tool, FISHDA is a very useful and easily comprehensible communication tool for fishers. It can show them how their actions in the fisheries will impact their resources, livelihood, and fishery resource sustainability. For example, if they allow

TIP!

Involving fishers from Day 1: FISHDA output reliability is improved if inputs are validated by fishers and simulations are ran in front of fishers as the parameters are modified.

too many fishers to fish, they will see their catches decline consequently. Also, it presents resource state in economic terms that is easier for fishers to understand and comprehend. For example, if they do not form a strong fisheries association to demand reasonable fish prices and battle against illegal fishing and poaching of commercial fishers in their fisheries, they will find themselves in a future with no more fish to catch.

III. FISHDA: DATA PREPARATION

The first step in running a FISHDA model is to collect and prepare the input data. Table 1 provides a checklist of the minimum biophysical and socio-economic data needed to run a FISHDA model and the values derived from the town of El Nido, Palawan, Philippines during our Ecosystem-Based Management (EBM) tools demonstration workshop on April 12-13, 2010.

> **NOTE!**
>
> A good, reliable model depends on good, reliable data… "Garbage In, Garbage Out (GIGO)"...

As a rule of thumb, the more accurate the data, the more realistic the modeling results are. Therefore, seek available data from published or unpublished reports (the latter are usually available from the municipal agriculture office [MAO] and LGUs of the municipality). If funds are available, it is advisable to conduct actual surveys and focused-group discussions months prior to using FISHDA modeling to have more time to analyze and summarize the results.

The facilitator, and various municipal stakeholders, especially policy makers and fishers, should be present during the model demonstration. If the modeling activity is well-attended and well-represented by the different stakeholders, it is more likely that the modeling scenarios and subsequent policy recommendations will be accepted. The facilitator should be knowledgeable in using the model so that he can correctly deliver the modeling insights to the community.

Table 1. FISHDA Parameters and inputs from El Nido, Palawan, Philippines
(Note: Commercial fishing was not simulated in El Nido. Hence, all commercial fishing variables used the value of "1").

PARAMETERS\TOWN	INPUTS FROM EL NIDO
Biophysical	
Area of coastal water (km^2)	1,745
Number of municipal fishers	3,000
Demersal fish biomass or initial stock (MT/km^2)	3
Pelagic fish biomass or initial stock (MT/km^2)	1.5
Municipal catch (kg/fisher/day)	7.93
Municipal fishing days per year	252
Municipal catch area (km^2)	(30%) 523.5
% Demersal fish in municipal catch	65%
Commercial catch (kg/fisher/day)	1
Commercial fishing days per year	1
Commercial fishing area (km^2)	1
% Pelagic fish in commercial catch	1
Socioeconomic	
Avg. municipal fish price (PHP/kg)	46
Avg. daily expenses per municipal fisher	315.73

a. Area of Coastal Water (km^2)

This is the total area of municipal waters which is up to 15 kilometers from the shoreline, except for coasts shared by neighboring towns (e.g., towns under embayed geographical topology) as stipulated in the Philippine Fisheries Code of 1998 (Republic Act 8550).

There are various methods to derive the area of municipal waters. The Municipal Agricultural Office (MAO) - Fisheries Department or the LGUs may have this data. The National Mapping and Resource Information Authority (NAMRIA) may have information on municipal water boundaries and corresponding area. If the data is missing or unreliable, consult a map-based information software such as ArcView GIS®. Based from experiences in the EBM tools demonstration workshops, the MAO and LGUs have an idea of their municipal water area. Just remember to make sure that appropriate units are used.

NOTE!

The unit of the area of municipal waters is km^2. If the available data is in hectares, use the conversion factor: 1 ha = 0.01 km^2 or divide the value given in hectares by 100 to get the equivalent value in km^2. Note that the unit of values for every parameter is crucial and error will substantially change the result.

b. Number of Municipal Fishers (number)

The number of municipal fishers (both registered and unregistered) fishing within the municipality is an important input for estimating total fishing effort. Do not include the fishers who are permanently fishing outside the municipality or municipal waters. These data can be obtained from the local government or by doing quick key informant interviews per barangay.

NOTE!

If you have no commercial fishers fishing within 15 km from shore or do not want to include them in your analysis, place a value of "15" on the input for the "nearest distance to shore for commercial boats". Use "1" as the value for all commercial fishing variables.

c. Nearest distance to shore for commercial boats (km)

As per the R.A. 8550, small to medium commercial fishing vessels or those weighing 3.1 to 150 gross tons may be allowed by a local government to fish within its municipal waters with distance of 10.1 km to 15 km from the shoreline. This has been a long standing debate on whether or not to allow commercial vessels to enter the municipal waters or fish closer to shore than the 15-km municipal water boundaries. If any number less than "15" is used here, the commercial fishing variables will be activated (i.e., number of commercial fishers, commercial catch per fisher per day, commercial fishing days per year, commercial catch area, and percent pelagic in commercial catch). If "15" is used, all commercial variables will not be used. If the model will be used without commercial fishers, just leave a value of "1" for all commercial fishing variables mentioned to prevent a division-by-zero error.

d. Demersal initial stock (MT/km²)

The users are asked to estimate the current demersal fish biomass of their municipality in the unit of metric tons per square kilometer (MT/km²). This estimate can be derived from the fish visual census. If the value is not known, the default value of **1.5 MT/km²** can be used for soft bottom areas outside the reef areas and mostly within pelagic areas. Demersal fishes are those who live or spend most of their time at the bottom of the water and they are usually nearshore species. Examples of the fishes in this category are the reef-associated fishes ("Isdang Bato") such as serranids ("lapu-lapu"), acanthurids ("labahita"), lutjanids ("maya-maya"), and nemipterids ("bisugo") and for soft bottom areas example are the leiognathids ("sapsap").

TIP!

If you are having trouble estimating fish stocks and other parameters, use the FISH-BE Library of Models found in the CD (Philippine Environment Governance Project 2007) to get an idea of how much fish you have left by comparing your town with other towns presented in the book that you have personal knowledge of. You may use the values from other towns, provided you document and present your reason for doing so or selecting the value.

e. Pelagic initial stock (MT/km²)

Similar to the demersal fish biomass estimate, the users are asked to estimate

the pelagic fish biomass of their municipal waters. Pelagic fishes are those fishes that spend most of their time at the surface of the water and often form schools of fishes. They are usually silvery in color. Some of the examples of pelagic fishes are scombrids like tuna ("tulingan") and mackerel ("alumahan"); carangids ("talakitok"); and also includes Loliginidae ("pusit"). A default of **2 MT/km²** is often used as a last resort if no available information is present.

f. Fish turnover rate (demersal and pelagic; no units)

This is the rate at which fish populations or communities reproduce in one year. This value refers to how fast demersal or pelagic fishes reproduce. It is multiplied to the previous fish stock to determine how much fish will be available in the next time step. Smaller fishes are often fast growing and have high turnover rates than larger fishes. Pelagic fish turnover rate is often greater than demersal fish turnover rates. Default values of **1.5** for demersal stocks and **2.0** for pelagic stocks can be used.

g. Fish carrying capacity (demersal and pelagic; MT/km^2)

This is the maximum biomass that can be reached by a fish group. In most cases, these values often do not have a bearing on simulations because many areas do not reach this value. Maximum fish biomass is usually set at 10 MT/km^2 for demersal fishes and 3 MT/km^2 for pelagic stocks. Pelagic stocks have smaller carrying capacities since they are often not site-attached.

h. MPA spillover rate (demersal and pelagic; %)

Marine protected areas (MPAs), if enforced strictly, can become sanctuaries for fishes where they are allowed to grow and mature and, eventually, move into open fishing grounds where chance will determine their fate (Abesamis and Russ 2005). Movement of fish from MPAs to other areas is called "spillover". A default of 10% spillover is used. This means that for every time step in the model, 10% of fish biomass inside the MPA spills over to non-protected areas, making them accessible to fishers.

i. Municipal catch per fisher per day (kg/fisher/day)

Ideally, municipal governments should have established regular fish catch monitoring that is designed to accurately and precisely estimate how much fish is being taken from the municipal waters. In the absence of reliable data sets, an estimate of the average municipal catch rate per fisher per day can be obtained from structured interviews of fishers or through focused-group discussions. As with any of the parameters, the user can change this input with values that fishers or the audience think or feel are more accurate just to demonstrate its effects on fishery carrying capacity and MPA size requirements.

FISHDA can be used to identify data gaps and establish community-based fish catch monitoring systems.

j. Municipal fishing days per year (days)

Information from fish catch monitoring or fisher surveys can provide the average number of days that fishers go out to fish within a year. Fishers can easily give estimates of the number of fishing days per month and the months they usually fish. Make sure to multiply the figure by the number of months they go out to fish as there should be months when fishing is almost halted especially during typhoon season (i.e., from August to October).

k. Municipal catch area (km^2)

This pertains to the extent of fishing grounds within their municipal waters. If all fishers access all parts of their waters, the municipal fishing area is the same as the area of municipal waters. On the other hand, if some areas are restricted from

fishing, they must be deducted from the total fishing area. "No-take" zones, transit lanes and other areas where fishers are not allowed are some examples of exclusions from fishing area. Usually, fishers do not fish in the entire municipal waters. Many fishers do not reach 10 to 15 km from shore.

Catch area is one of the most sensitive parameters in FISHDA. This can be estimated by asking fishers to plot their fishing grounds on a map. Put grids on the map with equal interval and known distance or area (e.g., 1 minute = 1.852 km). If the extreme points or fishing grounds are joined together, the catch area can be estimated by counting the number of cells on water and within the extreme points. Multiply by the area of one square and you will get an area estimate! The same can be done for estimating area of coastal waters, assuming you have clear boundaries.

I. Percent demersal in municipal catch (%)

Demersal fishes are those who live or spend most of their time at the bottom of the water and are usually found near the shore. Examples of the fishes under this category are the reef-associated fishes such as serranids ("lapu-lapu"), acanthurids ("labahita"), lutjanids ("maya-maya"), and nemipterids ("bisugo"). This information may be derived from frequent fish landing surveys. Alternatively, the facilitator can ask the fishers during the FISHDA exercise "In your daily catches or in one fishing trip, how many percent are demersal fishes?" followed by giving examples of demersal fishes. The percent demersal fish in municipal catch also describes the relative dependency of the municipal fishers on the demersal and pelagic stock and the fishing behaviour (i.e., if fishing pressure is concentrated on the reef or is more dispersed) of municipal fishers which is important in determining the projected fish stock over time (Cabral *et al.* 2010).

> **TIP!**
>
> Use quartiles (i.e., 25%, 50%, 75%, or 100%) in asking fishers about the percentage of demersal fish in their catches (unless there are actual fish catch data).

m. Average municipal fish price (PHP/kg)

This should be the average price per kilogram of fish sold to its first buyer that is realistic and representative of the overall fisheries, as oftentimes tropical fisheries are diverse and prices can vary. The first buyer may be a community member, wholesaler, broker, or resort owner. Similar to "farm gate price".

n. Average daily expenses per municipal fisher (PHP)

This pertains to the average daily expenses a municipal fisher needs to support his/her family's basic needs. The value of this includes all expenses from food, education, water and electricity bill, and medicines.

o. Commercial fishing parameters

If you want to include commercial fishers or test the impact of commercial fishing in your municipal waters, you would need to fill up the commercial fishing variables:

- number of commercial fishers (number)
- commercial catch per fisher per day (kg/fisher/day)
- commercial fishing days per year (days/year)
- commercial catch area (km^2)
- percent pelagic in commercial catch (%)

The definitions are the same as their "municipal" counterparts discussed previously. If commercial fishing will not be included in your model, leave a value of "1" for all the above commercial fishing variables.

For a more comprehensive guide, please refer to the FISH-BE model manual set found in the accompanying CD. The manual set contains three (3) books. The first is a user's guide where it describes how to use the FISH-BE (Castillo & Licuanan 2007), the second "BASIC FISHERIES PROFILE INFORMATION: INPUTS FOR FISH-BE" describes the methods on how to collect data and estimate values for FISH-BE

inputs (Campos & Castillo 2007), and the last book is a compilation of FISH-BE runs for different selected towns (Philippine Environment Governance (EcoGov 2) Project 2007). A user's manual of the FISHDA is also included in the CD.

IV. THE FISHDA GRAPHICAL USER INTERFACE (GUI)

The graphical user interface of FISHDA is shown in Figure 1. Labels are also included to guide the user on the different features of the model. A detailed version is included in this kit (reprinted from the EcoGov2 project; "FISHDA: FISH-BE Without Strings").

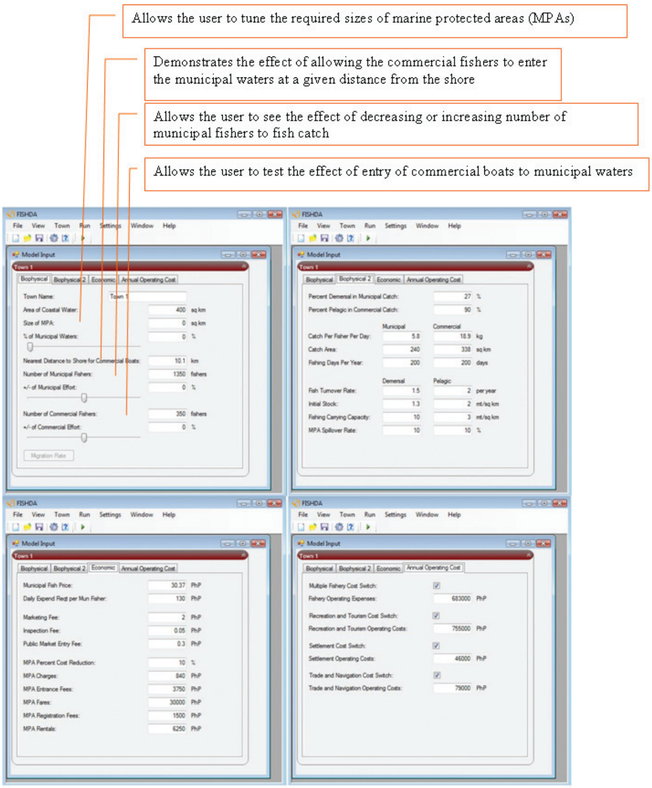

Figure 1. The FISHDA Graphical User Interface (GUI) and its parts.

V. FISHDA CASE STUDY: INPUTS FROM EL NIDO

The FISHDA inputs for the town of El Nido are listed in Table 1. This section focuses on some of the management scenarios that can be done during the modeling exercise. Note that the results presented here are not final since the FISHDA demonstration used rough estimates from a limited survey of fishers in El Nido. Data inputs need to be verified through a wider fisheries monitoring program. Scenarios and results presented here are for illustrative purposes only.

a. Changing the size of Marine Protected Areas (MPAs)

MPAs are designed to conserve and protect marine biodiversity, which in turn enhances the fish stocks. The adjacent fishing grounds are also enhanced from spillover coming from the protected areas.

Table 2 and Figure 2 show the number of municipal fishers that can be supported by the fishery after 20 years under varying MPA sizes. At 0% MPA (all municipal waters are fishing grounds), no fishers will be supported by the fishery. Increasing the size of the MPA also increases the number of fishers that can be supported by the fishery. When 42% of municipal waters are allocated as MPA, up to 3,132 fishers will be supported by the fishery after 20 years, more than the current actual fishers population (3,000). Increasing further the size of MPA results to a decreasing catch due to less area allocated for fishing.

It seems that if MPAs are the only management mechanism that will be employed in El Nido, 42% of its municipal water should be allocated as MPA. This value is very high and is much greater than what is stipulated in the Philippine Fisheries Code of 1998, which encourages the allocation of 15% of municipal water as

fish sanctuary or "no-take" zones. El Nido can target reaching the 15% stipulation in RA 8550 and add other fishery management interventions.

Table 2. Number of municipal fishers that can be supported by the fisheries after 20 years at varying size of marine protected areas (expressed in % of municipal waters).

% MPA	Number of Municipal Fishers Supported after 20 years
0	0
5	43
10	87
20	174
30	261
40	347
41	356
42	3132
43	3081
45	2980
50	2727
60	2221
90	809
100	0

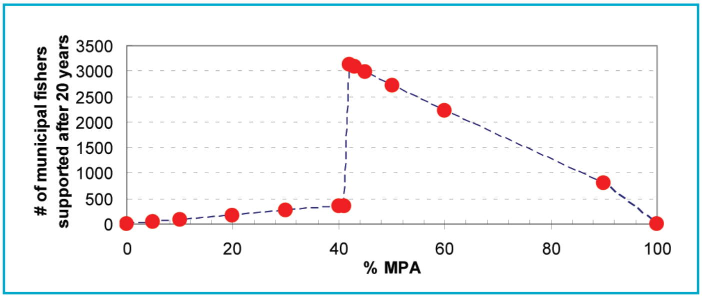

Figure 2. Plot of number of municipal fishers that can be supported by the fishery after 20 years for varying MPA size requirements (values in Table 2 represented as a line).

b. Varying the number of municipal fishers

Fishing pressure profoundly affects the projected fish catch and standing stock through time. Each type of fisheries has its unique fishing pressure capacity. If the number of fishers, and hence the resulting fishing pressure due to the fishing effort exceeds what the fishery can handle, catch will decline over time and, if left to continue unregulated, the stock and fishery will collapse and/or lead to great economic losses.

Increasing the number of fishers will simulate the effect of unmitigated entry of new fishers to the fishery and can further lead to Malthusian and ecosystem overfishing (Pauly *et al.* 1989). On the other hand, decreasing the number of fishers will simulate the effect of shifting of fishers to other livelihoods within and outside the municipality. The model initially evaluates the effect of changing the fishing pressure but the insights on how these could happen (e.g., shift of fishers to alternative livelihood, sources of alternative livelihood, or fishing grounds, etc.) should be derived from the discussions among participants as guided/facilitated by a facilitator.

Table 3 shows the effect of decreasing the number of fishers in the fishery. In its current state, the fishery cannot support any fishers after 20 years. If no other management initiatives are being employed in El Nido except decreasing the number of fishers, El Nido needs to reduce its current fishing pressure by half in order to increase the catches of the remaining fishers.

Table 3. Effect of decreasing the number of fishers through shifting to alternative livelihood options.

Current number of municipal fishers	Number of municipal fishers that can be supported after 20 years
3000	0
2000	0
1900	0
1800	0
1700	0
1600	2804
1500	2628
1000	1752

c. Effect of fish price

Fish price is one of the important economic factors that determine how the municipality will behave in order to meet their daily subsistence needs. Lower fish price means that fishers need to harvest more in order for them to meet their needs. On the other hand, higher fish price means two possible options. First, given that fishers regulate their catches according to their needs; high fish price means that lesser effort in fishing is required to meet the needs of fishers, which in turn translate to lower fishing pressure. Alternatively, fishers will not regulate their effort which means that increase in fish price will not affect the projected stock, but will affect the number of fishers that can be supported by the fisheries. The latter is the dynamics being employed in FISHDA. Table 4 shows the number of fishers that will be supported by the fishery after 20 years for two sizes of MPA, 15% which is the size required by the law and 42 % which is the optimal size of MPA for El Nido, if MPA is the only management initiative (See Table 2 and Figure 2). As expected, the number of fishers that can be supported by the fishery is higher when fish price is higher. For 15% MPA, the increase in fish price is not enough to support the needs of 3,000 fishers.

Upon demonstrating the effect of fish price, the facilitator may now initiate the discussion on how to come up with solutions in regulating the fish price. This is particularly relevant to fisheries with lower than average fish price, such as El Nido.

Table 4. Effect of fish price to the number of municipal fishers supported by the fishery. (The MPA size of 15% of the municipal waters is in line with the requirements of the law as promoted in the Fisheries Code and 42% which is the optimal size as shown in Table 2 and Figure 2. The present number of municipal fishers is 3,000.)

Fish price (PHP)	Municipality with comparable fish price	Number of municipal fishers supported after 20 years (with 15% MPA)	Number of municipal fishers supported after 20 years (with 42% MPA)
46	El Nido	130	3,132
56	Bolinao, Lubang	159	3,813
66	Verde Island, Masinloc	187	4,494
76	Alaminos, Looc	215	5,175
86	Mabini, Subic	244	5,856
96	Puerto Galera	272	6,536

d. Effect of encroachment of commercial fishers in municipal waters

Poaching of commercial fishers inside the municipal waters are experienced by most municipalities and several management measures in the Philippines are being initiated to address this.

Five inputs are needed to simulate the effect of poaching on the stock and catch of the municipality. These are: (1) number of commercial fishers, (2) catch per commercial fisher per day, (3) number of fishing days per year for commercial fishers, (4) commercial catch area (the total area being explored by the commercial fishers) and (5) the distance from the municipal shoreline where the commercial fishers intrude or are allowed to fish.

Let us assume that the number of commercial fishers is equal to number of commercial boats. Each boat catches 200 kg per day and fishes 100 days per year. The catch area of commercial boat is 100 km^2. Further, suppose that El Nido allocates 42% of the municipal waters as MPA. Table 5 shows the effect of variable number of commercial boats entering the municipal water at varying distance from the shore. With one commercial boat, the number of municipal fishers that can be supported by the fishery after 20 years is maintained unless the commercial boats enter up to five kilometers from the shore, wherein the number of supported fishers abruptly drops from 3,132 to 365. When five commercial boats enter the municipal fishery, the number of supported fishers drops from 3,132 to 365 even though those boats are only allowed up to 12.5 km from the shore.

Figure 3 shows the projection of total municipal catch through time when there are five commercial boats entering the municipal waters at varying distances from the shore. The nearer the commercial boats to the shore, the faster the collapse of the stock and hence the fish catch.

Table 5. Effect of intrusion of commercial boats to the number of fishers that can be supported by the fishery after 20 years.

Number of commercial Boats	Nearest distance to shore for commercial boats (km)	Number of Municipal Fishers Supported after 20 years (with 42% MPA)
0	0	3,132
1	12.5	3,132
	10	3,132
	7.5	3,132
	5	365
5	12.5	365
	10	365
	7.5	365
	5	365

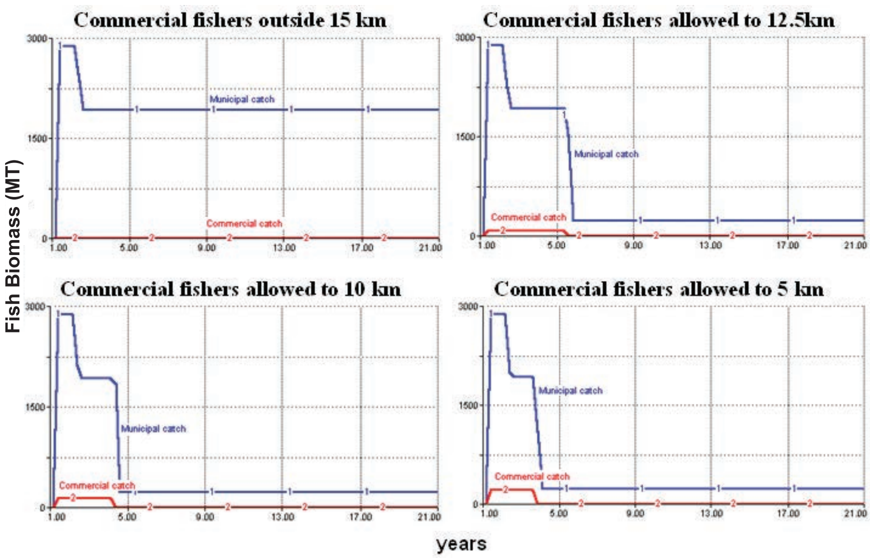

Figure 3. Projected total municipal (blue) and commercial (red) catch (MT) over twenty years for different scenarios of commercial fishing allowed within municipal waters. Five commercial fishing boats are allowed to come closer to shore across the four scenarios.

VI. OTHER SCENARIOS THAT CAN BE EXPLORED USING FISHDA

a. Changing the number of fishing days in a year

Another way to regulate fishing pressure is by adjusting the number of fishing days in a year. However, in FISHDA the decrease in number of fishing days corresponds only to the linear decrease in fishing pressure, but in practice, reduction of fishing days is targeted, i.e., during the months of spawning season which may have a different end-result in reality.

b. Insights from percent demersal fish in municipal catch

The catch composition of municipal fishers gives insights into the type of fishing strategies the municipal fishers employ. If their catches are mostly pelagic, it means that the fishers are more dispersed, i.e., they are mostly fishing offshore. On the other hand, if their catches are mostly demersal, fishers are concentrated in nearshore and reef areas.

VII. SUMMARY AND FINAL REMARKS

The scenarios tested and illustrated here are only the basic ones. Users can explore many other scenarios, using the different parameters available in FISH-BE/ FISH-DA. A comprehensive planning process that uses FISHDA as a guide should test the parameters in different combinations in order to extract as many possible management combinations and choose the one that is most acceptable to the community.

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REFERENCES:

1. Abesamis, R.A., Russ, G.R. 2005. Density-dependent spillover from a marine reserve: Long-term evidence. *Ecol. App.* 15(5):1798-1812.
2. Cabral, R.B., Geronimo, R.C., Lim, M.T., Aliño, P.M. 2010. Effect of variable fishing strategy on fisheries under changing effort and pressure: An agent-based model application. *Ecol. Model.* 221:362-369.
3. Campos, W.L., Castillo, G.B. 2007. Basic Fisheries Profile Information: Inputs for FISH-BE. Philippine Environmental Governance (EcoGov 2) Project, Pasig City, Philippines.
4. Castillo, G.B., Licuanan, W.Y. 2007. FISH-BE I Model User's Guide. Philippine Environmental Governance 2 Project, Pasig City, Philippines.
5. De Castro, M., Go Ho, S., Kiac, J.C., Lao, A. 2007. FISHDA: Fishing Industries' Support in Handling Decision Applications. User's Manual.
6. Lachica-Aliño, L., Wolff, M., David, L.T. 2006. Past and future fisheries modeling approaches in the Philippines. *Rev. Fish. Biol. Fisher.* 16:201-212.
7. Licuanan, W.Y., Aliño, P.M., Campos, W.L., Castillo, G.B., Juinio-Menez, M.A. 2006. A decision support model for determining sizes of marine protected areas: Biophysical considerations. *Philipp. Agric. Sci.* 89:507-519.
8. Licuanan, W.Y., Geronimo, R.C., Aliño, P.M. 2007. Going Beyond FISH-BE: Towards understanding ecosystem scale and simple rules for local fisheries management. *In:* Aliño, P.M. (ed). 2007. FISH-BE Library of Models. EcoGov 2 Project, Pasig City, Philippines. 100p.
9. Licuanan, W.Y., Mamauag, S.S., Gonzales, R.O.M, Aliño, P.M. 2008. The minimum sizes of fish sanctuaries and fishing effort reductions needed to achieve sustainable coastal fisheries in Calauag and Tayabas Bays. *Philipp. Agric. Sci.* 91:51-60.
10. Pauly, D., Silvestre, G.T., Smith, I.R. 1989. On development, fisheries and dynamite: A brief review of tropical fisheries management. *Nat. Resour. Model.* 3:307-329.
11. Philippine Environmental Governance (EcoGov 2) Project. 2007. FISH-BE Library of Models. Alino, P.M. (ed). EcoGov 2 Project, Pasig City, Philippines, 100p.

About the authors:

Reniel B. Cabral is an MS Physics Student at the University of the Philippines Diliman and the Ecological Modeler of the Ecosystem-Based Management (EBM) Project.
Email address: reniel.cabral@gmail.com

Rollan C. Geronimo is a graduate of MS Marine Science at the University of the Philippines Diliman, and is currently a Marine Policy Consultant for Conservation International - Philippines. He is the Assistant Project Supervisor of the EBM Project.

Porfirio M. Aliño is a Professor at the Marine Science Institute, University of the Philippines Diliman and the project leader of the EBM Project.