Assessment of Humphead Wrasse (*Cheilinus undulatus*), Spawning Aggregations and Declaration of Marine Protected Area as Strategy for Enhancement of Wild Stocks

Filemon G. Romero and Akkil S. Injani*

Mindanao State University, Tawi-Tawi College of Technology and Oceanography, Bongao, Tawi-Tawi, Philippines
* filemon.romero@yahoo.com

Abstract

Humphead wrasse, known as the Napoleon fish (*Cheilinus undulatus*), is the largest living member of the family Labridae. It is slow growing but can grow to a maximum size exceeding 2 m and 190 kg. This species was the first commercially important coral reef food fish to be listed in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Appendix II in 2004 because of its vulnerable status and the ongoing threat to its conservation from international trade. Like many coral reef fishes, the humphead wrasse, *Cheilinus undulatus*, aggregate in reef areas when they spawn and this spawning behaviour makes them highly vulnerable to overfishing. Assessment of the spawning aggregations of this species was conducted in the municipalities of Sibutu and Sitangkai in the province of Tawi-Tawi, Philippines. Key informant interviews (KII) with fishermen, mariculturists, and other stakeholders and focus group discussions (FGD) with local government leaders, Fisheries and Aquatic Resources Management (FARMC) members, mariculturists, and exporters were conducted. Guided by the results of these KII and FGDs, underwater visual census of mameng (local common name for Napoleon wrasse) populations (juvenile and mature) were conducted to document spawning aggregation sites. Since there was no photo-documentation of actual spawning aggregations of *mameng* in the reef areas, indirect measures were used. Result of the KII and FGD indicated that the Baligtang Reef in Sipangkot and Tando Owak are major sources of spawners. Anecdotal accounts of Bajau fishermen showed that Dungun Dungon, Baligtang reef, Tando Owak and Tugalan are traditional fishing grounds for *mameng* spawning aggregations. From the length-frequency analysis of *mameng* caught by hook and line and fish pot in the Baligtang Reef in Sipangkot, the estimated length at maturity of this species was found to be 25-35 cm. There were 134 individuals caught within this size range so they are considered potential spawners. Another indirect proof used was the underwater documentation of juvenile humphead wrasse which were regularly observed and photographed in association with seagrass beds and branching coral reefs in Baligtang Reef in Sipangkot, Sitangkai. Gonadal study also indicated that the *mameng* caught in this area had mature and ripe gonads but the number of mature fish depends on the season. These were the basis of declaring Spawning Aggregation Sites in Tando Owak and Dungun Dungun in Sibutu and Baligtang Reef, Sipangkot and Tugalan in Sitangkai. These were declared as marine protected areas by ordinance of the municipal *Sangguniang Bayan* of the two municipalities. Management and enforcement plans have been developed and *Bantay Dagat* have been trained to protect the spawning aggregations and this strategy aims to protect the wild stocks of humphead wrasse. Protecting the spawners would ensure that there would be enough recruits, prevent recruitment overfishing and enhance the wild stocks.

Keywords: humphead wrasse, assessment, spawning aggregations, management

Introduction

The Sulu Archipelago Reef complex, an ecologically important component of the Coral Triangle, is known to be one of the main sources of the live food fish trade particularly groupers (red grouper) and humphead wrasse or Napoleon wrasse (*Cheilinus undulatus*). It constitutes about 25% of the coral reef cover of the Philippines. Fisheries and agriculture contribute 17% to the Gross Domestic Product and is the primary contributor to the national diet. Since these also provide nearly two-thirds of the population's animal protein (FAO, 2000) requirement, there is a need to assess the small-scale fisheries which produce about 95% of total marine fisheries production of the country. It was estimated that more than 80% of the small-scale fishers and their families have net incomes below the national threshold poverty level (FAO, 2000).

Sibutu and Sitangkai in the province of Tawi-Tawi, Philippines are mariculture centers in the area. A study of Romero and Injani (2010) indicated that humphead wrasse is the primary species cultured in more than 350 cages of different sizes and number per cluster of cages surveyed. This constitutes about 76% of the cultured species while others hold various species of groupers, caranx, siganids and lobsters. From these pens, a total of 31,071 humphead wrasse fingerlings (0.2-0.5g) were counted. There were 6,914 under sized (0.6-0.8g) and 4,675 marketable size (1.0kg-1.4 kg) humphead wrasse. However, in 2004 the Napoleon fish has been listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Appendix II provides that all species, although not necessarily threatened with extinction at the present time, may become so unless trade in specimens of such species is subject to strict regulation in order to avoid utilization incompatible with their survival. Section 97 of RA 8550 otherwise known as the Fisheries Code declares it unlawful to fish or take threatened or endangered species as listed in the CITES. Likewise, Section 11 of RA 9147, otherwise known as Wildlife Act also provides for the implementation of regulations in international trade of endangered species of wild fauna and flora. Despite these laws, mariculture of this Napoleon wrasse is still being done using juveniles harvested from the wild.

Francisco *et al.* (2009) recommended that "sustaining profitable, yet responsible mariculture micro-enterprises for poor fishing communities participating in fisheries management programs can be a two-pronged strategy: to increase rural income and foster broader motivation and vigilance for the protection of habitats and resources." The sheer number of individual Napoleon wrasse stocked in pens and cages shows that the fishermen are still able to catch fingerlings and immature wrasse from the wild and many believe that this species is not endangered or threatened.

Reef fish aggregations are groups of fish gathered for either spawning, feeding or shelter. By definition, a spawning aggregation is a group of con-specific individuals grouped together in densities three times higher than those found during non-reproductive periods. Species that periodically and predictably congregate on land or in the sea can be extremely vulnerable to over-exploitation. It is common practice that fishermen target these spawning aggregations sometimes with the use of dynamite. This practice could possibly result in growth overfishing of this species. Growth overfishing results in the loss in biomass that is greater than the biomass gained through growth, and is usually due to high fishing rate or to collection of stocks before they have time to grow. Humphead wrasse, like other reef fishes, is known to spawn in aggregations consistently at the same specific period of the year at a specific area. Unlike the groupers which have large spawning aggregations, humphead wrasse has small aggregations and the sites are usually on the outer reef slopes, in reef channels, or at drop-offs. This study is done to determine the occurrence, history, and management of spawning aggregations of this species.

A good understanding of the effects of fishing on reef fish spawning aggregations, gained through sound scientific study, is the key to their successful management and conservation. This is in line with the 2011 Coral Triangle Support Partnership (CTSP) Program that targets to contribute to 350 hectares of new MPAs in Tawi-Tawi and Palawan. However, the assessment of the fishery and biological parameters and spawning aggregation sites needs to be done to increase awareness among communities of their ecological significance and vulnerability and to adopt a policy of protecting these spawning aggregations as a strategy to enhance the wild stocks like declaring these spawning aggregations as marine protected areas.

Objectives of the Study

1. To gather baseline information about Napoleon wrasse and their spawning aggregation using KII with fishermen, mariculturists and FGD with other stakeholders;
2. To document spawning aggregation sites in Sibutu and Sitangkai areas and determine the seasonality of spawning activity by conducting underwater visual census;
3. To establish baseline data on spawning aggregations of Napoleon wrasse in terms of sizes, places and time of spawning; and
4. To adopt policies for the protection of spawning aggregation sites and their management by recommending relevant ordinance/s.

Review of Literature

Humphead wrasse (*Cheilinus undulatus*) is the largest living member of the family Labridae, It is slow growing but can grow to a maximum size exceeding 2 m and 190 kg. Like many coral reef fishes, humphead wrasse form spawning aggregations. Spawning is the term used to describe the reproductive act of some aquatic animals such as fish, mollusks, and crustaceans. Spawning occurs when sperm and eggs are released for fertilization into the water column or deposited onto the seabed. According to Mancilla and Ponce Taylor (http://scuba.about.com/od/ConservationandDiving/p/Fish-Spawning-Aggregations.html), the sperm and eggs must be expelled at around the same time and at the same place for this form of external fertilization to work. This species is a protogynous hermaphrodite (i.e. they mature first as females and later change to males), has low productivity and occurs in naturally low densities in reef-associated areas throughout its geographical range in the Indo-Pacific (Sadovy *et al.*, 2003). In recent years, this species has been very much in demand in the live fish trade and has become one of the most vulnerable species to the impacts of fishing in reef fish assemblages. Substantial declines in local abundance have been observed in many locations within the species' range due to several factors, but most prominently because of trade-driven overfishing (Sadovy *et al.*, 2003).

Species such as giant grouper and humphead wrasse are particularly susceptible to overfishing because of their slow growth and long development to sexual maturity. Due to over fishing, humphead wrasse (*Cheilinus undulatus*) is the first reef fish now listed in Appendix II of the Convention on International Trade in Endangered Species (CITES) and must now be strictly regulated by importing and exporting countries. Under CITES regulations, countries exporting Appendix II species are required to demonstrate that export quotas are derived from legal fisheries and that such exports will not be detrimental to the survival of the species or its role in the ecosystem. However, there is paucity of data for the humphead wrasse on the levels of exploitation of the stock from the fisheries. Data limitations in small-scale capture fisheries pose a very big constraint in decision-making for the management of this fisheries. It also recognizes the development of approaches for fisheries assessments in data-poor situations as one of the key areas of action for improving information on status and trends of marine capture fisheries (FAO, 2003). From the point of view of responsible fisheries management, a non-detrimental finding (NDF) implies defining and enforcing a catch level that maintains the abundance of the stock above a state where it would be considered overfished or depleted and that would have a negative impact on the ecosystem. The problem is that information about the targeted resources is often so poor for many fisheries that it is very difficult to make inferences about their status or about sustainable catches.

Trade in live reef fish represents an important commodity in Asia and the Pacific and includes fish caught, shipped, and exported live to the consumers like the live reef food fish trade and ornamental fish caught for the aquarium hobby industry. The live reef food fish trade primarily targets grouper species and other reef species like the humphead wrasse for the markets of Hong Kong and southern China. Southeast Asia and Australia are the major suppliers of this trade; yet, operators are increasingly seeking fish in more remote parts of the Western Pacific including Papua New Guinea and the Solomon Islands. The centre for the live reef food fish trade is located in Hong Kong. According to a report by TRAFFIC International-East Asia, a wildlife trade monitoring network hosted by World Wildlife Fund (WWF)-Hong Kong, the total annual value of live reef food fish imported into Hong Kong is estimated to be over US $400 million (40% of the estimated $1billion value of global trade). Total imports flowing into Hong Kong included 10,153 metric tons, of which 30% was re-exported to mainland China. Other major markets include Singapore and Taiwan.

Reef fishes are significant socially, nutritionally and economically, yet biologically they are vulnerable to both over-exploitation and degradation of their habitat. Their importance in the tropics for living conditions, human health, food security and economic development is enormous, with millions of people and hundreds of thousands of communities directly dependent, and many more indirectly so. Reef fish fisheries are also critical safety valves in times of economic or social hardship or disturbance, and are more efficient, less wasteful and support far more livelihoods per tonne produced than industrial scale fisheries.

Spawning aggregations are best documented with direct evidences - observations of actual spawning or documenting the presence of hydrated oocytes within gonads of females on the site (www.scrfa.org). If direct evidence is not available, indirect evidences include density increases, spawning-specific color changes and behaviours, swollen abdomens and increases in the gonadosomatic index. A combination of indirect observations increases the likelihood that the aggregation is actually a spawning aggregation. Reef fish spawning aggregations are predictable in space and time. Two different types of spawning aggregations have been defined ("resident" and "transient") using three criteria, i.e. the frequency of aggregations, the longevity of aggregations, and the distance travelled by fish to the aggregation. Spawning in resident aggregations is common to most rabbitfish (siganids), wrasses (labrids) and angelfish (acanthurids). In this type of aggregation, spawning is brief (often 1-2 hours), occurs frequently (often daily) and involves migration over short distances to the spawning site. Spawning in transient aggregations, by contrast, is the strategy used by most grouper (serranids), snapper (lutjanids), and jacks (carangids), along with several other families. Accounts of reproductive activity in the field reveal that, depending on location, this species spawns between several and all months of the year, in small or large groupings, that spawning coincides with certain phases of the tidal cycle and that groups of spawning fish can form daily, at a range of different reef types (Colin, Choat, Hamilton and Oakley, pers. comm.).

Figure 1. Location map of Sitangkai and Sibutu.

Materials and Methods

Study Sites

Sitangkai is a remote island municipality located at the southernmost portion of Tawi-Tawi province. It is one of the areas covered by the CTSP Program in the Sulu-Sulawesi Marine Eco-region in Tawi-Tawi assisted by the World Wide Fund for Nature – Philippines (WWF-Philippines). It is bounded in the east by Tumindao Channel, in the south by Celebes Sea and in the north by Sabah, Malaysia. It is a 5^{th} class municipality composed of 14 barangays.

Sibutu is a newly created municipality out of the Sitangkai municipality by virtue of MMAA No. 197, which was subsequently ratified in a plebiscite held on October 21, 2006. It is a sixth class municipality in the province of Tawi-Tawi. It lies about 14 km east of the coast of Sabah, Malaysia. It is comprised of Sibutu Island and four more small and uninhabited islands 3.4 to 5.9 km south of the main island.

Key Informant Interviews (KII) and Focus Group Discussions (FGD)

Gathering of information about the fishery and spawning aggregations of the fish species included in this study was done through the conduct of KII with fishermen, mariculturists, and other stakeholders. An interview instrument was formulated and administered by the enumerators in the two municipalities. A total of 40 fishermen and 50 mariculturists were randomly selected for the KII. Interview instruments were designed to get anecdotal accounts or actual information about fishing practices and spawning sites of the humphead wrasse. The best means of obtaining information is to compile traditional knowledge from resource users. Traditional fishers were particularly valuable source of information as they provided a temporal perspective on given spawning aggregation sites. KII results were validated through FGD with local government leaders (municipal and barangay levels), FARMC members, MPA management board members, mariculturists and exporters.

Underwater Visual Surveys

Underwater Visual Surveys (UVS) using SCUBA were conducted by laying a 100 meter transect line in each of the stations. The laying of the transect lines were in the reef slope parallel to the shoreline and this was repeated five times in each station. Observations were conducted 5m to the right and to the left of the transect line using two SCUBA divers. All these were recorded on slates. The area covered for each transect line was 200 m^2. The total area swathed by the five transect lines was approximately 1,000 m^2. An underwater photo-documentation was done using an underwater camera and the depth of the observation areas varied from 60 to 160 ft. This activity documented the presence of juveniles and mature humphead wrasse species and hoped to encounter a spawning aggregation. Using GPS, the coordinates of the stations for the underwater visual surveys, were documented during the first, second, third and fourth quarters of the year. The maximum depth reached was also documented. A total of 24 dive sites were surveyed.

Physical Measurements at Spawning Sites

Surface currents

The current system in the two study sites are predominantly influenced by tidal currents and is observed to be semi-diurnal, two high tides and two low tides. The surface currents were measured quantitatively with a GPS and a current drogue. The GPS distance and bearings functions and the data sheet were used to plot the speed and direction of the surface currents.

Tides and Winds

Information on tides used the local tide charts for 2012 issued by the National Mapping and Resource Information Authority (NAMRIA). The wind direction was assessed by a hand-held compass. For the wind patterns, although there are observed localized winds the monsoon winds were used for this study. April and May (SW monsoon) locally known as *Satan*, August (Inter-monsoon) and November (NE monsoon) locally known as *Uttara* were used as the wind indicators. Winds and currents are considered to be important factors that affect the fate of eggs and their dispersal.

Effort and Length Frequency Analysis

Catch from different kinds of gears and catch per unit effort (CPUE) were monitored as one relative index of the status of the fishery. Life history data size frequency distribution was used to analyse the size (and potential age) structure of the population, and to gather information on the size at reproductive maturity. The best place to collect CPUE data is at fishery landing site, while fishermen are capturing, cleaning and processing freshly caught fish.

For size frequency analysis, the following information were recorded on the data sheet:

- Fork length - length in cm from tip of snout to middle rays of caudal fin
- Weight - gutted or whole weight in grams
- Sex - male or female; maturity stage, i.e. immature, early development, late development, ripe and running, or spent
- Hours and/or number of days spent fishing. This is also defined as "soak time" or the actual number of hours fishing. For traps, it is the number of hours the baited traps are kept underwater before they are hauled. For handlines, this is the number of hours of fishing on site.

Reproduction and Gonadal Assessment

One indirect way of assessment of spawning aggregations is to gather samples of mature *mameng* species from the landed catch and get gonad samples of mature species to determine their level of maturity. The fishes were brought to the MSU laboratory and dissected and their gonads examined under the microscope. Depending on the state of the oocytes, they were classified as inactive, immature, resting, or developing. Presence of ovulatory follicles was also noted. Anecdotal information from fishermen, and behavioural observations were also used to provide a preliminary understanding of the reproductive biology of the humphead wrasse. This is another indirect way to determine possible areas of spawning aggregations.

Results and Discussion

History of the Fishery and Profile

The results of the KIIs with fishermen, mariculturists and other stakeholders show that fishing for humphead wrasse is not considered a traditional targeted fishery. It was more of an accidental catch of other reef fishery according to 85% of the respondent-fishermen. The 95% of the key informants said that this became a targeted fishery in 1987 due to local demand for live fish from Chinese businessmen in Bongao. Fishing for this species intensified when demand for live reef fish, especially for humphead wrasse, grew among the live fish restaurants in Sabah, Malaysia. As demand and the need for ready supply increased, fishermen started to grow them out in pens in 2000 on a trial and error basis. Demand for this species increased in Hong Kong and Taiwan and because of the success of their experimental grow-out system, more fish farmers followed suit.

Humphead wrasse is locally known as *mameng*. When it is sexually mature, the locals call it *Pehakan* (referring to sexually mature female). It is considered as protogynous hermaphrodite meaning the adults can change sex from female to male. Large male species are called by the natives as *langkawit* and they are characterized by a prominent bump in the head when it has reached a very large size. It has a low productivity.

The grow-out cages are primarily dependent on fingerlings or immature fish caught from the wild for stocking. Fishing for fingerlings is limited to shallow reef edges or in the mixed seagrass beds with coralline substratum. The larger *mameng* are caught in deeper areas especially in reef channels, which the natives call *takot* or on the edges of the fringing reefs. Other species which are typically associated with the live reef food fish trade (LRFT) like groupers, caranx, and lobsters are also grown out in these pens.

Fishermen describe the fishing grounds to be characteristic of fringing reef areas, reef channels and lagoons where branching, table and massive corals are located. They claim that humphead wrasse are found in areas where there are drop offs at various depths and varying slope inclinations. Juvenile *mameng* are found in mixed seagrass and coralline substratum but the larger ones are found in deeper reef areas. These were validated in the underwater visual census and the focus group discussions.

Figure 2 shows the location of the fishing grounds for humphead wrasse in Sitangkai and in Sibutu. The areas which are marked by circles are the major fishing grounds and include sites e Cebuggal, Serunga, Ligayan Halo, Tumindao and the North Lagoon, particularly near Sipangkot Island.

The fishing crafts used are non-motorized and motorized boats. The most dominant non-motorized boats according to majority of the informants are the dug-out boats locally called as the *beggong*. This is used to fish near the edge of the reef area or within the lagoon near the community and usually catches fingerlings only. This is also sometimes used to retrieve the *lambunan* or fish traps which are set near the community. The *papet/tariret* is a small and slender type of motorized boat with a more tapered bow and powered by 7.5 hp to 13 hp engines. This is a faster craft and is predominantly used for multiple troll line for tuna fishing. The *tempel/kurikong* is bigger with a more bulging hull. This is a motorized boat powered with 10 to 16 hp engines. Some use double engines. This is used to fish in far reef areas. The *jung-jung/katigan* is an out-triggered boat usually with 10 to 18 hp engines. This is used to reach outer reef areas near the Semporna area.

For the fishing gears, hook and line is the most common traditional gear used in catching humphead wrasse and other live reef fish. Baits of fresh pelagic fish like big-eyed scad or hermit crab are hooked to attract the fish. This is the least efficient among the gears. The *lakud* is a type of modified beach seine which uses fine mesh nets and also utilizes divers with scare lines to drive the fishes to the net. This gear can catch 10 to 20 reef fishes and this can include humphead wrasse depending on the season and the fishing grounds. This is used by about 35% of the fishermen. The *linggih lakoran* is modified gill net usually 50 m long, 1.3 m wide and mesh size of 2 inches. This is usually hung vertically in the water column and fish that gets entangled in the mesh net. This is usually weighted so that it can catch fish in mid-water or at the bottom and used by 30% of the fishermen interviewed. *Bungsud* or *angpas* (fish corral) is a stationary trap designed to intercept and capture fish. This is usually set perpendicular to the shoreline. This fencelike structure consists of rows of bamboo stakes, plastic nets, and other materials with a wide entrance leading to a catching chamber, bag or purse where the fish are caught or trapped. This is used by 20% of the fishermen. *Lambunan* is a fish trap usually made of bamboo frame with hard green plastic net wrapped into a rectangular basket with dimension 6 inches x 24 inches x 40 inches. The bottom part of the trap is loosely fastened on one side so that the trapped fish can be easily removed. On one side of the trap is a conical opening usually about 6 inches in diameter to serve as entry point of the fish and this would not allow the fish to escape. This is not usually baited but is covered with coral stones to simulate a coral formation and catches 1-5 fingerlings depending on the season. Cyanide with compressor diving is also used. Although majority of the fishermen interviewed do not admit directly using cyanide in catching humphead wrasse, use of this destructive method is still prevalent. The mortality of humphead wrasse in the earlier stage of grow-out in pens is an indication of shock due to cyanide exposure.

Eighty-six percent of the fishermen also claimed that they usually have a good catch during the southwest monsoon from April to June and during full moons. However, nowadays there has been a decreasing trend in their catch and they associate this to the sheer number of fishermen fishing for this species. Some say that there may already be less *mameng* that could be caught in the wild. Majority of the respondents also say that they spend longer time in the fishing grounds; have to go farther to catch fish than in the past; catch has not been stable and they catch smaller humphead wrasse. These were validated in the FGDs.

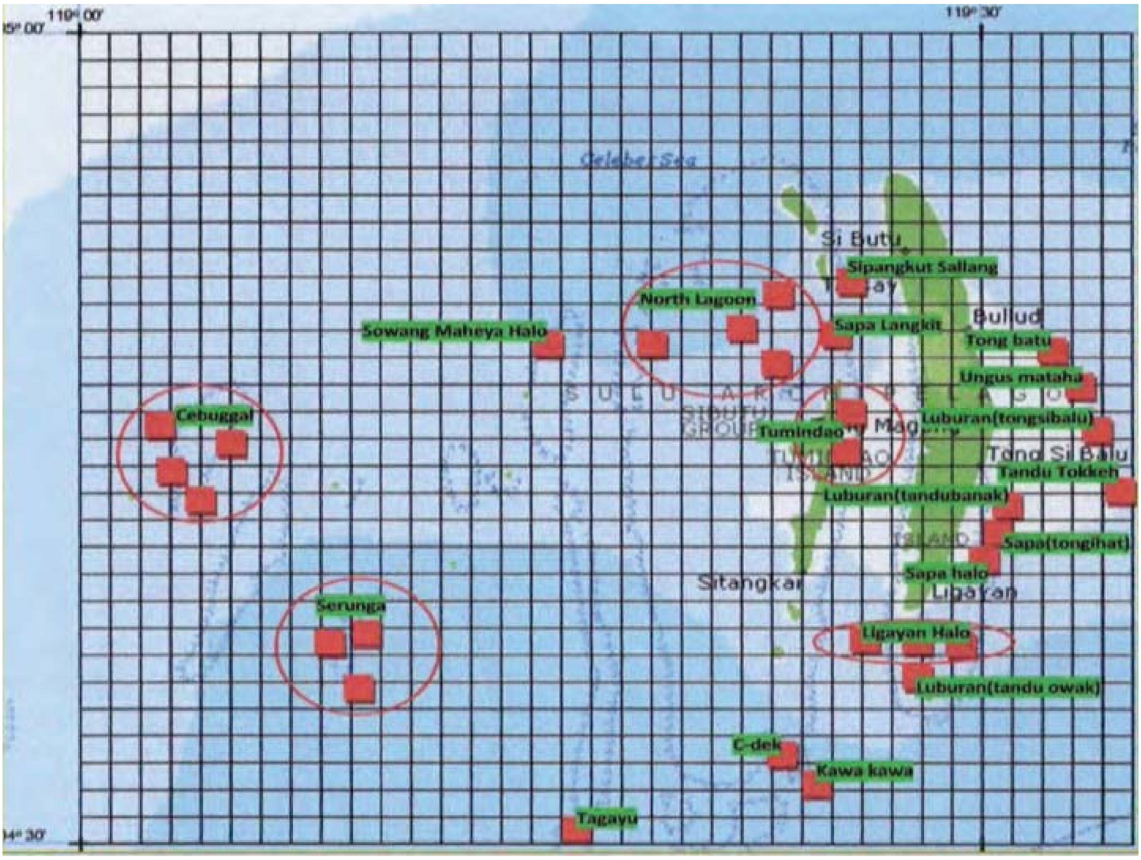

Figure 2. Map of the fishing grounds.

Mariculture Practices

As the demand for the humphead wrasse and groupers grew and considering that the price of live *mameng* is 250% more than that of fresh dead fish, more and more pens were constructed as grow-out for these live reef fishes in the eastern coastline of Sibutu Island. Now the grow-out cages are found in many areas of the North Lagoon, in the reef edges of Sitangkai and from Tandubanak to Tando Owak in Sibutu within the lagoon extending to about 10 kms along the shoreline. Figure 3 shows the distribution of the grow-out cages in Sibutu and Sitangkai and Figure 4 shows the mariculture cages of *mameng*.

Spawning Aggregation Sites (from interviews)

Based on the KII results, the respondents indicated that spawning aggregation sites are the reef areas in Dungun Dungun up to Tong Bakkaan, Ligayan Halo and Tando Owak, Tando Tokkeh and Tahing in Sibutu. In Sitangkai the respondents pointed to the reef areas in Sipangkot and Baligtang Reef, Cebuggal, Tagayu and Tugalan. From the anecdotal accounts of Badjao fishermen, this phenomenon is known to them as *Nabo* – a season when this spawning aggregation occurs.

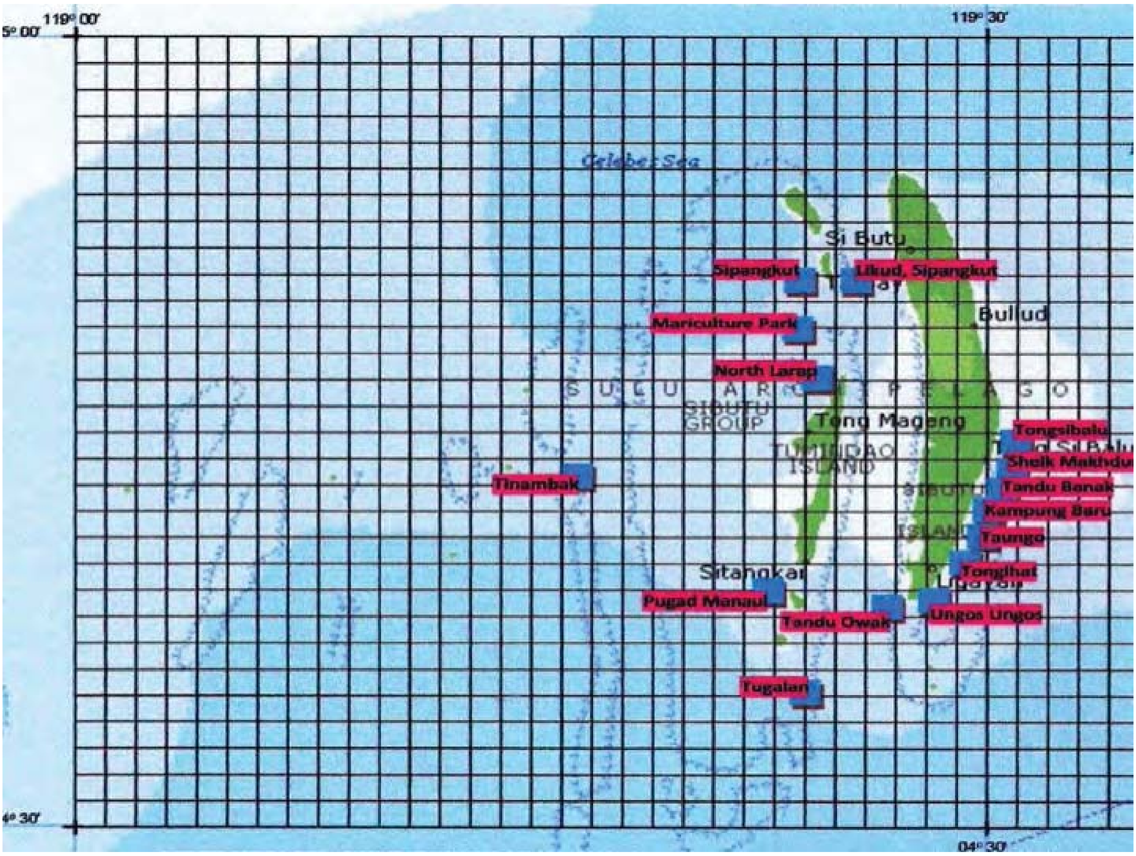

Figure 3. Location of the mariculture pens and cages.

Figure 4. Mariculture cages in Tandubanak Lagoon, and humphead wrasse species in grow-out cages.

Underwater Visual Surveys

Table 1 shows the distribution and estimated abundance of the juveniles, males and females in the fifteen (15) study sites for a total of 45 transect lines. These sites were identified by local fishermen and traditional *bajau* fishermen who served as guides since they use these sites as their fishing ground for the *C. undulatus* species. Underwater surveys were conducted to document density and distribution of humphead wrasse and have an estimate of the current size of the population. The lunar phase was also noted and this is associated with the amount of catch. The fish density, expressed as the number of individuals seen in 1,000m^2 area, ranges from a low 0.006/1000m^2 to a high of 0.027 /1000m^2 and an average of 0.016/1,000m^2. These results confirm the behavior of this species to be solitary and confined to specific areas in the reef. This also indicates high fishing pressure.

Table 1. Estimated distribution and abundance of *Cheilinus undulatus* juveniles, males and females and fish density/1,000 m^2.

Name of Site	**Abundance**	**Juveniles**	**Mature Females**	**Immature Females**	**Date**	**Lunar phase***	**Fish Density (no./1,000m^2)**
Tando Owak	6	2	1	3	5/13/2012	NM	0.006
Tando Tukkih	23	21	1	1	7/25/2012	NM	0.023
Langkawet Cave	6	2	2	2	7/25/2012	NM	0.006
Tongehat luuran	27	24	0	3	7/25/2012	NM	0.027
Taoungo Luuran	33	31	0	2	7/25/2012	NM	0.033
Tahing	7	5	1	1	7/25/2012	NM	0.007
Pamilikan	11	8	1	2	7/25/2012	NM	0.011
Dungon-dungon	27	23	1	3	10/10/2012	LQ	0.027
Baligtang	23	21	0	2	10/13/2012	LQ	0.023
Last ball	9	9	0	0	10/14/2012	LQ	0.009
Buton, Sibutu	4	1	0	3	12/10/2012	LQ	0.004
Tong Bakaan, Sibutu	24	22	0	2	12/10/2012	LQ	0.024
Serunga, Sitangkai	23	23	0	2	3/3/2013	NM	0.023
Sebabbal, Sitangkai	10	9	0	1	3/3/2013	NM	0.01
Sebuggal, Sitangkai	12	12	0	0	3/3/2013	NM	0.012
Suwang maheya, Sibutu	13	13	0	0	3/3/2013	NM	0.013
Total	**258**	**226**	**7**	**27**			

From the Underwater Visual Census, there were 27 immature and 7 mature females encountered in the dives, although they were evenly distributed, very few males with only 27 individuals were encountered in the whole stretch of the dive surveys. However, there were more juveniles encountered especially in shallow reef areas or a mix of seagrass beds with corals in areas near what fishermen say are spawning aggregation areas. Figure 5 shows the underwater shots of the juvenile humphead wrasse associated with seagrass beds and branching corals. Likewise this shows an underwater shot of the immature and mature female wrasse.

During the sampling periods, the catch of the fishermen were monitored. The catch from hook-and-line and *lambunan* (fish pots) the tail length (TL) in centimeters and weight (kg) of every individual catch were measured. The biomass of the fish caught was also determined. The catch per unit of effort (CPUE) was also computed based on the total catch and the number of hours spent fishing, which is generally 6 hrs.

Reproduction and Gonadal Assessment

Anecdotal information from fishermen, behavioural observations and gonad samples provide a preliminary understanding of the reproductive biology of the humphead wrasse. Throughout the study, a total of 51 fish samples of various sizes ranging from 20 mm to 105 mm were collected from the catch of the fishermen.

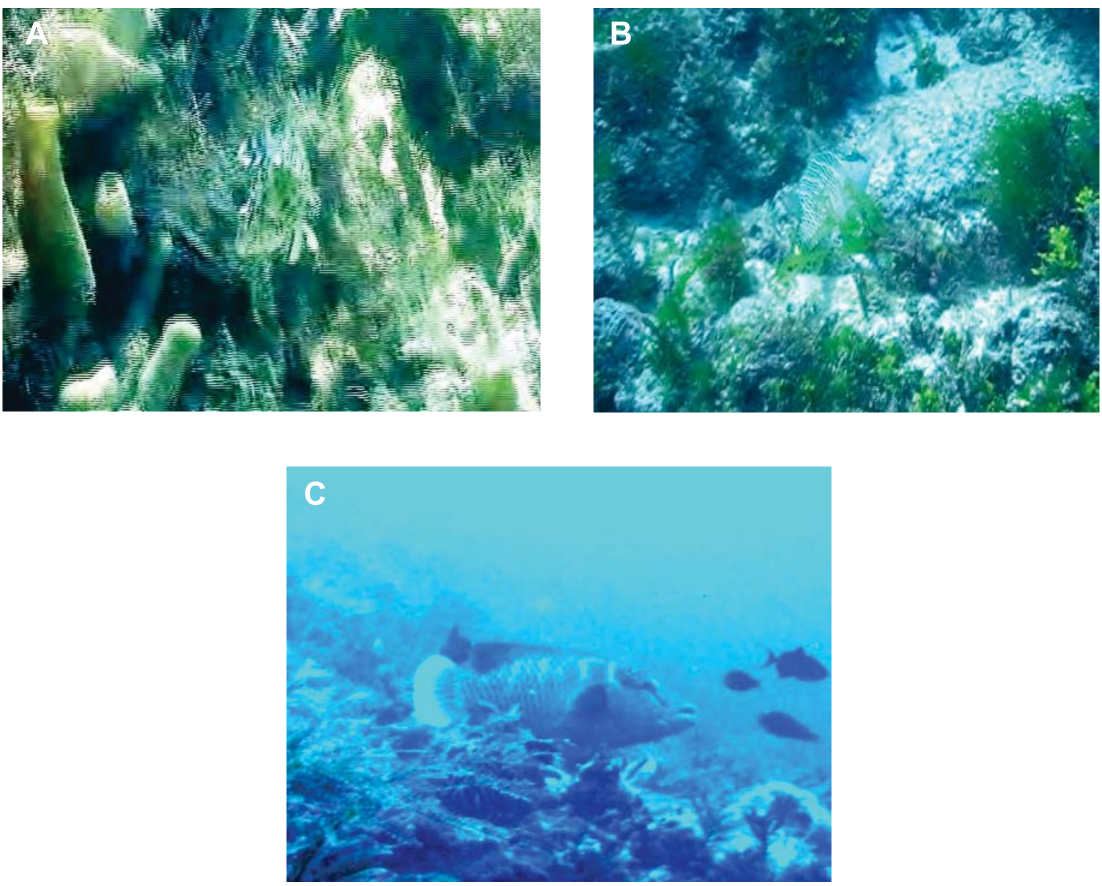

Figure 5. Pictures of juvenile (A), immature (B) and mature (C) female humphead wrasse *Cheilinus undulatus* taken during the underwater visual census.

The gonads were examined macroscopically, as shown in Figure 6, then under a stereo microscope in the laboratory. Inactive females had previtellogenic oocytes and the classification of gonads included immature and resting or developing females; the latter may or may not have spawned previously. Mature or ripe females were those with vitellogenic (i.e., yolky) or hydrated oocytes or with clear indications of spawning activity, such as post-ovulatory follicles. The presence of both features together in some individuals suggests that individual females spawn on multiple occasions during a reproductive season. Based on the Von Bertallanfy growth curve and the data on length frequency distribution, along with field observations that Napoleon fish do not reach maturity before 35 cm TL, the length at maturity was determined. Specifically, data on the proportion of fish larger than 35 cm that are mature by 5 cm size-class were used to estimate the parameters related to fecundity. The 51 female samples taken from the fishermen were in varying stages of maturity, from immature to mature but none had fully developed eggs. Thus, the egg count as a measure of fecundity could not be done. The smallest female (immature) sampled was 24 cm and the smallest mature, ripe female was 55 cm TL. The smallest immature male was 29.5 cm TL, while the smallest mature, ripe male was 55.0 cm TL. Few large fish were sampled, partly for practical and economic reasons (i.e., hard to catch or expensive), but also because they were rarely available; if larger fish are more likely to be male, then the apparent heavy female may create bias in our samples.

Options in the Management and Protection of Spawning Aggregation Sites

Some of the management options for the conservation and protection of aggregating species include: declaration of spawning sites as marine protected area; temporary closure of spawning site to fishing; seasonal ban on fishing during spawning season and conventional management such as quota, and size limits, etc. throughout the year.

Figure 6. Macroscopic examination of the gonads of humphead wrasse. Mameng - 1.05 kg; gonad - 1.5 g.

Some of the indirect types of evidences of spawning aggregation sites from the landing sites include the number of gravid females, gonadosomatic index (GSI), and observed color changes in the fish species. As shown in Figure 7, out of the 299 individual fish species landed in Sitangkai, 134 or 45% were gravid females. These came mostly from the fishing grounds of Sipangkot and Tugalan and these recommended declaration of these areas as marine protected areas.

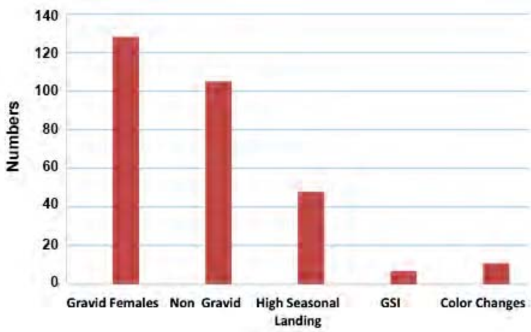

Figure 7. Indirect evidence of spawning aggregations from landed catch (n=299) in Sitangkai.

Similarly, indirect evidences such as the number of gravid females, gonadosomatic index (GSI), and observed color changes in the fish species were used in the selection of spawning aggregation sites from the landing sites in Sibutu. As shown in Figure 8, out of the 312 individual fish species landed in Sitangkai, 138 or 44% were gravid females and these came mostly from the fishing grounds of Dungun Dungon and Tando Owak. So these two sites as shown in Figure 10 were recommended for selection of spawning aggregation protected area.

Ripe adults are the capital and spawning aggregations produce interest (eggs) and enhance the wild stock. They are the source of fish for the future spawning aggregations that naturally generate larvae and juvenile humphead wrasse that would soon recruit to the fishery, contributing to food and livelihoods and increased income to the fishermen.

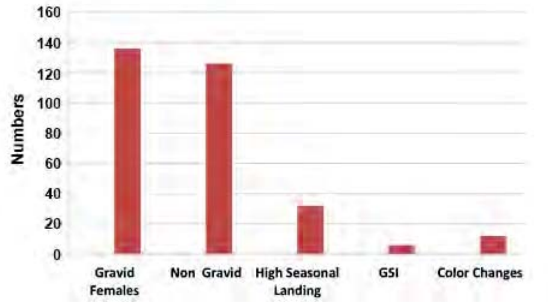

Figure 8. Indirect evidence of spawning aggregations from landed catch (n=312) in Sibutu.

During this study, more of the anecdotal accounts from the fishermen especially the *Badjao* fishermen were relied upon in the identification of spawning aggregation sites. The initial sites identified in the KII were used in the underwater visual surveys in gathering the length weight frequency analysis and in the gonadal assessment of the levels of maturity of the humphead wrasse species. From the length and weight analysis of *mameng* species caught by hook and line and fish pot in the Sibutu Reef, there were 134 individuals caught from which the length at maturity of this species was estimated at 25 to 35cm. So potentially they would be spawning soon. In Sitangkai Reef, data from 243 individuals showed that TL of mature humphead wrasse were 26 to 35cm. Another indirect proof used was the underwater documentation of juvenile/small humphead wrasse which were regularly observed in association with seagrass beds and branching coral reefs in Tongehat Halo in Sibutu, Baligtang Reef in Sipangkot, Sitangkai. There were some accounts of juveniles found also in Tahing and Tando Owak Sibutu. The larval dispersion pattern was not determined in the study but concentrations of juveniles along the reef areas in Tongehat Halo, Sipangkot island indicate that they were spawned in nearby reef areas of Tando Owak and Baligtang Reef.

A series of stakeholder workshops were conducted with the communities to give feedback on the results of the *mameng* fishery study to the local government units, barangay officials, mariculturists, fishermen and traders. It also aims to discuss with these stakeholders the recommendations made in the study. This was also done to validate with the local government units, barangay officials, mariculturists, fishermen, traders the results of the spawning aggregation study; validate the identified spawning aggregation sites and the sites where the juveniles converge in the shallow coralline areas and seagrass beds; and to discuss the passage of an ordinance declaring these spawning aggregation sites as protected areas. All these information were presented to the communities in a series of stakeholder's workshops and the municipal council locally called Sangguniang Bayan, passed these ordinances. For Sibutu, the Municipal Ordinance No. 3 Series of 2013, An Ordinance Establishing *Mameng* Spawning Aggregations Marine Protected Area in Tando Owak, Dungun Dungon and Tong Bakkaan and Tahing Ungus Mataha in the Municipal Waters of Sibutu, Province of Tawi-Tawi, was passed providing management thereof, and for other purposes. For the municipality of Sitangkai, a similar ordinance was passed, Municipal Ordinance No. 3, Series of 2013, An Ordinance Establishing *Mameng* Spawning Aggregations Marine Protected Area in Sipangkot and Tugalan Reef Area in the Municipal Waters of Sitangkai, Province of Tawi-Tawi, providing management interventions thereof, and for other purposes. Figure 9 shows the locations of the Spawning Aggregation Marine Protected Areas.

The common provision of these ordinances defines the boundaries of the Spawning Aggregation MPA and had the following regulations:

- Prohibitions of all kinds and forms of illegal fishing, such as but not limited to the use of poisonous substances/chemicals (e.g. sodium cyanide and toxic plants), explosives (e.g. dynamites), and fine mesh nets, compressor fishing and other illegal forms of fishing as defined by the Muslim Mindanao Autonomy Act 1986 (MMAA86) and other existing local ordinances;
- Catching, gathering, collecting of berried and spawning fish specifically during the spawning period;
- Closure to any fishing activities during the spawning season of the humphead wrasse which is from January to April of every year; and
- Any other acts or activities that will destroy or will place/pose imminent danger or potential harm to the area are strictly prohibited, and other illegal activities as defined by MMAA86.

It also provided for the creation of a Management Board under the supervision of the Municipal LGU from among the representatives from municipal and barangay LGU, FARMC, academe, youth/women and religious groups in close coordination with the Philippine National Police (PNP) Maritime Group, PNP, DA-BFAR and other enforcement units.

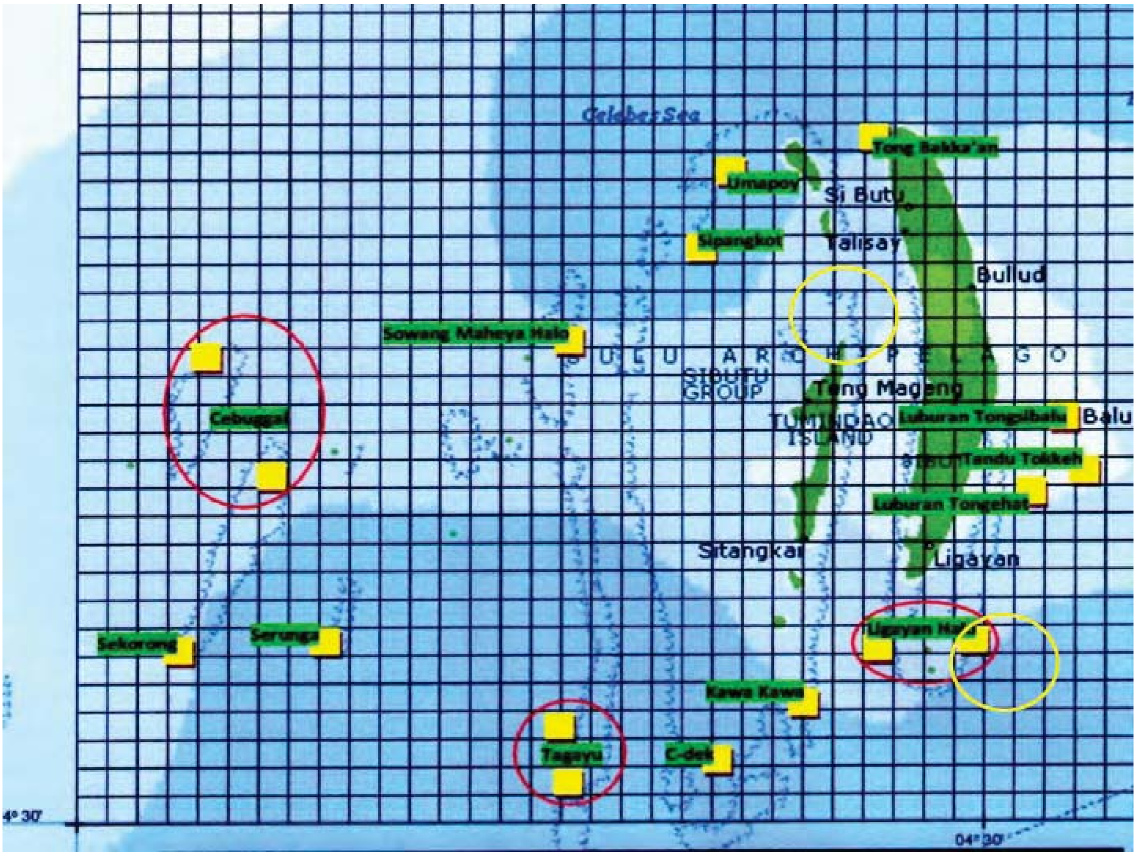

Figure 9. Spawning aggregation recommended for declaration as protected areas based on indirect evidences in Sitangkai and Sibutu.

The Council among others is responsible for management, protection, conservation, and development as well as overseeing the operations of the marine protected area. Within 90 days from the approval of this ordinance, the Management Council shall formulate its internal rules and regulations governing its operations and management. An MPA management Plan has been adopted. Subsequently, the Coastal Law Enforcement Training, Creation of the Municipal Coastal Law Enforcement Team, Training of the *Bantay Dagat* (Sea Guards), and the Development of the Mariculture areas in Sibutu and Sitangkai as Community-Managed Areas were some of the follow-up activities.

Summary and Conclusions

Using both anecdotal accounts and indirect evidences, this assessment has provided sufficient information for the communities in Sitangkai and Sibutu in Tawi-Tawi province. Consequently, these municipalities were able to decide on the declaration of the Spawning Aggregation Sites in Tando Owak, Dungun Dungon and Tong Bakkaan and Tahing Ungus Mataha in the Sibutu, Tawi-Tawi, and in Sipangkot and Tugalan Reef Area in Sitangkai, Tawi-Tawi. This also provided management interventions and regulations for a Marine Protected Area, a strategy for enhancement of wild stocks and for ensuring that the health of the stock would be sustained, so as to continue to provide source of sustainable livelihood for the people of these island communities.

References

Francisco BS, Romero FG, Mancao R and Sabal RM. 2009. Assessment of the Sustainability of Mariculture of Live Reef Food Fish in Sibutu and Sitangkai, Tawi-Tawi, WWF Philippines, 46 pp.

Mancilla M and Ponce-Taylor (http://scuba.about.com/od/ConservationandDiving/p/Fish-Spawning-Aggregations.html).

Romero FG and Injani A. 2012. Study of the Humphead Wrasse (*Cheilinus undulatus*) Fishery and Spawning Aggregations in Sibutu and Sitangkai, Tawi-Tawi. WWF Philippines, 45 pp.

Sadovy Y, Kulbicki M, Labrosse P, Letourneur Y, Lokani P and Donaldson TJ. 2003. The humphead wrasse, *Cheilinus undulatus*: Synopsis of a threatened and poorly known giant coral reef fish. Reviews in Fish Biology and Fisheries 13(3): 327-364.

Suggested Readings

Campbell SJ, Mukmunin A, Prasetia R Reef Fish Spawning Aggregations in Aceh, Sumatra: Local Knowledge of Occurrence and Status The Wildlife Conservation Society, Indonesian Marine Program, Jalan Pangrango 8, Bogor 16141, Indonesia.

Colin PL. 2010. Aggregation and spawning of the humphead wrasse, *Cheilinus undulatus* Ruppell (Pisces: Labridae): General aspects of spawning behaviour. Journal of Fish Biology 76: 987–1007.

Heyman W (ed). 2004. Reef Fish Spawning Aggregation Monitoring Protocol for the Meso-American Reef and the Wider Caribbean. Wildlife Conservation Society.

Pet JS and Muljadi AH. 2001. Spawning and aggregations of groupers (Serranidae) and Napoleon wrasse (Labridae) in the Komodo National Park. Monitoring Report March 1998 – March 2001. The Nature Conservancy, Jakarta, 26 pp.

Sadovy Y. 2005. Trouble on the reef: The imperative for managing vulnerable and valuable fisheries. Fish and Fisheries 6: 167–185.

Sadovy Y. (ed). 2005. Napoleon fish (humphead wrasse), *Cheilinus undulatus*, trade in southern China and underwater visual census survey in southern Indonesia. IUCN Groupers and Wrasses Specialist Group, 26 pp.

Sadovy Y. (ed). 2006. Development of fisheries management tools for trade in humphead wrasse, *Cheilinus undulatus*, in compliance with Article IV of CITES. IUCN Groupers and Wrasses Specialist Group. Final Report April 2006, 103 pp.

Sadovy de Mitcheson Y, Liu M and Suharti S. 2010. Gonadal development in a giant threatened reef fish, the humphead wrasse *Cheilinus undulatus*, and its relationship to international trade. Journal of Fish Biology 77(3): 706-718.