



The Banggai cardinalfish: An overview of conservation challenges

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Introduction

The Banggai cardinalfish (*Pterapogon kauderni*) (BCF) is a popular marine aquarium fish that has been collected in the Banggai Islands of Indonesia for at least the last 15 years, according to fish collectors there. This account attempts to identify some of the issues surrounding the conservation and trade in this species, and the area in which it is found. It also proposes a number of suggestions for actions, without which the management of this species and its wild habitats is likely to fail. The case of BCF to some extent reflects the wider issues and problems of wild species conservation throughout Indonesia. The way in which this species and its habitat are managed will determine how other internationally traded species are handled in the future. The work on this aquarium trade species — which is being done as part of the government's Banggai Marine Conservation Area Management Plan — will, if successful, potentially act as a model for conservation of marine species and habitats elsewhere in the archipelago.

BCF is only found in a small group of islands, the Banggai Archipelago, in central Indonesia, which lies at 1°35'S and 123°30'E. It is the first marine ornamental fish to have become an international issue under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). In 2007 it was proposed that the species should be listed on Appendix II of CITES, a move that would hopefully go some way towards controlling and restricting the wild trade of this species. This proposal came about partly because of concerns from some quarters that over-collection might lead to its extinction in the wild. Several BCF population studies point to this possibility (Kolm and Berglund 2003; Vagelli and Erdmann 2002; author's observations) but accurate current wild population estimates are still unavailable. Kolm and Berglund (2003:911) wrote, "It is unknown to what extent the aquarium fishery trade may affect the wild populations of any reef fish" and for BCF, this is clearly still the case.

The level of awareness of the importance of BCF among people in the supply area is still very low. Furthermore, those who are keen to instigate positive changes in the management and conservation of the Banggai area suffer from a lack of manpower, coordination, skills and funding. Although there has been some research on this species, more needs to be done to translate the findings into helpful guidelines for the local authorities and other decision-makers. It is vital that they first gain an understanding of the issues, and then make policy decisions and allocate funds so that practical conservation and management actions can happen at the field level. Without full stakeholder support, efforts to protect the area are likely to fail.

The Marine Aquarium Council (MAC), an international non-governmental organisation (NGO) based in Hawaii, developed a certification system to improve the management of the marine aquarium trade. MAC has helped to develop collection area management plans, and has trained collectors, middlemen and exporters in supply countries, including Indonesia, in "best practices". Successful implementation of these practices has led to the possibility of the traders applying for MAC certification, which means adhering to an internationally recognised standard. The objectives of certification include an improvement in product quality and reduction in mortality rates of the organisms collected and sold, safer practices for collectors, and fairer prices being paid to collectors. Since 2008, MAC International has continued to develop the certification guidelines, while the training for fish collectors, local trainers and government officials in Indonesia has been taken over by Yayasan Alam Indonesia Lestari (LINI, or The Indonesian Nature Foundation). LINI is a new local NGO staffed by former MAC staff. It focuses on surveys, capacity building and training for local suppliers of the marine ornamentals trade, and reef restoration. LINI was asked by the local government's Department of Marine Affairs and Fisheries to help with the development of a species management plan for BCF, which would

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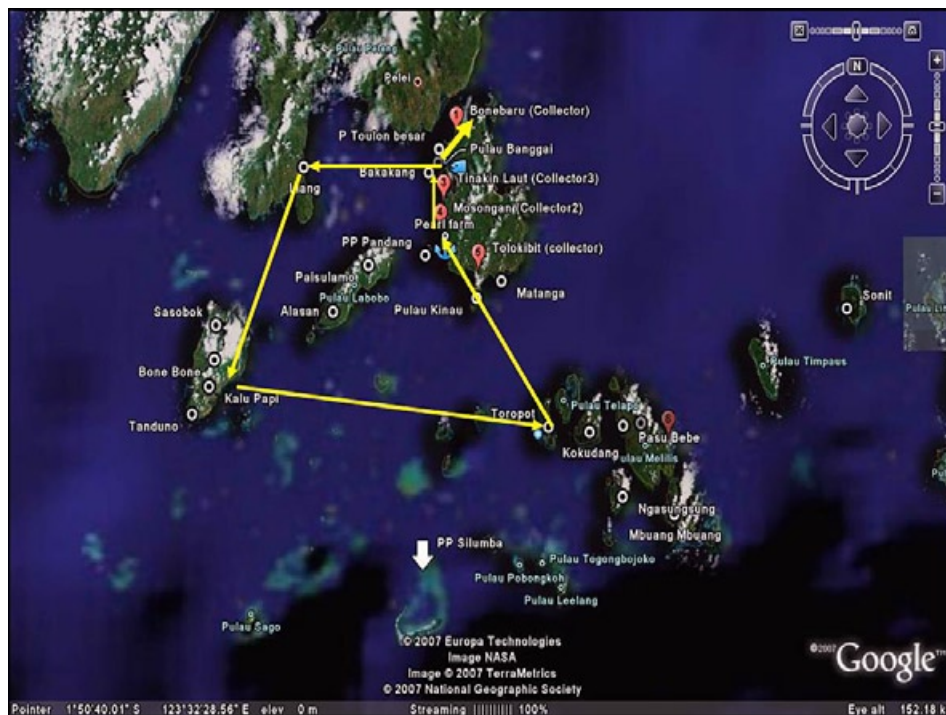


Figure 1. Islands visited in the Banggai Archipelago. Arrows indicate the route taken during the MAC Indonesia team's site visit in November 2007 (adapted from: Google Earth 2007).

become part of the Banggai Marine Conservation Area Management Plan, under development by the local government.

Site assessment in Banggai

In November 2007, at the request of the local Department of Marine Affairs and Fisheries, a MAC Indonesia team visited the Banggai area for 10 days to conduct a site assessment. The areas visited included Luwuk, P. Banggai, Bone Baru, Bone Bone, Liang, and P. Teropot (Fig. 1). The Banggai Archipelago is located in east-central Sulawesi, and is separated from the Togeian islands and Tomini Bay to the north by a narrow peninsula. Several BCF collection sites were visited, and people from various stakeholder groups (e.g. collectors, villagers, village heads, middlemen, government officials) were informally interviewed. A number of stakeholders who were interviewed requested that their names not be divulged.

The islanders are mainly a mixture of Bajo and indigenous Banggai. Many of them live in houses on stilts over the reef flat (Fig. 2). BCF collectors explained that, according to official statistics, they do not even exist, being identified as "farmers" in the local censuses, although there is virtually no farmland on these

islands. Some of these villagers do farm very small plots of land, but access to fresh water is a problem, and soil productivity is low. Most of their income is derived from the local sale of marine products, including food fish, octopus, squid, groupers and sea cucumbers. They also sometimes catch BCF and other marine fish species for the aquarium trade. More recently, villagers have begun to supplement their incomes by farming seaweed. These people are very poor, and the sales of BCF do have a significant positive impact on the livelihoods of at least several hundred families.



Figure 2. Typical Bajo house in Liang with *Diadema* urchins and Banggai cardinalfish underneath (photo by Ron Lilley, LINI).

Recently, the “Banggai Cardinal Fish Centre” was opened in the offices of the Department of Marine Affairs and Fisheries in Banggai town, with the full support of the local District Head (*bupati*). The purpose of the centre is to have a “one-stop” information source about BCF. The trade of BCF and other marine aquarium species in the area remains largely unmonitored and undocumented. Accurate figures and other information concerning any aspect of the trade are lacking; this basic groundwork needs to be done as a crucial first step in the development of a credible species management plan for BCF.

Some short transects were surveyed by snorkelling to provide a rough estimate of BCF abundance. In those areas visited where there has been recent collection, BCF numbers were relatively low — only a few tens of fish were seen during a one-hour swim, and these were sometimes in small groups of two or three fish. In contrast, at sites where there had not been recent collection, BCF stocks appeared to be healthy and locally abundant, usually occurring in groups of at least several tens of fish. These groups were large enough to be seen by looking down from the boat into the water. According to the collectors, BCF populations occur around many of the 123 islands in the Banggai Archipelago, but there was general agreement among collectors interviewed that these populations may be suffering from overexploitation. Once a collection area has been stripped of BCF, it is abandoned until stocks recover. It was not clear as to how long this recovery period might be, although one collector said that collection at one site had stopped “about a year ago”. In some cases, collectors venture to neighbouring islands to collect BCF, but this is costly because of the extra fuel requirements and rising fuel costs. These collectors are also regarded as “poachers” of other peoples’ resources, and run the risk of being forcefully driven away by villagers.

Some key issues were identified during the visit, and these are discussed in the sections that follow. Much of the information presented here is anecdotal in nature. Except where specific sources are cited, the source of this information is the author’s observations, most of which were made in the course of the November 2007 site visit by the MAC Indonesia team and the interviews conducted during that visit.

Lack of no-take zones

Poaching of marine resources by people from neighbouring islands and farther away is a widespread problem. Government patrols of the area are infrequent and insufficient to act as a credible deterrent to would-be poachers or traders from elsewhere.

In the past, villagers on some islands tried to develop nearshore no-take zones, with their own initiative and money, and using simple marker buoys and signs. They said that “visible” no-take zones were necessary to deter people from other islands from coming to fish there, using bombs or other methods (the use of homemade bottle bombs for fishing is far more common than the use of dynamite). However, because these no-take zones were not part of a coordinated regional plan, the buoys and ropes were stolen within a few days of being installed. There was no “scientific” rationale for the location of the no-take zones, and no guarding systems were put in place. Villagers are generally reluctant to have to guard areas that are far away from their villages, especially if they have to stay there overnight. Proximity of the collection area to the village is an important consideration when setting up community-based guarding and patrolling schedules. According to villagers, a physical human presence near the collection area can act as an effective deterrent, with a few shouts often being enough to drive poachers away.

Fuel shortages

The price of fuel (petrol, diesel and kerosene), used for transportation and cooking, has recently more than doubled. Problems of irregular supplies (from Java) and distribution delays have further increased economic hardship. High prices and problems of fuel availability conspire to make the movement of boats between the islands costly and sometimes prohibitive, particularly for villagers living on the outer islands. These constraints are having a significant negative impact on local trade, not only of aquarium fish but also of food fish, water, food and all other products and materials that are traded by boat between the islands. Harsh economic pressures



Figure 3. A group of Bajo women on their way to market in a dugout canoe in Bone Bone Village, Pulau Bangkulu, Banggai Islands (photo by Ron Lilley, LINI).

such as these oblige people to take more desperate measures when seeking incomes, including the use of destructive fishing techniques. It also encourages the clearance of wooded slopes and mangroves through the chopping of trees for firewood.

Threats to collection areas

All collection areas visited appeared to be threatened by poachers and activities that have destructive impacts on the reefs. These include fish bombing, cyanide use and careless boat handling and anchorage. Over-collection of trade species — including BCF — could deplete these resources to a point where recovery is unlikely, even if non-destructive collection techniques are used. There is no evidence that explosives are being used to catch aquarium trade species — this practice is only used for food fish collection.

Sedimentation from inland activities such as logging and construction threatens corals, and increased nitrate runoff from the use of fertilizers and human waste encourage algal growth on the reefs. There are plans for mining on the main island of Peleng, which could also negatively affect the surrounding reefs. The lack of coordinated regional planning means that information about proposed developments for the area is difficult to access.

Significant amounts of plastic, netting, Styrofoam and other rubbish were seen floating in the sea and draped over the reefs. In fact, given the relatively low human population numbers, it was surprising to see the high levels of solid waste in the sea, especially around harbours and areas of human habitation. There is currently no waste management or garbage disposal system in place for the islands, although piles of accumulated rubbish, as a result of an increasing human population, coupled with the replacement of traditional, biodegradable banana leaf packaging with plastic bags and Styrofoam, are evident everywhere .

Banggai cardinalfish habits

BCF are easily observed in shallow waters throughout the area, including around piers in harbours. Significantly, one of the best places to observe relatively large numbers of BCF was in one of the pearl farms, where public access is strictly prohibited.

BCF live in groups in and among coral heads, anemones, seagrass, jellyfish, and sea urchins (Fig. 4). If the reef is badly degraded or there are high levels of nitrates in the water (i.e. near dwellings, piers and raw sewage outlets), algal growth is encouraged, which in turn promotes the proliferation of black long-spined sea urchins, *Diadema setosum*. In areas where the coral cover has been destroyed and the



Figure 4. A group of Banggai cardinalfish swimming over anemones, Pulau Teropot, Banggai Islands (photo by Yunaldi Yahya, LINI).

reef flat is covered in algae, numerous groups of *Diadema* sea urchins become the main refuges for BCF.

Kolm and Berglund (2003) say that villagers also collect *Diadema* as a food source, and that currently used collection techniques for BCF cause physical damage to the sea urchins' spines. The collection of sea urchins and the means by which BCF are driven out of the urchins into nets both deprive BCF of hiding places (Kolm and Berglund 2003). Indeed, the sea urchin is a favored hiding place for BCF, and the black and white striped patterns of this fish make it difficult to see when it retreats among urchins' spines (N. Kolm, Uppsala University, pers. comm. 2008).

In areas with little or no corals, seagrass or urchins, BCF were observed to cluster and shelter around any large object, including pieces of wood and other rubbish. The fish were also observed swimming very close to the walls of piers. In other words, it seems likely that, once the reef has been degraded and there are no more corals or seagrass in which BCF can hide, they will "make do" with hiding in the sea urchins, which proliferate when the area becomes covered in algae.

Although not observed firsthand, the team was told that BCF could occur in significant numbers in association with a certain (unidentified) species of jellyfish. Because BCF have a very low capacity for dispersal, as they do not have a pelagic larval stage, it might be that the jellyfish provide a means of dispersal for BCF by passive drifting on ocean currents. It is important to understand this and other dispersal mechanisms for species management purposes. DNA studies (Hoffman et al. 2005) indicate significant genetic differences within BCF sub-populations, which need to be preserved for the continued well-being of the species.



Figure 5. Collectors demonstrating how they use the *cang* net, with a long-handled scoop net, to catch Banggai cardinalfish (photo by Ron Lilley, LINI).



Figure 6. *Cang* net with *Diadema* urchins (photo by Ron Lilley, LINI).



Figure 7. Free-diver using a *cang* net to capture Banggai cardinalfish, Pulau Teropot, Banggai Islands (photo by Yunaldi Yahya, LINI).

When approached, BCF do not swim rapidly away, but try to make themselves inconspicuous, turning away so that their narrow profile is presented to the potential predator. In spite of their black and white cryptic coloration and long spines, the fish would seem to be easy prey. Sea snakes (*Laticauda colubrina*) were seen in a number of places where BCF also live, and these might be predators of BCF.

Capture and handling techniques

Almost all the BCF collectors said they were free-divers; that is, they held their breath while diving for fish, and did not use dive tanks or compressors. They often dove using only simple masks (which can be homemade from wood, glass, sealer and strips of tire rubber), and without fins. Where fins were used, these were either homemade from plastic or wood and fastened with string to the collector's feet, or store-bought fins that were in poor condition (most of these had been donated by visiting tourist divers). Most of collectors we interviewed said they used masks only, and had no experience of using a snorkel. Regular long trousers, long-sleeved shirts and woollen *balaclavas* (hoods that completely cover the head and neck, except for holes for eyes and mouth) were used to retain body heat. Becoming cold was cited as one of the main factors limiting collection time. There were reports of compressors and air lines (hookah gear) being used to collect other aquarium species at greater depths.

Access by collectors to a supply of cheap masks, fins, snorkels and wetsuits would increase efficiency and safety, as would some basic dive safety training. In some areas of Indonesia, for example in Komodo National Park, the use of compressors for catching fish has been banned, but the ban is hard to enforce, given the lack of marine patrols. Compressor use greatly facilitates the use of cyanide for fish catching, but poor maintenance and a disregard for safety (e.g. no watches or depth gauges are used) has led to many accidents, including cases of paralysis and death. There is no decompression chamber in the Banggai area, the nearest one being in Manado, about 40 km away (by sea). This is too far away from Banggai for emergency evacuation to be an option for collectors. A lack of health services in the area means that injured collectors receive only "traditional" treatment in their villages. MAC does not support the use of compressors for diving.

It is very easy to catch large numbers of BCF at one time, by simply driving them out of the sea urchins with a stick into a waiting funnel net, called a *cang*, which is hand-woven of coarse material (Figs. 5–7). When the net is lifted to the surface, hundreds of variously sized BCF are concentrated in the bottom of the net, resulting in damage to scales, fins and eyes. Although large numbers can quickly be

caught using this technique, the high mortality and rejection rates make this method inefficient. In the minds of collectors, rejected and dead fish are not considered as lost potential earnings. Based on the author's experience in other areas, a short session with collectors on the economics of what they do, and how much money is being thrown away each time they go collecting, would be a very useful addition to any training programme.

After collection, BCF are transferred to Styrofoam boxes in canoes, where an initial sorting takes place. Collectors said that a significant number — between one-quarter and one-half — of fish collected in this way become damaged and are thrown back. The fish are then transferred to floating holding pens in shallow water, where several thousand fish may be kept together for up to three days. The buyer then selects only the healthy fish of medium size. Those that are sick, damaged, too big or too small are thrown back into the sea. Collectors estimate that about half the fish held in the floating pens die, and as few as one-fifth to one quarter of the fish they catch are finally bought by the buyer, although, as no records are kept, these figures are anecdotal.

Prices paid for fish

In Banggai, collectors are generally paid about 250 rupiah (IDR) (0.02 US dollars, or USD) per fish. Local middleman can sell each fish for up to IDR 1500 (USD 0.16). Exporters sell the fish for roughly USD 2–5. One exporter said the reason for this dramatic increase in price was that, unlike fish collectors, exporters had huge overheads to pay for running their facilities, transportation costs, and a higher standard of living. An importer sells the fish for about IDR 90,000 (USD 9.55). The retailers in the buying countries can sell each fish for about IDR 189,000 (USD 20).

At the end of the 1980s, collectors received IDR 10 per fish, which in real terms was greater than the current price. The same is true for middlemen and exporters, who are now paid less in real terms per fish than they were 20 years ago. As a result of having to accept low prices for their fish, coupled with rapidly escalating fuel and food costs, collectors are faced with increasing debt. This economic pressure provides an incentive for collectors to join food fishermen in their use of cyanide and other destructive techniques, in order to try to make ends meet financially. By being taught some basic economics and negotiation skills, and becoming part of a Banggai-wide collectors' organization, collectors would be in a much stronger bargaining position when dealing with middlemen. As long as the market still needs wild-caught fish, collectors are still in a position to recognize and take better advantage of their power as important players in the aquarium trade.

The middlemen

Many middlemen arrive by boat at the villages, negotiate directly with collectors, select the fish, and then return to their places of origin (mainly Manado, Tumbak and Kendari, but also Bali) to sell the stock to exporters. They use larger boats than collectors, and/or trucks for overland transport to Manado (although these trucks are sometimes owned by exporters). Sickness and mortalities of the stock during this stage of transport, which may take several days from source to facility, are common because of "gang packing" (i.e. packing 30–50 fish in one bag), and infrequency of water changes.

Other aquarium fish species, including angel-fish (Pomacanthidae), and notably the palette surgeonfish, known locally as "letter six" (*Paracanthurus hepatus*), which is one of the most sought-after fish for aquaria, are caught in the Banggai area. Among these, the species that are faster-swimming, or that live in deeper water, are caught using compressors (hookah). Middlemen are known to be one of the main sources of the cyanide used to catch these species.

Exporters

Some Indonesian exporters are experimenting with captive breeding of BCF, but so far, the fish have only been bred in very small numbers. Exporters report that the captive fish are apt to suffer from stress-related disorders, including internal parasite infestations, because of overcrowding. Some exporters prefer to buy from suppliers located nearer to them (e.g. in Bali), and are willing to pay higher prices for locally supplied fish, knowing that they have not been gang-packed and transported for many days by boat from Banggai.

Tourism

An influx of tourists in the future would significantly improve the economic outlook of the area. However, Banggai currently has almost no infrastructure in place to accommodate visitors. The potential for tourism development is also hampered by the current security warnings to potential travellers to central Sulawesi. Now that the BCF is becoming better known locally, it has been suggested that this fish become the provincial mascot, and that its image be used to promote tourism in posters, brochures and television advertisements. Simple awareness and "socialization" programmes for schools, government departments and the local people would do much to raise their awareness of the economic possibilities associated with tourism. The presence of growing numbers of tourists could also act as an incentive to manage the area more effectively, such as reducing pollution and poaching.

It was suggested by a person from the Banggai tourism department that a community-based tourism programme be included as part of the government's Banggai Area Development Plan², as none currently exists for the area. Standards for visitor transportation and accommodations, including hygiene, and the provision of information to tourists will need to be significantly improved if tourism is to become a viable industry in Banggai.

Tomini Bay and the Togean Islands are geographically not far from Banggai (due north across a narrow peninsula), and have had experience in developing community-based tourism, although this has recently fallen apart because of security risks and other factors. This is an ideal source of information and lessons learned, especially given its proximity and cultural similarities with the Banggai area.

The issue of land-based aquaculture versus community-based mariculture

At present, the numbers of BCF being captive-bred are too small to support or supplant the trade in wild-caught fish. Individuals produce only 30–40 eggs at a time, a factor that somewhat limits the potential for captive breeding. Some people, including those in the local fisheries department, have argued that the development of land-based aquaculture for BCF in Banggai should be the main thrust of the species management plan for BCF. Although this might eventually help to provide fish ready “on the shelf” for the market, and perhaps even provide a few local villagers with alternative income, land-based aquaculture requires expensive investment and, in isolation, has little to do with conserving the species in the wild, or keeping collectors above the poverty line. So far, there is little evidence to support the idea that captive breeding can develop to the point where it could help to maintain wild populations. Moreover, land-based (aquaculture) facilities require expertise and investment that might be better spent on development of community-based mariculture efforts in the sea near villages, which would provide incentives for islanders to protect the surrounding reefs. Well-managed wild collection that is slowly augmented by community-based mariculture would arguably provide a better means of conserving wild stocks than *ex-situ* captive breeding can achieve on its own.

Feral BCF populations of BCF elsewhere in Indonesia

Over the years, middlemen and exporters have released rejected BCF in various parts of the Indonesian Archipelago. Introduced populations of BCF can be found in north Sulawesi, including

Manado, Palu Bay and the Lembah Strait (Vagelli and Erdmann 2002) and in north Bali. A few adult BCF have also been seen swimming in the harbor at Luwuk (see Fig. 1), where the ferries from Banggai Islands arrive, and from where aquarium fish are sent for export to towns with international airports. Recently, the author made a visit to a site in north Bali where significant numbers of BCF are collected by Balinese collectors, who are paid up to IDR 4000–6000 (USD 0.40–0.60) per fish. One exporter said he preferred to buy “Bali BCF” because the extra price was offset by lower mortalities. He was selling these fish overseas for IDR 12,000 (USD 1.20). Middlemen requested that the locations of these collection sites remain secret (Fig. 8).



Figure 8. Collector with Banggai cardinalfish in north Bali (photo by Ron Lilley, LINI).

Although these other sites may be more convenient for buyers because they are nearer to points of export, they do highlight the problem of alien species introductions and the potentially negative ecological effects of such releases, which are still poorly understood. It will be interesting to see whether these *ex-situ* sites are eventually given some measure of legal protection.

Research, management and conservation efforts in Banggai

There is a growing body of information about BCF, including a number of scientific papers, which detail, among other things, various aspects of BCF ecology, behavior and genetics (e.g. Allen 2000; Hoffman et al. 2005). These are for the most part in

2. This is a broad plan within which the Banggai Marine Conservation Area Management Plan will be a component.

English, and in need of translation into Indonesian, because very few Indonesians can read English. There have been efforts by local NGOs to work on various aspects of community development in the Banggai area, including the establishment of no-take zones. However, these efforts appear to have been done on a piecemeal basis, and have not been integrated into the Banggai Marine Conservation Area Management Plan. Recent meetings involving national and local stakeholders, including government, NGOs and the traders, have helped to create a more coordinated approach to the management of the area (Reksodihardjo and Lilley 2007).

The local politics of the Banggai area are very complex, not least because of current disputes about administrative boundaries. Efforts by outsiders and local NGOs to work there have, in the past, been beset by bureaucratic and administrative hurdles. In addition, there is a culture of secrecy, especially among middlemen and exporters, so they are reluctant to divulge details of their businesses to outsiders. In addition, gathering information is difficult because there is a tendency for people to give the replies that they perceive are expected of them rather than the objective responses that are being sought. It is therefore small wonder that information-gathering in this area is so difficult and time-consuming, and that previous assertions about the situation have differed so markedly.

It is hoped that the recently established Banggai Cardinal Fish Centre in Banggai town will help to create a central point from which management decisions and efforts can be coordinated and shared with the wider community.

The future

From the foregoing account, it should be apparent that a great many changes would need to take place in the Banggai area if it is to survive and develop economically. One component of this development is the aquarium trade. This will need to be addressed in terms of legal, financial, and technical support from government, the aquarium industry, local businesses, NGOs, and scientists. However, to realize these changes, local island residents will first need to be helped in understanding what these changes are and how they might benefit from them financially or otherwise. Securing residents' agreement and support means giving them the opportunity for active involvement in the development and implementation of the Banggai Area Development Plan and the species management plan for BCF. Therefore, other, more powerful, stakeholders will first need to acknowledge and respect the needs of the villagers, and then involve them in the process and provide them with some incentives to do so.

Development of the Marine Conservation Area Management Plan will involve all of the key stakeholders. If successfully implemented, it will afford the reefs greater protection and promote more sustainable marine fisheries. To achieve such outcomes, several local partners will need to cooperate to provide training and capacity building to local stakeholders in such areas as marine surveys, mapping and monitoring, mariculture, community savings schemes, and no-take zone development.

LINI will use MAC tools and expertise to conduct interviews with local stakeholders to identify and document current issues. This will include gathering information on BCF trade issues, the distribution of BCF populations, and the socioeconomic condition and prospects of BCF collectors. LINI will also provide training to collectors and suppliers, and conduct in-water surveys for the purpose of BCF stock assessment. Other local NGOs with a history of working with local communities in the area will also be involved in the development of the Banggai Marine Conservation Area Management Plan.

The formation of a collectors' association has been proposed so that all of the collectors throughout the Banggai area can have one voice when it comes to negotiating the price of fish with buyers. Participation in the association could be made contingent on the collectors being adequately trained and having permits from the government that give them exclusive collecting rights in the area. The number of permits to be made available could be determined once more accurate data are available concerning the status of fish stocks and their productivity. Such data could also be used to establish total allowable catches.

There is an urgent need to set up a long-term monitoring programme for BCF throughout the Banggai Archipelago. The programme would gather information on catch, sales, collection effort, and BCF population characteristics. Using this information, critical areas and fish populations can be identified, fish population trends can be monitored, and catch quotas can be established and enforced. In addition, studies are needed to determine how long it takes BCF populations to recover in "over-collected" areas. Instead of relying on foreign researchers to undertake this kind of work, as is currently the case, it would be more cost-effective to support the development of a long-term research programme that involves the training of local Department of Marine Affairs and Fisheries staff, students and local researchers in various survey methodologies.

Previous and current catch and sales data for other traded marine species would also be very useful for developing the management plan, as they would help to identify historical and present trends at

collection sites and in the trade. However, written records have so far not been kept by collectors, so at best there may only be anecdotal information available from them on the history of the trade. Traders are generally reluctant to share their purchase and sales data, but if they could be encouraged to do so in the future, they would be providing essential information to support a continued trade from the Banggai area. Simple record keeping for collectors and middlemen is a possibility, but would require agreement on their part, as well as training and long-term supervision.

The cost of establishing no-take zones is relatively small, especially if they are developed and maintained by the villagers. They have requested financial help for this from local government, but the initial development phase (including reef and resource surveys, community mapping and basic materials with which to demarcate the no-take zones) will need further support from outside donors. In addition, local communities will need further legal support from government to empower them to serve as effective custodians of their own resources.

The development of a waste disposal system for the whole Banggai area, coupled with an education programme for schools, would be timely at this stage and would anticipate the problem of having to dispose of much higher levels of rubbish in the not too distant future. Local human populations are growing, and plastics (particularly plastic bags) are replacing the traditional biodegradable banana leaf wrappings. Plans for mining and logging on some of the larger islands threaten to increase the amounts of sedimentation on surrounding reefs. The Banggai Marine Conservation Area Management Plan will need to take future developments into account, and credible environmental impact analyses will be needed to inform the planning process.

The estimates of fish mortalities and eyewitness accounts indicate that the processes of capture, post-harvest handling and holding are all extremely stressful and damaging to the fish. There is a need to employ experienced trainers to review and improve the capture, post-harvest handling and holding methods, and to train collectors in their use. Encouraging collectors to catch individual fish using hand (scoop) nets, using softer netting material, and redesigning holding pens would all help to reduce fish mortalities significantly. Only existing fish collectors will be targeted for training, because MAC does not advocate more people becoming ornamental fish collectors.

Given the very restricted geographical range of BCF, collectors should be in a strong position to set a more reasonable price than what they currently receive. As an example, a doubling of the price paid

to collectors, from IDR 250–500, would be equivalent to an increase of only USD 0.02–0.03 per fish. It seems reasonable to expect that hobbyists would be willing to pay, say, an extra 2–5 dollars for a 20-dollar fish (i.e. a 10–25% increase) that is known to come from a well-managed collection area. Then it only remains for that increase to be passed down the trade chain to collectors, for whom a doubling of the price would make a significant difference. MAC teaches collectors to adopt the “catch only to order” rule (i.e. catch only enough fish to respond to buyers’ requests), rather than opportunistically catching all of the fish they come across, and then hoping to sell them all to middlemen. This needs to be accompanied by the implementation of a total allowable catch system, which is also promoted by MAC/LINI. Total allowable catches would be based on the analysis of fish surveys in particular collection areas (a process that has already been successfully applied in some collection areas in north Bali). Community-based patrolling, monitoring, and data recording all need to be included as part of skills training. Given training and support, the island communities could do much of this work themselves.

Providing training in post-harvest handling and the use of better quality nets with soft netting, as well as snorkels, masks and fins, would be relatively cheap and would immediately reduce the rate of stock mortalities. These items and other basic equipment would be provided to the collectors’ group organizing committee, to sell to its members at cost (rather than encouraging dependence through the provision of free handouts). Sales of these items to members would provide funds for the next round of equipment purchases. Savings schemes of any kind are a new idea for these communities.

LINI has committed to act as facilitator of the development process for the species management plan for BCF and other needed work, but accomplishing these tasks will depend on others to come forward to help. LINI proposes that, where possible, all actions (both short- and long-term) should be firmly in the hands of local stakeholders. LINI could provide further support by enlisting the help of overseas organizations and expertise (e.g. the wildlife trade monitoring network, TRAFFIC, the Ornamental Aquatic Trade Association, and Ornamental Fish International) to look more closely at trade routes and practices beyond Indonesia, and how these might be better monitored and improved.

If implementation of the species management plan for BCF is successful, it would become a model for fisheries management throughout the Indonesian archipelago, and consequently bring economic benefits to a very large number of people for whom alternative income generation is not an option.

As wild natural resources become scarcer, captive breeding of species that have historically been collected from the wild becomes an increasingly economically attractive alternative for the industry. In their paper on *ex-situ* captive breeding of BCF, Hopkins et al. (2005:25) stated, “hobbyists will eventually learn that captive-bred Banggai make much better aquarium fish”; and further, “...raising Banggai can be profitable at the US\$7 farm gate price”. Arguably, the financial incentives that captive breeding provides should not be the only consideration for businesses in developed countries, when there are opportunities for them to also support the conservation of the species in the wild. Well managed community-based *in-situ* mariculture efforts, stimulated by fairer prices, can provide real incentives for people at the supply end to protect and conserve habitats. It is hoped that hobbyists in buyer countries can be encouraged to consider this factor when deciding which suppliers to make their purchases from. The successful development and implementation of a species management plan for the BCF will not only increase the chances of protecting this species in the wild, but hopefully also serve as a model for combining trade and conservation, in which all people along the trade chain can feel they have a stake.

Anyone requiring further information about LINI or interested in providing donations or funds towards our work in the Banggai Islands may contact LINI:

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Figure 9. Banggai cardinalfish with clownfish in anemone, Pulau Teropot, Banggai Islands (photo by Yunaldi Yahya, LINI).

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