



Towards a sustainable marine aquarium trade: An Indonesian perspective

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Introduction

With all the benefits and information that modern communications have to offer the end buyers of tropical marine ornamental organisms, it is disappointing to see just how little factual information is available to them concerning the sources of the organisms they buy, and the circumstances by which they are caught. This article seeks to provide a view of the aquarium trade from the perspective of one of the supply countries, Indonesia, and to identify the actions needed to bring about reform. One of the greatest stumbling blocks facing those who are trying to reform the trade is the acute lack of data from scientific surveys to support their arguments for change. A visit to collectors in this part of the world will illuminate far more than the written word can describe. For those not able to visit, constructive dialogue with those working in the supply countries will also help to enlighten them, and hopefully provide some solutions to the many problems experienced by the suppliers.

The context of the trade

Indonesia is the world's largest exporter of marine ornamentals for the aquarium industry, and has relied overwhelmingly on the harvest of wild organisms to supply the trade. Because it is situated along the equator, this developing country has been in a good position to supply both quantity and diversity of marine species to Europe, North America and Asia over the past 25 years. Many thousands of people living in coastal communities depend economically on the collection of fish, corals and other marine invertebrates for the aquarium trade. These communities are among the poorest in the country, and suffer from lack of education, health care and land. Therefore, their choices for income generation are very limited. Prior to being approached by buyers from the trade, most existing collectors will have been living at the subsistence level, fishing for food fish to either sell or

consume on the same day, or preserve using salt, as there are almost no refrigeration facilities available in their villages. Ironically, although they lack education and business skills, many of these collectors are highly skilled in the identification and capture of various marine organisms.

The sheer diversity of both terrestrial and marine biota in Indonesia has been both a blessing and a curse for the country. Like tropical forests, coral reefs have been overexploited to the point that although this vast archipelago rivals anywhere else on the planet in terms of natural living resources, it also has more endangered or threatened species – many of which are endemic – than virtually any other country. With an urgent need to develop and generate much-needed revenue, it was logical for the government to encourage – or at least not obstruct – high levels of exploitation. Official data on resource distribution and exploitation rates have always been lacking, and resource monitoring has been poor. Therefore, the true extent and impacts of years of largely uncontrolled exploitation of natural marine resources have only recently started to be recognized.

The Indonesian collectors and the trade

The marine ornamentals trade has taken full advantage of these circumstances in Indonesia. Unfortunately, all too many people in the marine ornamentals industry and elsewhere still seem to assume that the supply of wild marine organisms is unlimited. This industry has encouraged thousands of coastal fishermen to make a little extra money by becoming collectors for the aquarium trade. Being largely uneducated and unable to find other work, the collectors have been obliged to endure low prices, poor working conditions, disability and even death as a result of their collection efforts, in order to satisfy an expanding overseas market. Critically, they have thus far had little representation by national or local governments, although this situation is now slowly changing.

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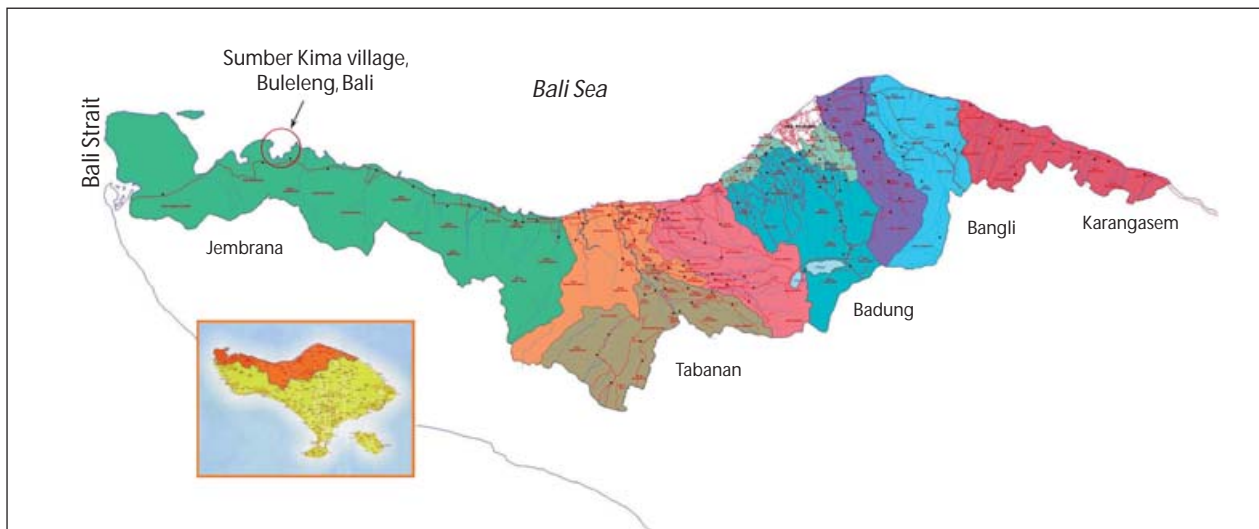


Figure 1. Buleleng district, Bali, Indonesia.

As many as three generations of collectors can be found among the poor families of a coastal village. The first generation used to be able to fish on the reefs in front of their houses. The older collectors tell of times when their reefs were intact, fish were plentiful, and many species that are now rare were easily caught within minutes of the village.

Since those early days, these nearby reefs have become progressively damaged or reduced to rubble by coral mining for building materials, the use of explosives and poisons for catching fish, land-based pollution, and sedimentation. The increasing frequency of crown-of-thorns starfish (*Acanthaster planci*) invasions and coral bleaching have also contributed to reef degradation. Finally, with a current national population of more than 220 million people, overexploitation of natural resources has in many places led to their total destruction, including the local disappearance of many species. As a result, second- and third-generation collectors have needed to journey progressively farther away from their homes in search of the target species.

The Bali situation

The fringing reefs of north Bali have been major collection areas for ornamental fisheries since the late 1970s. There are now two types of collectors operating in north Bali. Some villagers still collect along the Buleleng coast (Fig. 1) where common, “cheap” species (called “trash fish” by some traders) such as damselfishes (Pomacentridae) can still be collected nearby. Second, there are roving collectors, who must travel long distances to fulfil orders from traders. Roving collectors may be away from their

homes for as long as three weeks at a time, traveling in small boats over wide expanses of open sea.

One group of experienced roving collectors comes from Sumber Kima, a village located in the Buleleng district of north Bali (Fig. 1). Nearly 88% of the people in Sumber Kima depend on ornamental fisheries as their major source of livelihood. The village can be reached in three to four hours from the international airport in south Bali. Collection on the Sumber Kima reefs began in the early 1970s. In the 1980s, when demand increased and more varieties were requested by the market, the Sumber Kima collectors started to travel farther away from their village in search of new reefs. The first roving destinations were the reefs of west Lombok, with a distance from Sumber Kima and Madura of approximately 250 km, and farther to Sumbawa, Flores and Sulawesi.

The target species for rovers, some shown in Table 1, include high-value fish such as the palette surgeonfish (*Paracanthurus hepatus*), known locally as *leter six*, or the “letter six fish”.

Nowadays, roving collectors travel to remote reefs throughout the archipelago, including those in the waters of Sumatra, Kalimantan (Indonesian Borneo), Sulawesi, and along the island chain as far east as Papua. The 10 most-collected species from the Karumpa Reefs of Sulawesi are shown in Table 2.

These long boat journeys are undertaken in poorly maintained craft, without adequate navigational equipment, communications, dive gear or even life vests. Equipment for catching and holding the

Table 1. Target species for north Bali roving collectors.

Scientific name	Market name	Local name
<i>Abalistes stellatus</i>	Starry triggerfish	Triger batu
<i>Amblyeleotris guttata</i>	Spotted prawn-goby	Cabing titik merah, jabingan guttata
<i>Amblyeleotris steinitzi</i>	Steinitz prawn-goby	Bunglon lorek, jabing lorek, jabingan steni, cabing lorek
<i>Amphiprion ephippium</i>	Saddle anemonefish	Tompel tomat, tompel jakarta
<i>Amphiprion melanopus</i>	Fire clownfish	Tompel biasa, tompel lombok
<i>Apogon semiornatus</i>	Oblique-banded cardinalfish	Capungan merah
<i>Balistapus undulatus</i>	Orange-lined triggerfish	Triger liris
<i>Balistoides conspicillum</i>	Clown triggerfish	Triger kembang, pogot bintang
<i>Callopleiops altivelis</i>	Betta marine grouper / comet	Godam, komet, beta
<i>Centropyge bispinosus</i>	Coral beauty angel	Enjel kennedy/ enjel model
<i>Chrysiptera parasema</i>	Goldtail demoiselle	Betok blustar, blustar biasa
<i>Corythoichthys amplexus</i>	Brownbanded pipefish	Bajulan lorek
<i>Doryrhamphus dactyliophorus</i>	Ringed pipefish	Bajulan zebra
<i>Doryrhamphus exicus exicus</i>	Blue stripe pipefish	Bajulan kembang
<i>Doryrhamphus janssi</i>	Janss' pipefish	Bajulan api, bajulan merah
<i>Exallias brevis</i>	Leopard blenny	Cabing bunga, kapalan, jabingan bunga
<i>Melichthys vidua</i>	Pinktail triggerfish	Triger kaca
<i>Pomacanthus navarchus</i>	Majestic angel	Enjel piyama
<i>Pomacanthus sextriatus</i>	Sixbar angel	Enjel kalong, enjel roti
<i>Pomacanthus xanthometapon</i>	Blueface angel	Enjel napoleon, bidadari bercadar, kepe napoleon
<i>Paracanthurus hepatus</i>	Palette surgeonfish	Leter six
<i>Pomacanthus imperator</i>	Emperor angelfish	Enjel betmen
<i>Rhinacanthus acuelatus</i>	Blackbar triggerfish	Triger matahari
<i>Rhinomuraena quaesita</i>	Ribbon eel	Ular hitam, ular biru, selendang biru, belut hitam, belut kuning, belut pelangi biru,
<i>Stonogobiops xanthorinica</i>	Yellownose prawn goby	Cabing anten zebra, jabingan zebra model
<i>Sufflamen chrysopterygum</i>	Halfmoon triggerfish	Triger celeng, triger babi
<i>Synchiropus picturatus</i>	Picturesque dragonet	Mandarin B
<i>Synchiropus splendidus</i>	Green mandarin fish	Mandarin asli

Table 2. Ten most-collected species from the Karumpa Reefs (three days travel from north Bali).

Scientific name	Market name	Local name
<i>Amphiprion ocellaris</i>	Clown anemonefish	Clownfish, klonfish, kelon
<i>Pseudanthias dispar</i>	Peach fairy basslet	Gadis
<i>Nemateleotris magnifica</i>	Fire dartfish	Roket anten merah, anten merah
<i>Labroides rubrolabiatus</i>	Redlip / blackspot cleaner wrasse	Dokter mas
<i>Odonus niger</i>	Red tooth trigger	Triger biru
<i>Forcipiger flavissimus</i>	Yellow longnose butterfly	Monyong asli
<i>Chrysiptera cyanea</i>	Blue/sapphire damsel	Blue devil
<i>Oxymonacanthus longirostris</i>	Spotted/harlequin filefish	Jagungan, jagungan biasa
<i>Labroides bicolor</i>	Bicolor cleaner wrasse	Dokter asli
<i>Amphiprion clarkii</i>	African clown	Polimas

fish during the long sea voyages are woefully inadequate. Collectors use whatever materials are at hand for collecting, and tend to “make do” with what they have in terms of collecting equipment. For example, mosquito netting may be the only locally available store-bought netting that has a small enough mesh for catching ornamentals, but this is expensive and tears very easily. Collectors spend considerable time weaving their nets by hand, using cotton or nylon thread. Handmade nets tend to be highly visible to the fish, and their coarseness causes bruising to the fish. Collectors use old jerry cans set in inner tubes as floating containers for their fish. Very often, the plastic fish storage bags provided by the supplier are in short supply, and of the wrong sizes, so they must be reused many times. Bag shortages lead to “gang-packing” — the packing of large numbers of fish into single bags. This increases the risk of stress and injuries to the fish. Finally, once piled up in the holds of the boats, a significant number of bags burst, either because of the weight of other bags from above, or because of nails and splinters in the wood of the boat.

The collectors often fall prey to marine police patrols that extort money from them before allowing them to continue. All these factors increase stock mortality rates and risks to the safety of the collectors. Meanwhile, the marine ornamentals trade continues to treat marine organisms like a commodity and expects a steady, continuous supply of stock, with a constant stream of “new” products becoming available to satisfy demand. Collectors and suppliers are often the ones blamed when orders are late or of poor quality, although these problems can happen anywhere along the trade chain. Incorrect identification of ordered organisms at the supply end leads to frustration and rejection of stock. Such misidentifications are caused in part by a lack of agreement between buyer and seller on which identification guides and reference lists to use. However, some importers have helped by providing their exporters with pictorial identification guides that can be passed down the chain through the suppliers to the collectors. The problem of suppliers sending fish of the “wrong” sizes also occurs, because there is no agreement within the industry (particularly between different importing countries) as to what constitutes “small”, “medium” and “large” for a given species.

Hookah divers

In areas where shallow reefs (on which collecting can be done without the aid of compressed air) are already damaged and unproductive, collectors use compressors (of a type normally used to inflate car tires) with long hoses to supply them with air during their dives. This practice is called hookah diving, and enables collectors to dive to depths of

up to 50 m. At these depths, they are able to catch high-priced species that live at depth, as well as those that have been fished-out on shallower reefs. Without watches, pressure gauges or knowledge of safety diving and the need for decompression stops, these divers run the risk of decompression sickness, paralysis and even death. Some local authorities are restricting the use of compressors, which helps to reduce the negative impacts of fishing for such products as food fish, lobster, abalone, sea cucumber and other marketable marine organisms.

Cyanide use

In spite of claims to the contrary and the introduction of laws and increased frequency of patrols by law enforcement officers, the use of potassium cyanide (locally known as “potas” — burns with a blue/purple flame) to catch fish is still widespread in Indonesia. Some traders maintain that many of the fish caught using cyanide do survive and flourish even after they are purchased by the end buyers. They ignore the immediate and subsequent damage to the reef and the impacts to the thousands of non-target organisms that are affected by the use of cyanide. They do not see the numbers of target fish that die or are rejected and left underwater when the concentration of cyanide used is too high. Certainly, many fish do survive to reach the market, but the hidden costs are unacceptably high.

The problem of seasonality

Another source of pressure put on collectors by the buyers stems from the seasonality of both supply and demand. Bearing in mind that their only other source of income may be the capture and immediate sale or barter of food fish (as they have no cold storage facilities), being financially indebted to their buyers, the life of the average collector is comparatively difficult. Collectors may have families, extended families and friends who are all out of work, and who depend on the collectors for support. Schooling and health facilities are rudimentary but still cost money, so it is likely that collectors and their children have to forgo schooling in favour of being able to buy food. Some fish species are only available during certain seasons, and there may be long periods when collectors cannot go out in their boats because of rough seas. Demand for stock is also seasonal, with demand declining during times when hobbyists are on holiday (e.g. in the summer). These low periods of supply and demand do not coincide. During these times, collectors generally have no other sources of income, which is a major reason why so many of them get into debt through having to borrow money. Buyers may not place regular orders with collectors, and then might refuse the catch from the collectors at the last minute because the exporter has changed his order. Because of the lack

of adequate holding facilities in collectors' villages, stock cannot be held for any significant length of time after capture. Therefore, at times when no collecting is possible, or when demand is low, collectors sit idly in their villages, repairing their hand-made nets. Some exporters are attempting to hold stock in their facilities for longer periods in order to see them through times when supply is low or until demand picks up again. Holding fish for longer periods can ensure a more continuous supply of stock to the buyer, but it adds costs. Increasing the price of the fish would help to cover these costs, but that would require understanding and support from the buyers. In spite of many exporters' claims, collectors have no bargaining power whatsoever, especially if they are in debt to their suppliers. If collectors do ask for more money for their catch, then the buyer simply threatens to recall all their loans and go elsewhere for his fish. Another advantage of holding fish for longer periods before exporting them is that they have more time to recover from their journey to the exporters and are fed and monitored for a while, putting them in better condition to face the next (international) leg of their journey. This would be a radical departure from the traditional practice of each link in the chain selling on stock as quickly as possible.

Coral and live rock

Collectors of corals and live rock face problems similar to those faced by fish collectors. Corals command a higher price than fish on the international market, yet the methods of collection and transportation remain simple and inadequate. Reefs are subject to boat and anchor damage and trampling by collectors. Coral fragments or whole colonies are hewn out of the reef using pliers and crowbars. Corals are piled into buckets of seawater and then brought ashore. Without individual packing, many pieces become damaged in transit to the facility and are later rejected.

The trade in live corals for marine aquaria requires substantial investment, partly because, although the quantities traded are smaller than in the case of fish, the price paid per piece is higher, space requirements are greater, and breakages and losses through poor handling (and therefore rejects) are frequent. Transportation of live corals requires more space on the boat than is needed for bags of fish. Investment requirements include the purchase of wooden boats with inboard or outboard engines, compressors for supplying air to divers via hookah gear, a variety of containers, holding facilities, and means of transportation. This investment is generally made by exporters in return for regular supplies of corals by collectors, who are also given the responsibility of looking after and maintaining the boats. Unfortunately, rou-

tine maintenance is not part of the culture of collectors, and spare parts are expensive and hard to find. Consequently, breakdowns are frequent, and much time is lost while waiting for spare parts to arrive and repairs to be carried out.

Sometimes collectors rent motorbikes on the backs of which they balance Styrofoam boxes for transport to the suppliers. Suppliers generally either rent small open flatbed trucks, or use local long-distance public bus services to transport their boxes to exporters' facilities. Very rarely, the exporter will supply the trucks, but these are mostly open flatbed trucks, and the fish boxes (or just the bags of fish) are covered with a tarpaulin to protect them from the heat of the sun. Air-conditioned trucks are a rarity, although a very few exporters have invested in them.

The land-based ponds needed for holding corals are simply too expensive for most suppliers, so corals must be sent on to the exporters on the same day that they arrive ashore. Using sea-based coral storage facilities near the village runs the risks of pollution and theft.

Live rock — loose pieces of coral rubble covered in pink/purple algae and containing thousands of water-purifying micro-organisms — is used extensively in marine aquaria for both water purification and its aesthetic appeal. It is often collected by free divers (not using breathing apparatus) from the deep trough beyond the reef crest and brought to shore in small dugout canoes with outriggers.

Trader relationships

There are generally three steps in the chain of custody within Indonesia: the collectors, the suppliers that buy stock from the collectors, and the exporters that buy from the suppliers. The collectors live in coastal villages — some of the poorest communities in Indonesia. Many collectors are illiterate, have no land or other assets, and originally became collectors when buyers approached them to catch tropical fish. The suppliers are frequently ex-collectors who have had a little education and developed simple business skills. Occasionally there are other middlemen involved between the suppliers and the exporters. These middlemen are generally involved in the transportation of the stock between the supplier and the exporter. The exporters are business people for whom the sale of marine tropical fish is only one of their businesses. Many of the exporters are of Chinese descent, and run their export trade as small family businesses. There are no big companies, and certainly no multinationals, supplying the marine aquarium trade from Indonesia. The term "traders" refers to the suppliers and export-

ers, as they run businesses with export in mind, in contrast to the collectors. There are almost no foreigners working in the trade in Indonesia, apart from the occasional technical advisor sent from overseas to work with an exporter in order to improve stock quality.

Some exporters have been known to withhold payments to suppliers in order to keep prices low, believing that if they pay immediately, they will be perceived to be “rich”, leading to higher prices. In contrast, suppliers tend to live close to collectors and feel a greater moral obligation to pay collectors as soon as possible. Honest and transparent trading is clearly difficult to promote in a climate where there is little sense of obligation, loyalty or mutual trust. It is ironic that, in a market that is still expanding, suppliers appear to be fighting a constant battle to find and keep customers. This reflects a lack of binding contractual arrangements between sellers and buyers, as much as the unreliability of stock supply and variable quality.

As long as there are still fish in the sea, plenty of desperate collectors to catch them, and many suppliers to choose from, the number of buyers paying fair prices will remain small. Some argue that there first has to be a significant improvement in stock quality before they will consider paying higher prices. However, a few traders understand that it is the low prices paid for fish at the source that are driving collectors to overfish, use cyanide, and use poor methods of collecting, handling and transportation. Catching and sending far more stock than was ordered will hopefully continue to offset the high mortalities caused by the poor methods used. The collectors’ reasoning behind catching and sending far more stock than was ordered is that such opportunistic attempts at sales will offset the high mortalities caused by the poor capture, holding and transportation methods used.

Unlike the people they sell to, the concept of time being money is alien to collectors. They accept the high levels of waste in time, stock and money and the large amounts of rejected stock as normal. Their understanding of business is so meagre that, when simple business-training sessions are given for them and the potential savings and profits are itemized for them and presented as lost income over a year, they are usually genuinely surprised at how much money they are losing. (And they are always shocked when told of the price at which the stock they collect is finally sold to the hobbyist!)

There is simply too little investment by the trade in general to help support collectors and give them financial incentives to upgrade their skills and facilities. As time goes on, more reefs are destroyed or overfished, leading to further exploitation else-

where, and increasing competition among collectors’ groups for diminishing resources. This in turn promotes the use of more destructive collection techniques in order to catch larger quantities of fish, which collectors try to sell at any price before they die, further constraining the productivity of the resource.

There is an urgent need for the industry to work more closely with collectors and others at the supply end to help them improve stock quality, find responsible, trustworthy buyers, and promote reef management to help sustain the resources on which all players in the trade depend.

Recent initiatives to help the marine aquarium trade

The introduction of various capacity building measures for collectors, suppliers and exporters has started to show a positive impact, including an improvement in the quality of fish sold by some groups of collectors. These improvements are admittedly still very limited in scale because of the sheer size of the country, the large number of collectors involved, and constraints in funding and manpower for training and monitoring. However, awareness of the various problems is steadily growing among coastal communities that depend on marine resources for their livelihoods. The challenge is to help them recognize their power as a vital link in the trade chain, and then to encourage them to adopt the tools needed to achieve greater resource sustainability.

A few enlightened importers and exporters are already working more closely with their suppliers, providing them with expertise, training and equipment. These pioneers are being closely watched by the rest of the marine ornamentals trading community and are leading the way for the rest of the industry.

Together with several local nongovernmental organisations (NGOs), the Marine Aquarium Council (MAC) has begun to provide training for collectors, suppliers and exporters in Indonesia. It has welcomed the help of some foreign divers/collectors and a very few foreign trainers (including technical advisors sent by importers to work with their exporters). These trainers have provided technical assistance and instruction in capturing, holding, packing and transportation skills and methods. Experienced local collectors are being recruited to provide hands-on practical training in net-only capture techniques.

Dive instructors have given dive safety courses to collectors, and a local hospital in Bali allows collectors access to the only decompression chamber on the island. Representatives of MAC spoke

to doctors there, and it was discovered that collectors could use the facility at a reduced cost, provided they supplied evidence of their status as poor coastal villagers. The hospital had never had any collectors use the chamber until recently. Once the first group of collectors had visited the chamber, they took back to their villages the message that this was something to help cure them, rather than something to be afraid of. The collectors' group has now established its own fund to pay for transportation and treatment in the event of a decompression case. (It must be remembered that none of these villagers had ever considered making the three-hour journey to the main town, let alone visit a hospital! Many more collectors still rely on traditional cures, and cases of death and paralysis from deep diving accidents still occur all too frequently.)

The Community and Conservation Investment Forum (CCIF), a San Francisco-based non-profit organisation with a field office in Bali, is developing training materials for basic financial management and marketing of marine aquarium products. The organisation encourages suppliers to become part of MAC-certified supply chains, form traders' associations, and link with MAC-certified buyers. Sales and species selection will hopefully become better managed, more rational and less arbitrary as communication among exporters, importers and retailers improves and the trade links between them are strengthened.

Sustainability also requires scientific assessments of the aquarium fishery resources and management plans for the collection areas, such as those that are beginning to be implemented in Indonesia, the Philippines and Fiji. This will take time and effort. The collectors and collectors' groups, supported by local governments, are in the front line in terms of learning to manage their resources more carefully. They need to be encouraged to use a precautionary approach to resource exploitation. This is not easy at a time when there is increasing competition for dwindling marine resources. The international Reef Check Foundation, together with the Indonesian Scientific Authority and local NGOs, is developing methods of determining sustainable harvest levels and establishing total allowable catches (TACs). These methods use both data from in-water visual surveys at collection sites, and catch data from collectors and suppliers. At the same time, efforts are being made to enable local communities to apply these methods so that they are able to assess the state of the resources in their area and adjust collection rates accordingly.

The current economic situation in Indonesia is putting great pressure on collectors. Fuel prices

for sea and land transport have recently doubled, sometimes making the costs of collecting trips prohibitive. Where the collectors and collectors' groups have made an effort to manage their local resources more responsibly, the financial rewards of their efforts will act as incentives for sustained positive change and help to reduce the need for roving collection. Increased prices paid for better quality stock are an obvious example of such incentives, but assistance in the form of cheap masks, snorkels, fins, and suitable netting, as well as regular support visits by the importers and exporters, would all serve to increase the sense of self-worth of the collectors. (Very few exporters and even fewer importers have ever visited a collectors' group to see how they live and how stock is caught.)

Educating collectors about how important they are as the first link in the trade chain serves to increase their sense of responsibility in providing a quality product, as well as pointing out the bargaining power many did not realize they had.

The frequency of government enforcement patrols has recently increased, so more cyanide users are being caught and fined. Meanwhile, local governments plan to provide trained collectors with individual collector licenses, which will allow them to collect legally in certain areas. The issuance of licenses will increase the collectors' sense of resource ownership and reduce the possibility of their being victims of extortion by unscrupulous enforcement officers. Licenses will be issued only to those collectors who have followed a particular training programme. If any collector is subsequently found to be using destructive collection methods, for example, their training certificate and license would be withdrawn. MAC is also helping with capacity building for local government officials so that they have the tools and skills necessary to regulate collection activities in the future, in cooperation with collectors' groups.

Coral propagation

Some exporters are moving towards coral propagation, which necessitates considerable investment in facilities and equipment and the adoption of new skills by their staff. Formerly, all corals for sale were collected from the wild, but now more corals are being propagated in shallow coastal waters from coral fragments ("frags") collected from reefs, and this provides local villagers with another opportunity for income. Broodstock colonies or fragments are relocated to "dead" areas of reef flats, and corals are grown from these original fragments. These corals are in turn fragmented, and successive generations are grown from them. Currently, many small-polyped species (e.g. *Acropora* spp.) are being grown because of their rela-

tively rapid growth rates. The market pays higher prices for the slower-growing large-polyped species (e.g. *Euphyllia* spp.), and it remains a challenge to manage the flourishing coral mariculture trade so that the market is not flooded with only a few fast-growing species. The development and spread of low technology mariculture will, in time, decrease market reliance on the collection of wild corals, while providing coastal villagers with an alternative source of income.

Corals are now being propagated in several areas around Bali and Java, both in the sea and in land-based facilities. Coral fragments are glued or tied onto bases or pegs, and these are arranged on racks, often situated in shallow water near the beach. The fragments and bases need to be cleaned periodically, and performing these simple maintenance tasks for hire can provide a source of income for local villagers.

A portion of the propagated corals can be used to rehabilitate damaged reefs, although efforts to do this have been very localized and limited. The steady increase in the numbers of coral species being propagated is an important first step in improving the prospects for sustainability of the Indonesian coral trade and in reversing the trend of reef destruction.

Future of the trade

The power of the hobbyists as consumers to demand a “better” product should not be underestimated. Increased awareness among hobbyists of the origin of the organisms they buy and the circumstances under which they are caught and shipped will help them to make more informed purchases. The collective mindset of consumers, many of whom still treat marine ornamentals as a disposable commodity, needs to evolve to one that recognizes them as being a valuable living resource that has a limited supply.

The number of marine ornamental species that are being captive-bred is still very low. Very few people will want to invest in expensive captive-breeding facilities as long as cheap wild-caught specimens are available. The development of low technology captive-breeding and rearing techniques that can be successfully adopted by coastal villagers would do much to reduce fishing pressure on wild stocks, as well as provide a more sustainable source of income. An interesting challenge would be to take the few “high-tech” techniques developed by experts in the marine ornamentals industry in the developed world and try to adapt them for use in the less-developed supply countries.

Some marine species are receiving legal protection in Indonesia. Their collection, sale and export are prohibited. For example, giant clams (*Tridacna*

spp.) were once very abundant throughout the archipelago but were over-collected to the point of extirpation in many areas. A number of giant clam species are now being successfully bred in captivity, and these can be used for restocking. Seahorses, once collected by the ton and dried for the Chinese traditional medicine market, are now being captive-bred. Clownfish are another very popular species that is now being captive-bred in quantity in Indonesia. Humphead wrasse (*Cheilinus undulatus*), a species that was widely caught for the live food fish export trade using cyanide, is now listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), meaning that exports must be documented by government authorities as having been taken legally. The list of captive-bred species produced in Indonesia is still pitifully short, but this may change as wild stocks decline and captive-breeding is recognized as a financially viable alternative.

All hard coral species are listed in CITES Appendix II, so their export and import are regulated. Indonesia has imposed further restrictions on coral exports. Since 1997, based on recommendations given by the Indonesian Government’s Scientific Authority, the Indonesian CITES Management Authority has set up annual catch quotas for corals, some at the genus level and others at the species level.

A few marine protected areas have been established in Indonesia, but rocketing fuel prices and high maintenance costs mean that there are too few enforcement patrols for these vast areas. Also, officially protected areas are a magnet for illegal fishermen because they contain some of the largest remaining intact reefs.

The need to protect marine species and habitats, at least in terms of providing a more sustainable source of saleable commodities, is a message that is slowly becoming more widely understood. Sadly, this realization has all too often come only after resources have been fished out and habitats destroyed. Furthermore, if the marine aquarium industry wants to reduce the likelihood of government officials taking rash and uninformed action to address issues in the trade, it will need to take greater initiative and be more proactive in reforming itself from within.

The amount of damage caused on a daily basis by the collection of marine organisms for the aquarium trade is relatively slight compared with the impacts of other human activities. Nevertheless, it is hoped that some of the positive initiatives towards a more sustainable aquarium trade will be expanded and will lead to a wider global understanding of the need to protect the wild natural resources on which so many people directly depend.

Summary of actions needed to promote a more sustainable marine aquarium trade

For Indonesia's marine aquarium industry to flourish and prosper in the longer term, a number of changes need to be made. In general, the buyers are best placed to provide greater support and incentives to those working lower down the chain (i.e. at the supply end). Actions to effect these necessary changes include:

- Training collectors in the use of non-destructive collection techniques.
 - Training in handling and shipping methods that maintain the health and quality of organisms.
 - Training in safe diving and compressor maintenance.
 - Empowering collectors through the formation of production cooperatives.
 - Teaching basic business skills for running viable collection and sales operations.
 - Promoting the use of written contracts between buyers and suppliers to encourage greater mutual loyalty.
 - Forming suppliers' and exporters' trade associations to increase their bargaining power.
 - Using the notion of increased environmental and social responsibility as a marketing strategy.
 - Promoting greater environmental awareness of coastal and marine issues in local communities and among participants in the trade, as well as among government personnel that could give greater support to them.
 - Establishing collection area management plans and empowering local communities to monitor and regulate natural marine resource extraction.
 - Establishing no-take zones within collection areas where stocks can recover and seed the rest of the reef, with management of such zones undertaken by local communities with local government support.
 - Campaigning to publicize the negative effects of cyanide use and developing portable cyanide detection test kits.
 - Establishing incentives for collectors and their communities to manage the reefs and control the trade at their end.
 - Encouraging buyers to share their expertise and information with their suppliers.
 - Providing basic equipment (e.g. simple water quality test kits, dive gear, nets) that may be expensive or not available to the suppliers.
 - Encouraging importers to provide training to exporters and suppliers.
 - Developing low-technology mariculture techniques as a viable alternative to collection from the wild.
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