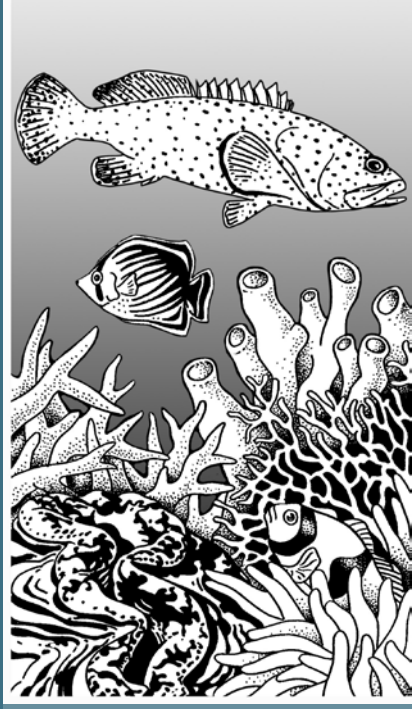

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LIVE REEF FISH
information bulletin

Inside this issue

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Editor's note

It's been more than a year and a half since this bulletin last went to press, suggesting that not much has been happening in the world of live reef fish fisheries. The articles in this bulletin, however, point to a flurry of recent activities. Let me introduce these stories in a geographical order of sorts.

In the Pacific Islands we have news on both food fish and ornamental fish. Antoine Teitelbaum and his co-authors from the Secretariat of the Pacific Community and the Secretariat of the Pacific Regional Environment Programme give an overview of the marine aquarium trade in the Pacific Islands. They identify challenges to achieving long-term sustainability of the trade, and based in part on the outcomes of a regional workshop, they offer specific actions that could be taken at national and regional levels. Two countries, Papua New Guinea and Solomon Islands, have been working on their national management plans for live reef food fish fisheries, as reported by Andrew Smith, Leban Gisawa and John Leqata. Being Yeeting and co-authors report on a recent effort to train Pacific Islands fisheries personnel in monitoring and managing fish spawning aggregations.

Reporting from slightly farther afield, in Indonesia, Joanne Wilson, Kevin Rhodes and Christovel Rotinsulu share their findings from the Raja Ampat islands, where grouper aggregations have been fished for the live reef food fish trade for at least 30 years.

Examining Hong Kong as a regional seafood trade hub, Shelley Clarke emphasizes the importance of demand-side management of fisheries, makes a case for certification schemes, and concludes that Hong Kong, whose "global footprint on fish stocks is enormous for its size," has the responsibility, and an opportunity, to lead Asia by example.

Yvonne Sadovy provides an update on the efforts made by parties to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) to regulate the trade of humphead wrasse since its listing on Appendix II of the CITES in 2004. She cites progress, but finds there is much work to be done in dealing with illegal, unreported and unregulated trade of the species.

The Coral Triangle Initiative, focused in six Asia-Pacific countries, is a massive undertaking involving governments, inter-governmental organizations and non-governmental organizations. It is taking on a range of issues under the themes of coral reefs, fisheries and food security, including the management of live reef fish fisheries, as described in the articles by Michael Abbey, Geoffrey Muldoon and Robert Schroeder.

The contributions to this bulletin are impressive in showing the broad scope of the efforts being made to put fisheries for live reef fish on a more solid footing. They range from projects to improve local fisheries management to international initiatives to regulate trade. I look forward to seeing reports of progress on all these fronts in future issues of this bulletin.

Tom Graham

PIMRIS is a joint project of five international organisations concerned with fisheries and marine resource development in the Pacific Islands region. The project is executed by the Secretariat of the Pacific Community (SPC), the Pacific Islands Forum Fisheries Agency (FFA), the University of the South Pacific (USP), the Pacific Islands Applied Geoscience Commission (SOPAC), and the Pacific Regional Environment Programme (SPREP). This bulletin is produced by SPC as part of its commitment to PIMRIS. The aim of PIMRIS is to improve the availability of information on marine resources to users in the region, so as to support their rational development and management. PIMRIS activities include: the active collection, cataloguing and archiving of technical documents, especially ephemera ("grey literature"); evaluation, repackaging and dissemination of information; provision of literature searches, question and answer services and bibliographic support; and assistance with the development of in-country reference collections and databases on marine resources.

PIMRIS
Pacific Islands Marine Resources Information System

Aquarium trade in the Pacific

Antoine Teitelbaum,[1] Being Yeeting,[1] Jeff Kinch[2] and Ben Ponia[3]

The Pacific region first became a part of the luxury aquarium trade in the 1970s. Thirty years later, the total annual value of aquarium organism exports from the region is between 40 and 60 million US dollars (USD), accounting for about 10–15% of the global trade. The aquarium trade is becoming an important source of income and employment for local communities in the Pacific. For example, in Fiji alone, the aquarium trade provides employment for 600 people, and fisheries revenue is second only to tuna.

Today, the activity has spread to more than 13 Pacific Island countries and territories (PICTs), finding its source in unique coral reef habitats. It has even come to some of the most remote places, where there are a number of rare or endemic fish species not found in Southeast Asia, the major competitor.

Sustainability concerns

There are concerns that extractive wild-capture practices are causing damage to marine environments. But evidence suggests that coral reef resources are resilient and that the trade could be managed sustainably to provide Pacific Island communities with a continuing livelihood.

There are a number of good practices around the region that demonstrate that the aquarium trade can be sustainable. For example, Tony Nahacky from Aquarium Fish (Fiji) Ltd has been harvesting the same numbers of corals and fish from the same area around Pacific Harbour, Fiji, each year, for 24 years. He feels that stopping the local communities from collecting marine aquarium fish and invertebrates in the wild may "result in much more destructive uses of the reef to replace that income." Diving on the reef every day, aquarium fish divers are the eyes and ears of the reef and can monitor the environment as it fluctuates. Some years there is great recruitment and some years there is not, and most of the time recruitment success is independent from the pressure of aquarium fish collectors. A well trained diver, collecting the right-sized specimens, focusing on species that are known to do well in aquaria, and spreading his efforts around a vast area, will cause only minimum impacts on reef fish populations.

Amphiprion percula, a top seller in the marine aquarium trade (photo by Antoine Teitelbaum).

However, if many divers operate in the same area, targeting the same species, then it is likely they will have an impact on the resource and the habitat. This has been observed in areas such as Christmas Island, Kiribati, where there was a flame angel "boom" several years ago that involved an unregulated number of divers hunting for the valuable *Centropyge loriculus*. The result was a decline in the resource as well as in the market price. In only a few years, flame angels went from an export price of more than USD 15 to less than USD 6. Such collection and handling practices that result in low quality fish can have negative repercussions on some of the long-lasting and quality-renowned operations in the region.

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This shows how important it is that the government work closely with the private sector to draft and establish an aquarium fisheries management plan in order to sustain and equitably share this valuable resource.

Emerging issues and challenges: Culturing marine ornamentals

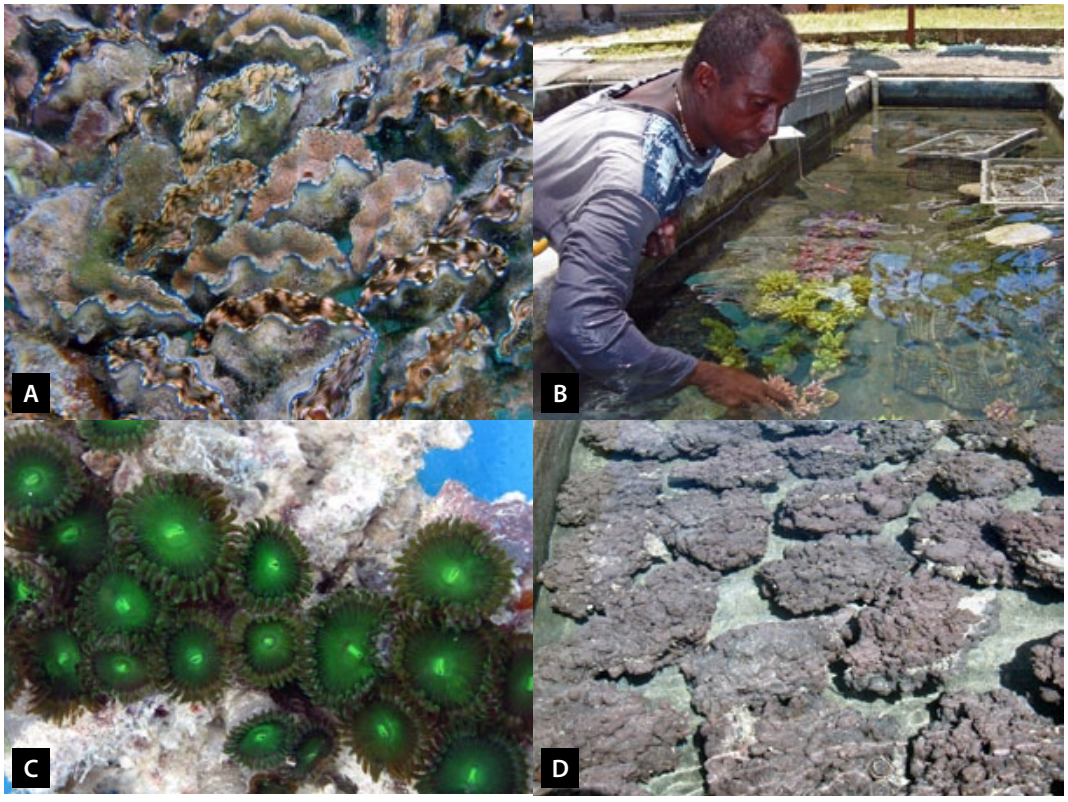
Traditionally, the marine aquarium trade has relied primarily on the capture of wild animals. Aquaculture, however, is providing the market with an increasing variety of cultured products. For example, giant clam farming has increased since the first trials in the 1980s; in 2007, over 75,000 cultured clams were exported from the Pacific.

Cultured corals and live rock are also being successfully marketed to environmentally conscious aquarists. In Fiji, Walt Smith international (WSI) has developed a range of cultured products to broaden its "regular" product line, including corals and artificial live rock made from cement, sand and volcanic pumice. Artificial live rock, once cured, is left in the ocean for 18–24 months. Cultured corals are fragmented from wild corals on site and placed on racks to grow for 6–12 months, depending on the species.

Recently, and as a result of Tonga's ban on the export of wild live rock and its reduction in the coral export quota to 150 pieces per exporter per week, WSI, the Government of Tonga, and the Aquaculture Section of the Secretariat of the Pacific Community (SPC) have started working on an aquaculture project targeting both of these commodities (cultured corals are exempt from the export quota).

Aquaculture will alleviate some of the concerns about wild collection but consumers will always want diversity and rarity in their products. As a result, it is likely that aquaculture products will just expand alongside — rather than replace — the list of existing wild-caught products.

The expansion of marine ornamentals aquaculture in the Pacific will bring alternative employment for people in rural areas. Aquaculture requires a range of new jobs, from hatchery managers to casual labourers. It is likely that aquaculture will continue developing in the region, assisted by worldwide demand as well as technology uptakes from other



A. Cultured *Tridacna derasa* in Aitutaki, Cook Islands, are sold through a Rarotonga-based exporter and shipped to the United States (photo by Antoine Teitelbaum).
B. Regon Warren, from the WorldFish Center in Solomon Islands, selects the best cultured *Acropora* corals prior to shipping from Honiara (photo by Antoine Teitelbaum).
C. *Protopalythoa* spp. collected from Tonga's waters (photo by Chris Turnier).
D. Artificial rocks placed in a raceway at the Tonga Fisheries Department's mariculture station (photo by Chris Turnier).

places where the range of marine ornamental cultured products is ever increasing. For example, in the Marshall Islands, Oceans, Reefs and Aquariums (ORA), a world leader in cultured marine ornamentals, has purchased an aquaculture facility to produce giant clams and corals in order to expand its range of cultured items for sale to the United States and other international markets.

The saga of air transportation

The aquarium trade has a symbiotic relationship with the airline industry. Live fishes and corals surviving on a limited oxygen supply must be shipped quickly to their destination, and the trade therefore depends on airlines to get its products to market.

At the same time, the flow of outgoing marine ornamentals provides a steady stream of business to airlines, helping some international flight routes to stay afloat. In Tonga, for example, the recent ban on live rock harvest caused a drop in airfreight cargo and reputedly contributed to the demise of one of Tonga's international flight connections.

It is difficult for some PICTs to further develop their ornamental fisheries or expand the range of products because of air transportation constraints. For example, in Solomon Islands, only a limited amount of cargo is allowed on each flight, and much of that limit is normally booked by "regular" orders of wild-caught products. As a result, this has limited the commercialization of the cultured marine ornamentals produced in the Western Province by the WorldFish Center, a non-governmental organization. In Vanuatu, the operators of a recently built tuna processing plant have offered airlines to fill the entire available cargo space with fresh tuna products, putting at stake most of the space usually used by exporters of ornamental products. A deal has been worked out to avoid such a situation, at least temporarily, but it demonstrates the importance of airlines and air transportation to this fragile industry. Governments should work with airline companies with the aim of negotiating specific commodity freight rates to ensure the sustainability of the aquarium trade, as well as other export-based sectors of economic development in PICTs.

Good practices in the Pacific: The need for certification

Certification of best practices for the marine aquarium industry has been considered previously as a good way of maximizing benefits and sustainable use of marine resources. The Marine Aquarium Council was established specifically to develop a system for such certification. The system that was designed was not practical for most PICTs, and therefore was never implemented successfully in the region.

During a regional consultation workshop held in Noumea, New Caledonia in December 2008, the issue was again deemed a high priority by both governmental and private sector stakeholders, with the understanding that in addition to enhancing the sustainability of marine resources, eco-labeling can add value to products, or at least help maintain market share. At the same time, however, industry stakeholders stressed the need to avoid past experiences with burdensome over-documentation, and to apply certification only in areas where operators already have strong commercial incentives to do well.

International compliance

The global nature of the market for marine ornamental products makes compliance and reporting increasingly stringent and complex. As aquarium products move from one country to another they must comply with national laws to implement the powerful UN Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). CITES aims to ensure that international trade does not adversely affect global biodiversity, and establishes permitting and monitoring requirements for CITES-listed species.[4]

Lately, the Pacific has been affected by temporary bans on exports of certain species that are important in the aquarium trade and in coastal fisheries in general, including corals, live rock, and sea cucumber. A factor in these bans has been poor coordination between governmental environment departments, which typically issue CITES permits, and fisheries departments, which are responsible for managing marine resources on which the industry relies.

Biosecurity is an issue of increasing importance. Recently, the European Commission (EC) imposed a requirement for all live aquatic imports to be accompanied by a disease certification and for exporting countries to be members of the World Organisation for Animal Health (OIE). The Pacific has become an unintentional victim of this new requirement. Most, if not all, PICTs affected by this ruling lack the institutional and funding capacity to carry out these measures.

Fortunately, there are some conciliatory gestures from the EC indicating that a regional approach coordinated by SPC may provide a temporary respite. However, the EC's measures are probably an indication that increasingly stringent biosecurity measures in the trade are right around the corner.

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4. Most hard coral species that are traded, as well as giant clams, are listed under CITES Appendix II, meaning that international trade of the species is allowed but monitored.

A regional consultation

SPC has been assisting the Pacific Islands region to develop resource management and monitoring regimes to ensure the long-term sustainability of the trade while promoting best eco-friendly industry practices to ensure maximum benefits from these resources.

As part of this effort, SPC and the Secretariat of the Pacific Regional Environment Programme (SPREP) hosted a sub-regional workshop on the marine aquarium trade in Noumea, New Caledonia in early December 2008.

The workshop was a technical consultation between private and public stakeholders, and specialists from the industry in the Pacific to examine current and emerging issues in the trade and to identify national and regional initiatives that will ensure the long-term sustainability of this important industry.

The consultation was highly beneficial to all stakeholders and stimulated much-needed dialogue between regional organizations, the private sector and government agencies.

During the workshop, several specific needs were identified, including the following:

- Conducting an analysis to gain a greater understanding of the market. This analysis could include identification of new aquarium products and their potential for sale; examination of factors affecting the commercial viability of ornamental product operations, such as freight costs, freight space and flight connectivity; and analysis of pricing structures. This analysis could assist governments and the private sector in their decision-making about management, profitability and sustainability issues.
- Assisting PICTs with compliance and capacity issues regarding CITES-related requirements and the new EC import regulation.
- Investigating the potential of a "Pacific Eco-Certification" program as an avenue for government and industry to work together to ensure sustainability of the aquarium fishery. It is important that any eco-certification program be based on best practices and not be too onerous. Eco-certification could serve to increase the desirability of some aquarium organisms from the Pacific region and ease some of the compliance issues.
- Assessing the relative virtues of formal stock assessments and risk assessments in regards to the sustainability of aquarium organisms. Risk assessments could in some cases preclude the need for stock assessments if fisheries information was current, and could also identify and prioritize the need for stock assessments when funding became available. Stock assessments, focused on a few key aquarium organisms, on the other hand, could be used to verify risks identified by risk assessments.
- Establishing a Marine Ornamentals Working Group as a Pacific Islands regional focal point for market analysis and international agreement advocacy (particularly on OIE and CITES issues). The group could serve to distil and discuss problems and issues, provide an avenue for promoting Pacific aquarium organisms, and coordinate research activities.

The future

With the worldwide demand for quality ornamental marine products expected to remain steady and growing interest in the aquarium trade from PICTs, the trade is expected to continue to grow in the region.

SPC will continue to coordinate efforts and provide the technical support and assistance required by Pacific Island nations to develop and manage this industry in a sustainable way.

A "Pacific" label that indicates high quality eco-friendly products that promote sustainability is an idea worthy of exploration by Pacific Island nations.

International trade measures have the capacity to either become a barrier for the Pacific marine aquarium trade or assist the trade in keeping a clean image.

Collecting fairy wrasses using a scoop net and circle net (both with a very small mesh size) and a fiberglass stick (photo by Éric Clua).

Aggregation fishing and local management within a marine protected area in Indonesia

Joanne Wilson,[1] Kevin L. Rhodes[2] and Christovel Rotinsulu[3]

Introduction

The live reef food fish trade (LRFFT) is a widespread commercial fishery that since the 1990s has spread from Southeast Asia to ever-expanding locales within the Indo-Pacific (Sadovy et al. 2003). Historically, the trade has focused on groupers and wrasses, with fish spawning aggregations (FSA) often the primary target. As a direct result of FSA fishing and the heavy fishing pressure otherwise associated with the trade, many targeted species have experienced population-level declines and aggregation loss (Sadovy and Domeier 2005). Some species, such as squaretail coralgrouper (*Plectropomus areolatus*) are now listed as vulnerable (www.iucnredlist.org) and yet are still highly sought after by the trade (e.g. Sadovy 2005). Partly as a reflection of the trade's capacity, annual grouper landings increased from around 30,000 tonnes (t) in the 1980s to more than 140,000 t by 2000 (FAO 2010). To gauge the scale of the impact of the trade, a recent study showed that live reef fish imports into Hong Kong — one of several import countries — equates to the maximum sustainable yield of the entire stock of groupers in Southeast Asia (Warren-Rhodes et al. 2003). China's increasing expansion into the trade as an importer will undoubtedly add significantly to both the volumes of fish harvested and the adverse impacts on fishery resources.

The LRFFT, by its nature, is a boom-and-bust industry, extracting large volumes of fish from an area and then moving on once stocks are depleted (Sadovy et al. 2003). In some locations, such as Indonesia, this cycle has been repeated since the 1980s when the LRFFT expanded from its origin. In most parts of Indonesia, FSA of many species no longer form and few viable aggregations are known. Where they do exist, they appear to comprise no more than a few or a few tens of individuals (e.g. Pet et al. 2005), with little reproductive and recruitment potential. As an example, a recent assessment of spawning aggregations in Misool and Kofiau, Raja Ampat, Indonesia, was unable to verify a single aggregation site among several historically known fishing areas due to the low number of fish remaining. At the inception of the trade in these same locales, fishers reported large aggregations and large volumes of fish exported. Currently, fishers rely on remaining stocks to fuel the trade, yet rarely catch more than a few fish daily. Nonetheless, local LRFFT operations continue to exist, targeting remnant FSA and rapidly depleting newly discovered ones.

In Raja Ampat (Fig. 1), interviews with fishers were initially conducted by Conservation International (CI) at a site that will not be disclosed here (hereafter referred to as Site 1). From these interviews, nine separate FSA of several commercially important species were identified, including among others, groupers (Epinephelidae), snappers (Lutjanidae), trevallies (Carangidae) and wrasses (Labridae). These species are critical to regional and local fisheries and many form the basis of the LRFFT. In addition, anecdotal reports of the spawning season and lunar periodicity were provided during interviews. The information in those reports was confirmed by results from a separate acoustic tagging study of squaretail coralgrouper, *Plectropomus areolatus*, the results of which will not be presented here. Findings confirmed anecdotal reports of a September through January spawning season for the species. Ownership of coral reefs and associated resources within Site 1, including the FSA, is distributed among island groups or clans, with some FSA contested between local villages. Management of, and fisheries for, these FSA is, therefore, complex. Currently, Site 1 is within a marine protected area (MPA) (Fig. 1), with permitted yet managed use of reef resources, including spawning sites. As one example of local management, seasonal or site closures (*sasi*) (McLeod et al. 2009) to fishing are practiced on FSA and there are strict gear restrictions on explosives and cyanide fishing. Damage from previous explosives use is apparent throughout Site 1, similar to the whole of Indonesia.

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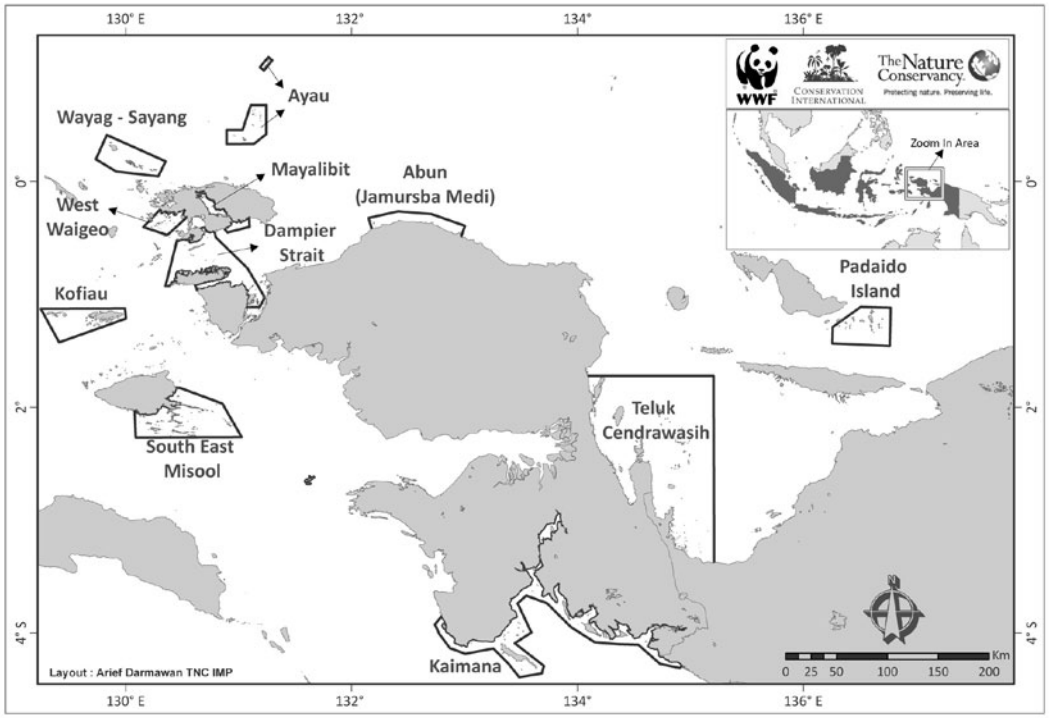

Figure 1. Map of Raja Ampat, Indonesia, where the study was conducted. Areas bordered by polygons represent marine protected areas.

Site 1 has a long history of FSA fishing that until the 1980s did not appear to be highly commercialised. In the 1980s, Site 1 FSA became subject to commercial fishing for the LRFFT, although the historical sequence of events surrounding the trade has been poorly documented. Anecdotal reports of past levels of fishing pressure (*circa* 1980–1990) and catch and export data from aggregation fishing for the LRFFT indicate a thriving trade, with multiple transport vessels frequenting Site 1 monthly and exporting tens of tonnes annually. More recently, declines in catch at Site 1 have been reported, with only a single transport vessel visiting a few times per year, in comparison to multiple monthly exports in the past. In September 2009, only 3 t of live fish and lobster were shipped from local *karambas* (holding pens), which represented catch from various areas at Site 1 and excluded catch from the study FSA that was at the time closed to fishing (see below).

The main objectives of the study reported on here were to verify and quantify one of several fished and locally managed FSA at Site 1, Raja Ampat, Indonesia. A further objective was to use conventional tag-and-recapture techniques to examine potential (straight-line) distances of movement and vulnerability to fishing of squaretail coralgrouper, *Plectropomus areolatus*, a primary target of the LRFFT. Thirdly, using the existing fishery for the LRFFT at Site 1, we examined catch per unit of effort (CPUE) of *P. areolatus* in order to quantify the impact to the aggregation from a discrete fishing period.

Methods

Monitoring (underwater visual census)

Underwater visual census (UVC) monitoring of the FSA was conducted 8–17 October 2009, using scuba. Since the site had not been investigated previously, initial dives were conducted to locate and define target fish species' aggregation areas and to characterise habitat. Once core aggregation areas were identified, fish counts were made. Fish abundance counts were made by two 2-diver teams swimming along the fore and back reef where FSA were observed to form. Counts were based on all individuals and target species encountered during swims. Monitoring in fore and back reef areas were similar in both depth and distance. Counts included all species suspected of using the site for reproduction.

Conventional tagging

From 10–12 October 2009, *P. areolatus* captured in the existing FSA fishery were tagged with conventional and acoustic tags. All fishing was done by local Site 1 villagers from motorised outrigger-type dugout canoes, each typically fitted with a 5-horsepower inboard 2-cycle gasoline-powered engine (Fig. 2). Fishers targeted their prey from the surface using eye goggles and hook-and-line baited with live soldierfish (*Myripristis* sp.). Fish used for tagging were purchased from fishers at 75,000 rupiah (about USD 8) each. Following purchase, fish were

Figure 2. A fisher and a typical local canoe, Site 1, Raja Ampat, Indonesia (photo by J. Wilson).

brought on board the research boat and placed in an aerated live well.

Floy dart-type (FT-94) tags were used for conventional tagging. Tags were inserted manually between the dorsal pterigiophores using a tagging needle. All conventional tags were uniquely numbered, with the word "Reward" (in Bahasa Indonesia) and contact information printed along the tag shaft. The tag programme was announced verbally and using posted colour posters to alert local stakeholders and fishers (Fig. 3). Prior to tagging, all fish were weighed (nearest 0.1 kg) and measured (nearest cm total length), with sex determined by size and coloration.

Catch per unit of effort and fishing methods

Information on CPUE of *P. areolatus* at the FSA was gathered from 9–17 October, exclusive of 11 October in recognition of local religious custom. Daily counts were taken of the total number of boats and fishers. The data were recorded by a provincial fisheries officer with the aid of local community members. For each fishing boat, surveys were conducted periodically throughout each day to record the type and number of fish captured per fishers, gear use, and total fishing times per individual. Fishing and, thus, CPUE estimates, were limited to daylight hours.

Results

Sites and site characteristics

Dive monitoring at the site during the October 2009 expedition identified three verified and several potential FSA along a finger-like extension (spur) of the reef. The spur was separated from the main fringing reef by a submerged back-reef cove, the depth of which ranged from a few meters to more than 40 m. At its widest point, the spur was separated from the fringing reef by about 100–200 m of sandy bottom, with characteristics that suggested periodic high current flow. The spur had a range of relief, type, cover and complexity. The fore reef was mostly bare of coral, except for a single large promontory that began at about 25–30 m depth and extended to more than 60 m depth. In that area, the substrate was interspersed with areas of scattered, moderate-relief coral (to 1 m of relief). The back reef was rich in coral throughout the length of the spur, with high relief (2–3 m) patch reefs at the shallow end and hard corals of moderate relief and increasing cover along most of the remaining sections. The top reef showed considerable impacts from explosives, with large (100 m^2 and greater) sections of rubble in the area of the FSA. Aggregating fish appeared to have less association with damaged than unaffected areas. Current flow along the spur was generally mild and varied

Figure 3. The poster used to publicise the tag programme.

in direction and strength throughout the monitoring period. Opposing currents, as localised convergences, were noted. Visibility ranged from a few meters to more than 30 m or more, depending on tidal flow and time of day.

Monitoring (underwater visual census)

During initial monitoring, aggregations of barracuda (*Sphyraena* sp., about 50 fish), humpback unicornfish (*Naso brachycentron*, about 100 individuals), longface emperor (*Lethrinus olivaceus*, about 40–60 fish), rudderfish (*Kyphosus* sp., about 100 fish), two-spot red snapper (*Lutjanus bohar*, about 100 fish) and bigeye trevally (*Caranx sexfasciatus*, about 400 fish) were observed, along with large schools of green humphead parrotfish (*Bolbometopon muricatum*, about 20–30 fish). Large adults of both humphead wrasse (*Cheilinus undulatus*) and blacksaddled coralgrouper (*Plectropomus laevis*) were common. During the first days of monitoring, large schools of ringtail surgeonfish (*Acanthurus blochii*) were also present. It is unclear if these aggregations were all reproductive, but direct observation of spawning in bigeye trevally was observed at about 1600 hr, along with associated colour change and courtship throughout the day.

UVC also identified substantial FSA of *P. areolatus* and brown-marbled grouper (*Epinephelus fuscoguttatus*). On the final day of monitoring, dive teams counted about 300 *P. areolatus* and about 80 *E. fuscoguttatus*, considered to be peak abundances for that lunar month. Brown-marbled grouper were associated with moderate coral reef cover and moderate-to-high relief corals in both the fore and back reefs. *E. fuscoguttatus* were found at 15–30 m depth along the back reef, and from about 10 m to greater than 60 m in the fore reef. *P. areolatus* were primarily associated with hard coral areas along the back and fore reef at depths of 15–20 m. On the final day of monitoring, most individuals of *P. areolatus* were found along a section of the reef crest about 200–300 m in length. Courtship, territoriality, colour change and gravid *P. areolatus* females were commonly observed, while biting, chasing and scars were associated with *E. fuscoguttatus*. Migrating schools of *P. areolatus* females were observed leaving the site two days before new moon, suggesting that some spawning had occurred.

Conventional tag-recapture

Over two days (10–11 October), 40 *P. areolatus* (27 females, 13 males) were conventionally tagged with FT-94B dart-type spaghetti tags (Fig. 4). Tagged fish ranged from 32–53 cm in total length (TL) and 0.4–1.8 kg in weight. Females averaged 40.5±5.0 cm TL and 1.0±0.4 kg, while males averaged 44.0±3.4 cm TL and 1.3±0.3 kg.

Figure 4. *P. areolatus* tagged with FT-94B dart-type spaghetti tag (photo by E. Joseph).

In total, fishers recaptured 5 of the 40 tagged *P. areolatus* (12.5% of the total). Three tagged females were recaptured at the FSA over five days of the aggregation period in October. Of these, two fish tagged on 10 October were recaptured once (recaptured 12 October and 14 October, respectively). The third female, tagged on 12 October, was recaptured first on 13 October and again on 15 October). A male tagged on 10 October was recaptured at the FSA site 28 October and a female tagged 12 October was recaptured twice at a location approximately 4 km away from the site, on 30 October and 3 December 2009.

Catch per unit of effort and fishing methods

Information on CPUE was gathered over five of the six days that fishing took place on the *P. areolatus* aggregation. The number of fishers generally increased towards the end of the aggregation period and ranged from 4–28 individuals per day (Fig. 5). During the survey, 564 *P. areolatus* were captured. In combination with the underwater monitoring results, this suggests an aggregation of 860+ individuals at the FSA. On average, CPUE was 0.7 fish hr^{-1} and ranged from less than 0.1 to 4.5 fish hr^{-1} (Fig. 6). Similar to the number of fishers, both CPUE and the number of fish captured increased at the FSA as the new moon approached (Fig. 5 and 6). Captured fish were maintained in a live well on board each vessel or transported to a nearby submerged holding net fitted with a surface float until they were transported to the village *karambas* (holding pens for the LRFFT).

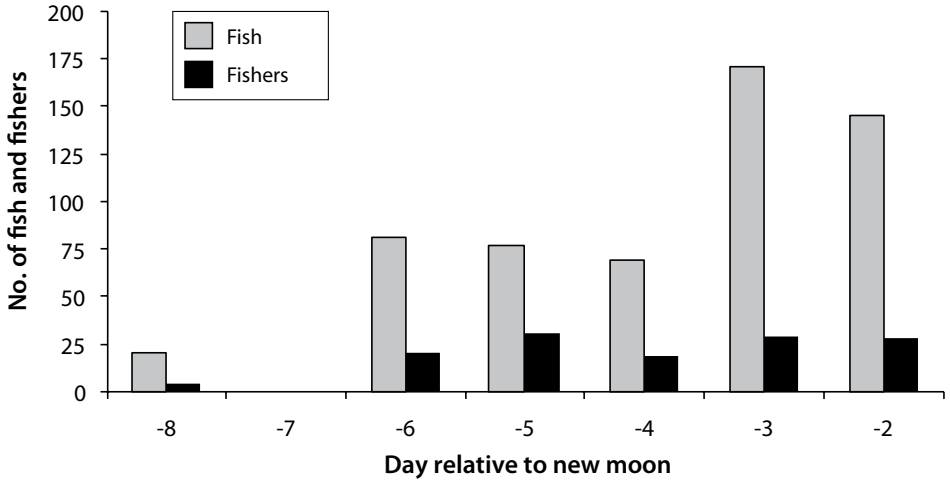

Figure 5. Total number of fish captured (grey) and number of fishers (black) by survey day, at the target *P. areolatus* FSA. No monitoring was conducted on the day seven prior to the new moon (Day -7) in observation of local religious custom.

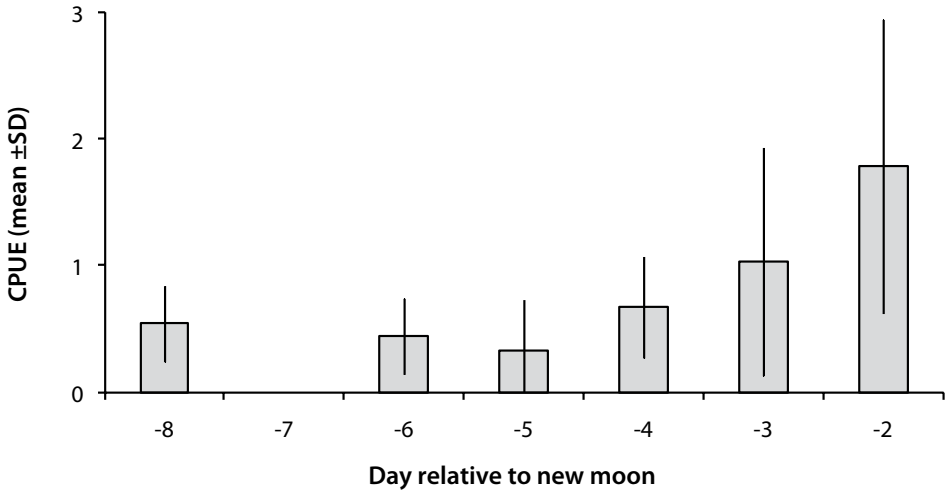

Figure 6. Daily mean (open bars) and standard deviation (SD) (lines) of catch per unit of effort (CPUE) for *P. areolatus*. Means (and SD) are derived by averaging the individual CPUEs for all fishers on the FSA during each day of monitoring. No monitoring was conducted on the day seven prior to the new moon (Day -7) in observation of local religious custom.

Discussion

Informal interviews with local Site 1 fishers by CI provided useful anecdotal information on FSA location, spawning season and species composition that allowed further investigations to be streamlined. In these interviews, *P. areolatus* were reported to form lunar monthly aggregations at Site 1 from September through January each year and to co-aggregate with *Epinephelus fuscoguttatus* at the site. This information was verified using a combination of underwater visual census and both acoustic (not presented here) and conventional tag-recapture surveys. As in previous studies, these results illustrate the utility of anecdotal information in identifying the location and timing of spawning aggregations.

The results highlight the extreme vulnerability to fishing inherent in commercially important aggregation-forming fish species. Specifically, fishing on the FSA over only six days removed what appears to have been more than two-thirds of the size of the *P. areolatus* aggregation.[4] During this same period, CPUE increased along with the number of fishers using the site. The study also provided meaningful insight into spawning aggregation site characteris-

4. Total abundance counts assume no fish left the site prior to the final day of monitoring and that all fish were present within the monitored area.

tics, dynamics, and an aggregation fishery previously unexamined in any detail.

Based on these monitoring results, Site 1 entertains at least one highly biodiverse and reproductively viable multi-species fish spawning aggregation. During monitoring, both *P. areolatus* and *E. fuscoguttatus*, along with one carangid (bigeye trevally, *Caranx sexfasciatus*) showed reproductive activity. The abundance of each of the three species was among the highest recorded in recent years at an FSA site in Indonesia.

The tag-and-recapture component of the study provided information useful for management, highlighting the vulnerability of fish to aggregation fishing. Similar findings have been shown elsewhere, with the highest level of vulnerability shown either at the aggregation or within the reproductive season (e.g. Johannes et al. 1999; Whaylen et al. 2004; Rhodes and Tupper 2008). Specifically, at Site 1, four of 40 tagged fish were recaptured within the FSA during the reproductive season, and one of those four fish was recaptured twice at the FSA. A fifth individual was recaptured twice within the spawning season, but at a locale 4 km northwest of the FSA site. It is likely that this fish was within its non-reproductive home range, assuming home range areas are similar across locales (e.g. Hutchinson and Rhodes 2010). Previous studies of aggregating groupers suggest that individuals migrate to home range areas between aggregation months (e.g. Starr et al. 2007). If true, the recapture of this individual twice in a locale away from the FSA suggests high home range site fidelity in a second regional locale.

The high percentage of recaptures at the FSA underscores the impact of aggregation fishing and provides strong support for protection of reproductive adults. Site 1 is inside an MPA that allows for multiple uses. Zoning and management plans are currently being developed for all MPAs in the Raja Ampat MPA network. Fishing is allowed but is currently controlled under *sasi*. At Site 1, fishing on FSA is only allowed by traditional owners (villagers) using specific gear and during specified periods within the spawning season. It is currently unclear what methods the village uses to determine the allowable period and level of catch. Nonetheless, the level of impact observed during the current survey clearly suggests that greater restrictions are needed, which may include a temporary or permanent no-take zone (NTZ). Using information from recent studies, an NTZ radiating 4–6 km from the "core" could protect reproductively active fish during the spawning period. Previous work on *P. areolatus* has suggested that a NTZ of 100–200 km^2 around and encompassing the aggregation site may be needed to provide full protection of spawning populations of this species, because such an area would likely incorporate migratory corridors and at least some of the home range area and habitat of the reproductive population (e.g. Rhodes and Tupper 2008; Hutchinson and Rhodes 2010). Alternatively, a catch and export ban would provide temporal protection of reproductively active fish, but at Site 1, such a ban is unlikely, given the limited economic alternatives at Site 1 and the historical involvement in the export of live reef food (and ornamental) fish.

At Site 1, commercial aggregation fishing for the LRFFT has been conducted for at least 30 years, presumably at all sites that were recently identified by CI. Whereas persistent, heavy fishing pressure in other locales has often resulted in aggregation extirpation over relatively short periods (e.g. Johannes et al. 1999; Hamilton et al. 2005; Hamilton and Matawai 2006), Site 1 appears to have been sufficiently managed to avoid FSA loss. The questions for Site 1 are: 1) What mechanisms are acting to prevent aggregation loss? and 2) What impacts have occurred to local reproductive fish populations? At Site 1, traditional management is a strong cultural component and is used to control coral reef fisheries, including aggregation fishing. One management technique is a *sasi*, or closure, which provides protection of a particular area during a particular period or periods (McLeod et al. 2009). At the FSA study site, a *sasi* prevented fishing during the 2009 September through January aggregation period, except for a 10-day period in October when fish were known to be aggregating. Similar bans exist elsewhere, such as the *bul* on several aggregations in Palau (e.g. Johannes et al. 1999) and the *tambu* in many parts of Melanesia (Hamilton et al. 2004) and Micronesia. Each of these systems seems to have had some success in controlling fishing. In Melanesia, *tambu* are often used to maintain or grow populations, with fishing only allowed during specified periods when populations appear robust. The Indonesian *sasi* are used similarly, but currently there is insufficient information to determine the rationale or effectiveness of the practice in regard to protecting local spawning aggregations.

Additional studies to investigate the history of both the LRFFT at Site 1 and the use of traditional management of marine resources would inform management options for FSA. Educational levels and per capita income at Site 1 are among the highest in Indonesia as a direct result of the income derived from participation in the LRFFT. Based on average prices paid to local fishers for *P. areolatus* in October (IDR 60,000 kg^{-1}), the October catch from the aggregation was worth USD 3,600. Communities at Site 1 clearly have a strong interest in maintaining aggregation sites and community leaders appear to have an understanding of the need for a balance between resource use and socioeconomic stability. Perhaps due to the strong implementation of the local man-

agement system, or *sasi*, Site 1 has been able to exploit FSA for more than 30 years. It is unfortunate that a similar recognition of balance has not been shown elsewhere in Indonesia with regard to the LRFFT. If the LRFFT is to continue in the country, it is clear that strong local governance systems are needed to protect FSA.

Acknowledgements

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Stakeholder workshops on managing live reef food fish fisheries in Papua New Guinea and Solomon Islands

Andrew Smith,[1] Leban Gisawa[2] and John Leqata[3]

The live reef food fish trade (LRFFT) is a high-value, reef-based fishery that is characterised by a boom-and-bust cycle with one area after another being overfished in Southeast Asia, the western Pacific and parts of the Indian Ocean. The trade is driven by the demand for live reef fish, especially in Hong Kong, Taiwan and southern China. It has resulted in the overfishing of large grouper and wrasse species, especially through targeting fish spawning aggregation sites, and has encouraged the use of destructive fishing methods, such as the use of cyanide.

The LRFFT has been identified as one of the critical issues to be addressed within the "Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security" (CTI; see http://www.cti-secretariat.net), of which Papua New Guinea (PNG) and Solomon Islands are members. The Coral Triangle Regional Plan of Action commits members to regional action and specifically agrees to the full application of the ecosystem approach to fisheries (EAF) management and to achieving effective management and a more sustainable trade in live reef fish.

Both the National Fisheries Authority (NFA) in PNG and the Ministry of Fisheries and Marine Resources (MFMR) in the Solomon Islands have completed consultative stakeholder workshops to help guide the management of the LRFFT in those countries. These workshops were facilitated by The Nature Conservancy and the World Wildlife Fund's Coral Triangle Network Initiative, with support from the United States Agency for International Development (USAID) through the US Coral Triangle Support Partnership (http://www.uscti.org). Both workshops followed a similar format, and fisheries officers from each country participated in the other's workshop to ensure complementary management across the two countries.

The "National Fisheries Authority Stakeholder Workshop on the Management of the Live Reef Food Fish Trade in Papua New Guinea" was held in Port Moresby, 7–9 July 2009. The purpose of the consultative stakeholder workshop was to review and update the existing National Live Reef Food Fish Fishery Management Plan (2003), bringing together

Participants of the National Fisheries Authority Stakeholder Workshop on the Management of the Live Reef Food Fish Trade in Papua New Guinea, 7–9 July 2009, Port Moresby (photo by Jeff Kinch).

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37 representatives of government (national, provincial and local), fishing industry, community and non-governmental organisations.

The "Ministry of Fisheries and Marine Resources Stakeholder Workshop on the Management of the Live Reef Food Fish Trade in the Solomon Islands" was held in Honiara, 4–6 August 2009. The purpose of the consultative stakeholder workshop was to review and update the draft National Management and Development Plan for the Live Reef Food Fish Fishery (2003), bringing together 49 representatives of government (national, provincial and local), fishing industry, community and non-governmental organisations.

For both workshops the review process applied the principles of EAF management and evaluated the plans against the International Standard for the Trade in Live Reef Food Fish.

The workshops employed a four-stage process to allow all participants to contribute fully. Given participants' wide range of experiences with the LRFFT — from extensive to minimal — a series of background papers and presentations was provided. Participants were broken into three "peer" groups — community, provincial and national — to identify the issues of concern based on, and relevant to, their particular groups' experiences of the LRFFT. The groups identified key issues of concern in three broad areas: ecological, socioeconomic and governance. To prioritise these issues each group was asked to undertake a simple risk assessment process, and then suggest management actions for the highest priority issues.

Using the information from the background presentations, combined with the discussion and prioritisation of the range of issues identified as being associated with the LRFFT, workshop participants then reviewed the current National Live Reef Food Fish Fishery Management Plan, in the case of the PNG workshop, and the draft National Management and Development Plan for the Live Reef Food Fish Fishery, in the case of the Solomon Islands workshop. Participants suggested specific revisions to the respective management plans and provided recommendations to the fisheries agencies concerning the broader operation and management of the live reef food fish fisheries in PNG and Solomon Islands.

PNG workshop participants recommended that:

1. NFA require any LRFFT operators to undertake training of local fishers in the best practices for capture and handling of live food fish, and to ensure that such a requirement is included in any memoranda-of-understanding (MOU) between the operator and local fishers and as a condition in the operator's license.
2. The development and management of the LRFF fishery in PNG be based on the policy of "user pays".
3. NFA require an independent service provider to conduct basic legal and financial awareness training for communities prior to their entering into a LRFF fishery MOU with operators.
4. NFA conduct the following research on the LRFF fishery as a matter of priority:
   a. stock assessments of target species, and impact assessments of non-target species and habitat;
   b. socioeconomic issues, especially:
      i. cost-benefit analysis
      ii. rate of return to villagers
      iii. potential income streams
      iv. benefit-sharing opportunities
   c. initiate a detailed independent viability assessment of the LRFF fishery in PNG, focusing on:
      i. economic viability
      ii. social viability
      iii. biological viability
   d. initiate a study to identify possible alternative income generation options to the LRFFT, including assessment of "live fish" versus "fresh/chilled/frozen fish" market options.
5. NFA develop and implement a community-based fishery management (CBFM) programme that incorporates fisheries management approaches and training that are appropriate to the management of local fisheries, including the LRFF fishery.
6. NFA modify the existing funding mechanisms to allow improved access to funds to develop local-level fisheries.
7. NFA require all MOUs developed between landowners and LRFFT companies to be reviewed by provincial authorities prior to signing.

Solomon Islands workshop participants recommended that:

1. MFMR reduce the complexity of the current draft LRFF fishery management plan, and review and incorporate the recommendations of the workshop. The management plan should be concise and easy to understand and implement.
2. MFMR conduct a review of the effectiveness of the LRFF fishery management plan one year after it has been adopted and implemented.
3. MFMR, as a matter of priority, seek a legal person to:
   a. undertake a national review of the status of provincial fisheries ordinances, including

reference to the LRFF fishery and the current revision of the Fisheries Act.

b. review, revise and make clear the consultative procedures for licensing between national, provincial and local authorities in respect of the LRFF fishery before issuing any licenses.

4. MFMR incorporate the use of fees and/or bonds as a part of the licensing process to address impacts and grievances resulting from the LRFF fishery, in particular:
   a. restoration and/or compensation for impacts due to the use of destructive fishing methods;
   b. exploitation of fishers through inappropriate or unfair agreements;
   c. cultural and social impacts, such as "one-year marriages";
   d. other impacts from the LRFFT operations.
5. MFMR actively seek financial and technical resources and support for capacity building, training and awareness programmes in support of the LRFF fishery. MFMR should:
   a. maximise the use of local expertise in fish spawning aggregation (FSA) monitoring to build MFMR, Provincial and community capacity to monitor FSA and target species throughout the country;
   b. seek assistance for training for enforcement officers and vessel observers;
   c. request or propose to the Solomon Islands' National CTI Coordinating Committee the allocation of resources and technical assistance for completing and implementing the LRFF fishery management plan;
   d. consider funding activities from the recurrent budget.
6. MFMR hold a stakeholder workshop (including provincial fisheries officers and administrators) immediately after the adoption of the LRFF fishery management plan as a part of the implementation process.
7. MFMR establish a multi-stakeholder technical advisory taskforce to consider and advise MFMR's Director on LRFF fishery issues.
8. MFMR provide Renbel Province (and other provinces that are currently being approached by LRFFT operators) with appropriate assistance and information on the LRFF fishery as a matter of urgency.
9. As a *high priority*, MFMR contract a detailed *independent* viability assessment prior to any potential new LRFF operations commencing. The assessment should consider:
   a. biological viability (target and non-target species assessments)
   b. economic viability
   c. social viability
10. MFMR coordinate, fund and build capacity for FSA and target species surveys and monitoring, building on the existing expertise in country (also see Recommendation 5).
11. MFMR develop and maintain a database and relevant records related to the LRFFT, and include data and information acquisition as a key license condition.

The results of the two workshops are being used by PNG's NFA and Solomon Islands' MFMR in the revision of their respective management plans for the live reef food fish fishery.

Participants in the Ministry of Fisheries and Marine Resources Stakeholder Workshop on the Management of the Live Reef Food Fish Trade in the Solomon Islands, 4-6 August 2009, Honiara (photo by Andrew Smith).

A regional Pacific Islands workshop on monitoring and managing reef fish spawning aggregations for sustainability: A first attempt

Being Yeeting,[1] Yvonne Sadovy,[2] Aisake Batibasaga[3] and Joeli Veitayaki[4]

From 7 to 10 October 2009, the Secretariat of the Pacific Community (SPC) and the Society for the Conservation of Reef Fish Aggregations (SCRFA) jointly organised a sub-regional training workshop at the University of the South Pacific campus in Suva, Fiji. The workshop was held in response to a request for assistance from five Pacific Island country fisheries departments that wanted to start monitoring and managing their reef fish spawning aggregations. Their desire for assistance stemmed in part from their concerns with live reef food fish trade operations, which were specifically targeting spawning aggregations of groupers and related species.

Reef fish spawning aggregations (FSAs) are common in the Pacific region and are well known to many local communities. Many reef fish species move away from their home reefs at particular times and migrate long distances to a specific part of the reef to form large aggregations for spawning. During these periods, aggregations are very good fishing grounds that, in the past, supported low levels of subsistence fishing and a welcome seasonal fishing activity. However, with growing human populations and increasing demand for food and income earning opportunities, as well as improved fishing technologies, these FSAs are increasingly being found and targeted. This threatens fish species with overfishing and compromises fisheries.

Within the last decade, FSAs have been targeted for live fish as part of the live reef food fish trade. Additionally, the establishment of ice plants and the development of deep reef slope fishing have facilitated fishing on FSAs in remote areas. Because these aggregations support important nearshore fisheries that are critical for people's livelihoods, establishing effective management measures for FSAs is urgently needed in the Pacific region. Management, however, requires a good understanding of these spawning aggregations in terms of their periods of formation and, in some cases, their location, by species. Unfortunately, the fisheries research skills needed to address this challenge are largely lacking in Pacific Island countries. Thus, there is a need to develop training programme that address gaps in knowledge and skills for effective FSA management. Although legislation that addresses the conservation and protection of spawning aggregations across Fiji is currently being considered in that country, monitoring will still be needed for adaptive management.

Fisheries officers from six Pacific Island countries participating in the SPC/SCRFA spawning aggregation workshop held at the University of the South Pacific campus in Suva, Fiji.

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The purpose of the workshop was to address this need for training. The workshop was designed to give participants an understanding of the major issues in coastal fisheries, and within that general context, to highlight the importance of FSAs, which are formed by many of the most valuable reef fish species. Training was provided through a series of lectures, hands-on exercises, discussions and documentary films. The importance and relevance of fisheries monitoring of FSAs was discussed. Novel methodologies for simply, cheaply and efficiently surveying reef fishes in aggregations, and estimating annual catches, were presented. To highlight the challenges of monitoring FSAs, hands-on experience gained in Palau and Fiji by invited keynote speakers was shared with workshop participants.

SPC team filming workshop session on teaching how to interview fishermen (photo by Yvonne Sadovy).

The importance of good science as a basis for developing appropriate management was highlighted in the workshop. Simple scientific sampling protocols, such as how to decide on minimum and representative sample sizes (e.g. how many fish to measure in markets to get a representation of species diversity) and how to simply and effectively study reproductive biology (spawning season) of key target species were introduced and later practiced through sampling at the local fish market and in a practical laboratory session working with fish specimens. This involved recording fish lengths, getting samples of gonads, and identifying species. Other relevant issues, such as the importance of size-at-maturity versus size demanded by the market, were also discussed. Trial fisher interviews were organised and conducted in a nearby fishing village (Kiuva) to provide training on how to collect biological data and characterise knowledge of spawning aggregations. Methods for handling and storing data, as well as simple analyses, were also conducted and discussed.

In total, 22 fisheries officers participated in the workshop — 11 from countries outside Fiji, including Cook Islands, Kiribati, Palau, Samoa, Tuvalu and Vanuatu. Local participants were from the Fiji Fisheries Department and from Fiji-based marine conservation and management non-governmental organisations. Feedback from participants was generally very positive, with all participants finding the workshop useful and relevant to their current fisheries research work in their respective countries. One of the key expectations of participants was that they would gain basic practical and hands-on skills in how to undertake research (collect data sets) and manage or protect reef fish spawning aggregations. These basic skills could then be adapted and applied to their own fisheries or monitoring sites.

The workshop was the first of its kind on such an important fisheries issue in the Pacific region. It provides the first — and very useful — opportunity to improve, and possibly expand, the design and delivery of such training if further needs arise. Participants were confident that they had gained very useful data collection and sampling skills and would be able to pass those skills on to other people within their own institutions and to communities that need to manage and protect their own spawning aggregations. One of the outputs from the workshop was the identification of outreach and educational materials and simple guidelines for conducting monitoring and long-term sampling. A compilation of relevant reference materials and educational examples (pamphlets, posters, etc.) was provided to each participant on CD.

SPC and SCRFA will continue to assist workshop participants as needed and as their own FSA-related research and management programmes develop. Workshop participants will serve as a regional network within which issues and experiences can be discussed.

Workshop conveners believe it is important to assist participants in engaging their institutions and countries. They should understand the threats that fishing on FSAs present to the sustainability of their reef fish stocks and be convinced that the time to act to monitor and manage these events is now. Pacific Island countries will require policy advice and follow-up meetings, preferably at the national level. SPC may undertake this work.

Funding for the workshop was provided by SPC's Coral Reef Initiatives for the South Pacific, a SCRFA grant from the David and Lucile Packard Foundation, and an SPC grant from the MacArthur Foundation.

Humphead wrasse and illegal, unreported and unregulated fishing

Yvonne Sadovy[1]

One of the biggest of all reef fishes is the humphead, Napoleon or Maori wrasse (*Cheilinus undulatus)*, which is widely distributed on coral reefs of the Indo-Pacific region. The species is listed as threatened on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species of Flora and Fauna (www.iucnredlist.org), and was the first tropical food fish listed on the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Appendix II following the 13th meeting of the Conference of the Parties, in October 2004. This listing, which is binding for all signatories (or countries), of which there are currently 175, requires that any animals traded internationally are part of a sustainable management plan. Appendix II is a powerful means of moving towards sustainable resource use for species that are vulnerable and receive little other management intervention. It is also a test case for our ability to move to a more sustainable mindset for reef fish fisheries, in general. It's been five years since the humphead wrasse was listed on CITES, and this is a good time to look at progress that has been made and identify challenges that remain.

The engagement of CITES in regulating international fisheries trade is a welcome trend and clearly demonstrates growing recognition of CITES as a key tool to complement other conservation and management measures, at national and international levels, for commercially important marine resources. Humphead wrasse presents a good model of the opportunities and challenges for using CITES to regulate the use of marine resources. Progress has been made with regard to humphead wrasse. The structure that the CITES listing has brought to its trade is proving beneficial. However, continuing vigilance and review of the need to fully implement the CITES listing will help to ensure the sustainable use of humphead wrasse for the long term.

Humphead wrasse is one of the highest-valued of all reef fishes in the live reef food fish trade. It is traded internationally by both sea and air. Primary exporters are in Southeast Asia, notably Indonesia, Malaysia, and the Philippines. Papua New Guinea is also an important exporter. Smaller volumes were once exported from other countries in the western Pacific and Indian Ocean regions. The primary importer of humphead wrasse is the People's Republic of China (China), specifically the southern Province of Guangdong and the Hong Kong Special Administrative Region (Hong Kong).

Since the Appendix II listing came into force in January 2005, several positive steps have been taken for better management of local and international humphead wrasse trade:

- The Food and Agriculture Organization of the United Nations (FAO), the Groupers and Wrasses Specialist Group of the IUCN Species Survival Commission (SSC), and the Government of Indonesia have together produced a stock assessment methodology that enables science-based, non-detrimental findings, which are a prerequisite for Appendix II-listed species to be traded internationally. The field work and fishery modeling work used to develop the model were variously funded or otherwise supported by the CITES Secretariat, FAO, IUCN, the US National Oceanic and Atmospheric Administration, University of Hong Kong, and the Government of Indonesia.
- The Indonesian CITES Scientific Authority has established an export quota of 8,000 humphead wrasse per year, and Malaysia will have export quotas of zero as of 2010 (it is allowing currently held stock to be sold).
- Hong Kong began implementing the Appendix II listing in December 2006 and Malaysia did the same in February 2007. The CITES Management Authority of Hong Kong now checks imports and re-exports, and coordinates verification of CITES permits with Malaysia and Indonesia.

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A mature male humphead wrasse in Palau
(photo by Patrick L. Colin).

- Several workshops have been held to discuss national and international action to facilitate CITES-compliant trade, enforcement and implementation challenges, and capacity-building for customs officials, including species identification.
- Regulations have been tightened at the national level in Palau and in Fiji.

A number of challenges remain before sustainable international trade can be achieved. The most pressing is illegal, unreported and unregulated (IUU) trade, which occurs at both local and international levels. As examples:

- *There is ongoing poaching by foreign vessels and illegal international trade by sea*. Illegal exports are occurring in Malaysia, Indonesia, the Philippines, and possibly elsewhere. In one high-profile case, the *Hoi Wan* (a Chinese vessel registered in Hong Kong) was apprehended in Tubbataha Marine Park in the Philippines' territorial waters, holding 1,200 live humphead wrasse. Export of live humphead wrasse is illegal in the Philippines, and the vessel had no paperwork authorising fishing of any kind. In a separate case, Taiwanese-flagged ships were reported to have shipped humphead wrasse illegally out of Tawi Tawi, southern Philippines. Also, there appears to be illegal trade in this species from the Philippines to Malaysia.
- *Unmonitored trade out of Singapore and into mainland China undermines enforcement*. According to Hong Kong's customs records, 12 and 6 tonnes of humphead wrasse were imported from Singapore by air in 2005 and 2006, respectively. However, officials of the Wildlife Regulatory Branch, Agri-Food and Veterinary Authority of Singapore indicate that they did not issue any permits for the export of humphead wrasse to Hong Kong in 2005 or 2006, and none of the exports were reported to the CITES Secretariat. Singapore does not have viable populations of humphead wrasse in its waters, so the fish must have entered Singapore from another country and been re-exported. There have been discrepancies in records of trade in humphead wrasse between those of China and Hong Kong. In 2007, for example, the CITES Management Authority of Hong Kong recorded the import of more than 21,000 fish, of which 3,453 were re-exported to China under 45 re-export licences. However, the CITES Management Authority in China's Guangdong provincial office received no applications to import the species and there are no records of seizures of humphead wrasse in Guangdong, which is known to be a major consuming region of humphead wrasse in China.
- *Humphead wrasse sales continue at the national level, despite regulations to protect the species and to ban destructive fishing practices*. In Fiji, for example, the species continues to be sold occasionally in local fish markets and can be obtained by special order at a number of restaurants in Suva, despite national protection for the species. In Indonesia, sodium cyanide continues to be used to catch the species, and undersize (smaller than 1 kg) and oversize (greater than 3 kg) fish continue to be exported illegally.

The biggest threat to the sustainable use of humphead wrasse and one that substantially undermines the efforts of countries to move towards the effective management of the species is IUU trade. Possible measures being discussed to address this problem are:

- Limit international trade to air and land — much of the international trade in humphead wrasse is already conducted by air;
- If shipments by sea are permitted, these should exit and enter through a small number of designated ports and only at times that are specified to management authorities in advance;
- Increase monitoring and verification of trade records by both exporting and importing countries and increase inspections of live fish exports;
- Increase awareness among government officials of the CITES listing for humphead wrasse, including improving the capacity among law enforcement officers to identify the species; and
- Step up enforcement at local markets and other food outlets, including restaurants, and raise awareness of the CITES listing among the general public.

The implications of failing to effectively implement the Appendix II listing under CITES via national laws are not only that the value of humphead wrasse will be lost to fishers and traders, but also that the climate in which IUU trade is allowed to continue will hamper efforts to manage other species and resources. This species happens to be among the more vulnerable of reef fishes. If this species and its fishery cannot be preserved, then the next most vulnerable species will go the same way, and so on. In the long term, lack of attention to reef fishery management and rampant IUU trade will severely undermine the fisheries themselves and the livelihoods and food they supply. The humphead wrasse is our test case: it is an important trial of CITES Appendix II in supporting and encouraging countries to use sustainable international trade practices. The CITES listing brings international "muscle" to enforcement and funding for assessments as well as international attention to the issue. Currently, a project on illegal trade in humphead wrasse in Southeast Asia, funded by the US government, is being carried out in collaboration with the Trade Records Analysis of Flora and Fauna in Commerce (TRAFFIC) East Asia and World Wildlife Fund in the Philippines. A better understanding of the IUU trade will greatly improve enforcement ability and help to better determine how to improve compliance with the CITES listing and move towards more sustainable international trade.

Juvenile humphead wrasse on sale illegally in southern China (photo by Alex Hofford).

Sink or swim: Hong Kong can take a lead in Asia by supporting a certification scheme to save world fish stocks[1]

Shelley Clarke[2]

It is now widely accepted that the world's fish stocks are under threat from the combined effects of overfishing, pollution and even climate change. These problems may seem remote and intractable, but for all of us who eat seafood, they are issues with which we engage, knowingly or not, each time we find fish on our plates.

Fish are arguably the most migratory, least visible and hardest-to-police food supplies. For many coastal states with rich resources but limited financial, governance and scientific capacities, fisheries management is still in its infancy. At the other end of the spectrum are regional fisheries management organisations responsible for managing some of the world's most valuable commercial species, including tuna, swordfish and cod. But even these organisations have not been able to prevent severe depletions from occurring.

One reason for this is poor data. As anyone who has read the book or seen the movie *The Perfect Storm* knows, there is an inherent incentive for fishermen to be as secretive as possible about where, when and how they catch fish. This can lead to huge biases as fishermen under-record catches of target species to avoid exceeding regulatory limits.

On top of this, illegal or pirate fishing operations, estimated to be as high as 19% of the total catch, provide no records whatsoever. Assumptions necessary to mathematically model changes in fish populations compound these data-quality issues. Not surprisingly, the results of such models are often so uncertain that, where some scientists see a stock in decline, others see no need to reduce fishing efforts. Even when all scientists agree, calls for catch reductions often go unheeded because of the political fallout of cutting quotas.

Hong Kong has a poor record of fisheries management. Despite receiving strong recommendations in 1998 to start licensing fishing vessels, the Hong Kong government has yet to do so. Its fisheries management scheme remains one of Asia's most primitive. Though clearly not a major fishing power, Hong Kong's global footprint on fish stocks is enormous for its size. The city has for years profited handsomely from trade in shark fin, live reef fishes and abalone, several species of which are now listed by the Convention on International Trade in Endangered Species. The Hong Kong government claims that managing these resources is the responsibility of the producing countries. Yet many of them have weak or nonexistent management capacities.

Hong Kong should realise that effective trade monitoring here may be the only way to sustain these species. But, in the case of live reef fish, all species except humphead wrasse usually arrive by boat from Southeast Asia; they are exempted from customs reporting and declared only on a voluntary basis.

Meanwhile, exciting developments are occurring on the demand side of fisheries management. One of these is the partnership between scientists, fishermen, businesses and consumers embodied in the independent, non-profit Marine Stewardship Council (MSC). It runs a global eco-labeling scheme for wild-caught fish that meet strict sustainability standards. Worldwide, 26 species comprising 7% of the global edible seafood catch are either certified or currently under MSC assessment.

A few years ago Wal-Mart, the world's largest retailer, announced that in the following three to five years it would acquire all its fresh and frozen products from MSC-certified fisheries. Initially introduced in Europe and the United States, the MSC recently opened an office in Japan and launched several products in Japan and Hong Kong.

The beauty of the MSC model is that it shortcuts the political stalemates that stymie most fisheries management systems. Once a fishery is judged to meet MSC standards, consumers — including major retailers and the catering industry — can decide to support it by buying its products.

This is not altruism. The business advantage in avoiding threats to the supply chain by acquiring sustainable seafood should make as much sense in the Asian market as it does in Europe and the United States.

Hong Kong needs to recognise its role in the current problems facing fisheries, as well as its role in the solution. The MSC provides local business and consumer communities with a chance to directly support the sound management of marine resources, through their purchasing choices, and to lead Asia by example.

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International Coral Reef Initiative meeting discusses fish spawning aggregations

Yvonne Sadovy[1]

The most recent General Meeting of the International Coral Reef Initiative (ICRI) was held in Monaco, 12–15 January 2010. One of the sessions, organised by Éric Clua of Coral Reef Initiatives for the Pacific (CRISP), was on fisheries. Topics covered included climate change and its potential impact on coral reef-associated fisheries (Philip Munday, James Cook University), sharks as vulnerable species (Éric Clua), and a summary of the live reef food fish trade workshop that took place recently in Hong Kong (Kelly Milton, United States government). The vulnerability of reef fish spawning aggregations to unmanaged fishing and the problem of threatened species were addressed by Yvonne Sadovy (Society for the Conservation of Reef Fish Aggregations – SCRFA – and the University of Hong Kong).

The need for a greater focus on managing coral reef-associated fisheries was highlighted and an ICRI *Ad Hoc* Committee on Fisheries was established at the meeting. While such fisheries are immensely important for livelihoods and food security around the tropics, they receive very little effective management attention from either governments or non-governmental organisations, and few are covered by regional fishery management authorities.

One aspect of coral reef-associated fisheries that is particularly in need of management attention is their spawning aggregations. These are formed by many commercial fishes, some of them also naturally vulnerable to fishing. Despite their importance, they are rarely managed effectively, risking loss of the fish populations that form them. For information and news on fish spawning aggregations and their management, please see SCRFA newsletters, which are available online at: http://www.scrfa.org/index.php/education-and-outreach/newsletter.html. Articles for the next newsletter are welcome. Please contact me at yjsadovy@hku.hk.

Coral Triangle Initiative tackles live reef fish trade reform

Michael Abbey[2] *and Geoffrey Muldoon*[3]

The Coral Triangle covers 1.6% of the planet's oceanic area but is home to about 76% of all known coral species, 37% of all known coral reef fish species, 33% of the world's coral reefs, the greatest extent of mangrove forests in the world, and spawning and juvenile growth areas for the world's largest tuna fishery. These resources directly support the livelihoods of more than 120 million people. The leaders of the Coral Triangle countries — Indonesia, Malaysia, Papua New Guinea, the Philippines, Solomon Islands and Timor Leste — (or "CT6") signed a joint declaration known as the Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI) in May 2009 to protect these resources.

The US government, with funding from the US Agency for International Development (USAID) and the Department of State, supports the CTI through the US Coral Triangle Initiative Support Program (USCTI). This program is jointly implemented by the US National Oceanic and Atmospheric Administration (NOAA), the Coral Triangle Support Partnership (CTSP) – a consortium led by the World Wildlife Fund (WWF), with Conservation International (CI) and The Nature Conservancy – and the "Program Integrator" (PI), an institutional contractor (ARD, a TetraTech Company) supporting coordination and communication across all US government partners.

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A key issue in the Coral Triangle is the live reef food fish trade (LRFFT), regionally worth nearly 1 billion US dollars annually and in need of urgent reform. The main Coral Triangle LRFFT export countries are the Philippines, Indonesia and Malaysia, with the main export markets being Singapore, Hong Kong and mainland China. Export is potentially moving east through the Coral Triangle into Papua New Guinea and Solomon Islands as LRFF stocks are depleted in the areas currently being fished.

NOAA, CTSP, the PI and WWF's Coral Triangle Network Initiative (CTNI) are combining efforts to reform this industry under the CTI goal of applying ecosystem approaches to fishery management (EAFM). With USCTI and US State Department funding, WWF and CI held a workshop in Hong Kong in November 2009. The workshop, entitled "Towards a More Sustainable Live Reef Food Fish Trade in the Coral Triangle", provided a forum to discuss implications of the LRFFT for livelihoods, food security and the potential to devastate the region's coral reef and marine ecosystems. Because of the wide range of participants, the workshop provided an opportunity to move beyond previous discussions on these issues.

The workshop included participants from source and demand countries, government and industry representatives from Hong Kong, Indonesia, Malaysia, Papua New Guinea and the Philippines, and, the US Department of State and NOAA Fisheries Service, WWF, CI and academic institutions. Again, this was the first time that such a wide range of stakeholders in the LRFFT had convened. Participants identified gaps in current information and outlined priorities for future action. Recommendations focused on encouraging national and regional efforts to combat declining reef fish stocks, preserving economic and job security while emphasizing government-to-government collaboration, science for management, enforcement, and identification of critical biophysical policies (e.g. quotas, size limits and controls on fishing techniques).

Representatives of the CT6, NOAA Fisheries Service, WWF's CTNI, CT and other CTI partners will hold a follow-on regional workshop in September 2010 in Sabah, Malaysia, with three objectives: 1) develop a common understanding and endorsement of EAFM to guide LRFFT reform; 2) develop an agreement for a coordinated CTI regional position on LRFFT reform; and 3) achieve commitment for the instatement of a regional forum to facilitate and coordinate future LRFFT reform in the Coral Triangle. Results of this joint CT6-USCTI supported workshop will be presented at an Asia-Pacific Economic Cooperation (APEC) Fisheries Working Group meeting on the LRFFT in October 2010 entitled "Market-based Improvements in Live Reef Food Fish Trade". The working group meeting is supported by APEC and WWF's CTNI, and sponsored by the government of Indonesia with co-sponsorship from the governments of Papua New Guinea, the Philippines and the USA.

Over the next few years, efforts will revolve around four stages that organize USCTI and WWF-CTNI efforts into measurable and comparative units: Planning (ongoing), Learning, Applying (best management practices/capacity building) and Adapting (country-led leadership and training). The program emphasizes regional cooperation at policy and operational levels, short-term bridging of current capacity gaps and developing capacity within the CT6 to effectively manage their LRFF fisheries for long-term job and economic security.

NOAA/USAID-Coral Triangle Initiative partnership in the live reef food fish project

Robert E. Schroeder[1]

The Coral Triangle region in Southeast Asia includes about 6 million km^2 of nearshore waters and reefs. The Coral Triangle Initiative (CTI) was launched in December 2007 as a multilateral partnership of six countries (CT6): Indonesia, Malaysia, Papua New Guinea, Philippines, Solomon Islands and Timor-Leste (or East Timor), to help conserve coral reefs and food security in the region. In May 2009, a CTI Regional Action Plan was endorsed by the six heads of State at a CTI Summit.

The live reef food fish trade (LRFFT), from harvesting to export, occurs primarily in the CTI region, with retail markets mainly in Hong Kong and other major urban centres in China. The trade began in the mid-1970s and spread first through Southeast Asia, then into the Indo-West Pacific. The LRFFT is a multi-million dollar trade in the Asia-Pacific area with a total estimated retail value of USD 810 million in 2002.[2] Major concerns with the industry include: 1) life-history characteristics of target fish that make them vulnerable to fishing; 2) depletion of fish stocks, especially predators, and reduction of food available to coastal residents; 3) increasing demand for and scarcity of reef fish; 4) destabilization of the coral reef ecosystem (e.g. loss of top predator control); and 5) reduction of biodiversity, which helps maintain resilience and integrity of the reef ecosystem.

The US Coral Triangle Initiative (US-CTI) Support Program was officially launched in February 2010, with finalization of a consolidated work plan. This five-year program is being implemented by the United States Agency for International Development (USAID) through the US National Oceanic and Atmospheric Administration (NOAA), and a consortium of non-governmental organizations

The Coral Triangle region in Southeast Asia (map produced by Charles Huang, Conservation Science Program, WWF-US through the Coral Triangle Support Partnership).

1. NOAA Fisheries Service, Pacific Islands Region, Habitat Conservation Division. Email: Robert.Schroeder@noaa.gov
2. Sadovy J.Y., Donaldson T.J., Graham T.R., McGilvray F., Muldoon G.J., Philips M.J., Rimmer M.A., Smith A. and Yeeting B. 2003. While stocks last: The live reef food fish trade. Manila: Asia Development Bank. 147 p.

(NGOs) (e.g. World Wildlife Fund, The Nature Conservancy, Conservation International), under the Coral Triangle Support Partnership (CTSP). To address the concerns, ecosystem-based fishery management (EBFM) is proposed as a major CTI regional goal. EBFM aims to conserve and sustainably manage target species and maintain a balanced and productive ecosystem by reducing impacts on non-target species (bycatch), habitats, ecosystem functions, and other environmental relationships, including the use of adaptive management approaches. The LRFFT is a main component of the major US-CTI project on EBFM. Other major US-CTI projects include enforcement and/or mitigation of IUU fishing, marine protected areas (MPAs), and assessing the impacts of climate change.

Live reef fish, mostly grouper, ready for order and consumption in a tank at a Hong Kong restaurant (photo by Stanley Shea).

The humphead wrasse (*Cheilinus undulatus*), a prized live reef food fish (photo by Robert Schroeder).

The NOAA/USAID-CTI partnership, a component of the US-CTI Support Program, includes leaders and local fishery agency staff from CT6 nations, NGOs, and a support team of technical experts from NOAA's National Marine Fisheries Service, University of Hong Kong, WorldFish Center, and Australian institutions. The NOAA/USAID-CTI program will implement regional exchange activities to achieve effective management and sustainable trade in live reef fish through a five-step approach: 1) regional partnership building; 2) collaboration and technical assistance (e.g. government-to-government support and technical assistance); 3) scientific and management/policy advice; 4) training and capacity building; and 5) assistance with alternative approaches (e.g. expand full-cycle mariculture of LRFF species, such as groupers). NOAA's target audience for capacity building is the CT6 governments, while CTSP works with local people and NGOs. Results accomplished to date include development of regional work plans for training in EBFM, proposing priority projects for specific sites, and assistance with preparing CT6 nations for international meetings. Activities planned for the coming year include a Regional Exchange Workshop, to be held in Sabah, Malaysia in late 2010, where CT6 nations will develop a collaborative work program and a common position paper, participation at an Asia-Pacific Economic Cooperation fisheries workshop, and initiation of a CTI-LRFFT roundtable.

While this NOAA/USAID-CTI partnership is expected to enhance fishery biology and management in an ecosystem context, locally supported and effective enforcement of necessary regulations remains critical to the success of improving the sustainability and equitable economics of the LRFFT in the Coral Triangle region.

News and events

Fishermen and traders pledge to limit Palawan grouper catches

At the Live Reef Fish Summit held at Palawan State University 23 Feb 2009, agreement was reached to reduce the Palawan annual live grouper harvest by 25%, to no more than 516 tonnes, in an effort to arrest the decline in the resource. The summit was organised by the Palawan Council for Sustainable Development, the Philippines Bureau of Fisheries and Aquatic Resources, the Palauan Provincial Government, and WWF. See this 9 March 2009 story posted by WWF: http://wwf.panda.org/?158261/Endangered-groupers-to-stay-off-dining-plates-under-Philippines-deal.

Museum selling clownfish

A science museum at Tokai University, which has bred 11 species of clownfish originating from the coral reefs of Australia, is selling the cultured fish to discourage people from capturing them in the wild. See the 1 April 2009 story in *UPI.com*: http://www.upi.com/Top_News/2009/04/01/Aquarium-selling-Nemo-fish/UPI-90581238597507/).

Oriental sweetlips bred for first time

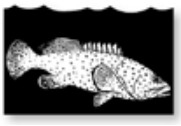
According to *Taiwan News*, a research team at Taiwan's National Museum of Marine Biology and Aquarium Fish Reproduction and Larviculture Laboratory has succeeded in breeding the Oriental sweetlips, *Plectorhinchus vittatus*, a world first (see the 11 August 2009 story at: http://www.etaiwannews.com/etn/news_content.php?id=1016675&lang=eng_news).

Typhoon damages Taiwan's grouper farms

Typhoon Morakot hit Taiwan in August 2009. According to a 22 August 2009 story in *Taiwan News*, the typhoon damaged more than 90% of the 1,500 hectares of grouper culture ponds in Taiwan, production from which is worth USD 120 million, representing 58 percent of global production (see: http://www.etaiwannews.com/etn/news_content.php?id=1038468&lang=eng_news&cate_img=35.jpg&cate_rss=news_Business).

Taiwan's grouper aquaculture expected to benefit from new cross-strait trade pact

Under a new economic cooperation framework agreement, Taiwan's cultured groupers will be given zero-tariff treatment, which is expected to boost trade and production and help Taiwan's growers recover from the losses caused by Typhoon Morakot in August 2009. See the 28 June 2010 story in the *Focus Taiwan News Channel* (http://focustaiwan.tw/ShowNews/WebNews_Detail.aspx?Type=aECO&ID=201006280033).



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