



Secretariat of the Pacific Community

LIVE REEF FISH

The live reef fish export and aquarium trade

Number 15 – December 2005

I N F O R M A T I O N B U L L E T I N



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Production: Information Section, Marine Resources Division, SPC, B.P. D5, 98848 Noumea Cedex, New Caledonia. [Fax: +687 263818; cfpinfo@spc.int; <http://www.spc.int/coastfish>]. Produced with financial assistance from Australia, France and New Zealand.

From the Editor

If there is a theme in this issue of the bulletin, it is making live reef fish fisheries in the Asia-Pacific region sustainable. Admittedly, that's a broad theme. In fact, the five articles cover a diverse range of topics, from the challenges of achieving compliance with destructive fishing laws, to the ability of various taxa of reef fish to survive in aquarium conditions.

Using some sobering law enforcement statistics from the Calamianes Group of Islands in the Philippines, Dante Dalabajan reminds us that the best conceived policies and laws mean nothing if they cannot be enforced. The Calamianes have active fisheries for live food fish and ornamental fish, and there are a variety of national and local laws designed to prevent cyanide fishing. But Dalabajan finds that in practice the legal system as a whole provides little deterrent, and cyanide fishing is consequently common. He proposes a number of changes to the law enforcement system, including mobilising citizens' groups, in order to "fix the broken net."

Thierry Mulochau and Patrick Durville take advantage of five years of routine monitoring of the comings and goings of reef fish at a public aquarium on Reunion Island to measure the survival rates of fish within 43 families, thus improving our understanding of which reef fish species might be more "suited for life" in aquaria.

The trade in ornamental reef fish has been the subject of efforts by the Marine Aquarium Council (MAC) to implement a certification and labelling scheme for a number of years, as regularly reported in this bulletin. In a study independent of MAC, Liliana Alencastro et al. examine the degree to which an eco-label on ornamental fish might be important to hobbyists — that is, whether hobbyists are willing to pay a premium for such a label.

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The results give an indication of how well a certification program such as the MAC scheme is likely to work, or alternatively, an indication of how much outreach to consumers will be needed to make it work.

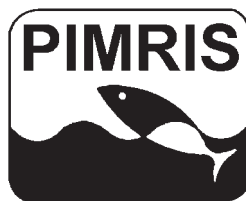
The trade in live reef food fish has taken the first tentative step towards a certification scheme, with the recent release of an “International Standard for the Trade in Live Reef Food Fish” (see issues 11 and 12 of this bulletin for reports on the development of the Standard). Geoffrey Muldoon and Peter Scott review the standard, examine the prospects for achieving compliance with the standard via a certification program, and outline a plan for implementing such a program.

The final article in this bulletin, by Brian Johnston and Being Yeeting, describes the proceedings of a recent workshop held as part of a three-year study of the economics and marketing of live reef food fish. The purpose of the project is to assist producer countries in securing adequate returns from their fisheries and to ensure that supply is sustainable in the long term, from both wild-caught and cultured sources.

Tom Graham



PIMRIS is a joint project of 5 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 South Pacific Forum Fisheries Agency (FFA), the University of the South Pacific (USP), the South Pacific Applied Geoscience Commission (SOPAC), and the South 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



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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.



Fixing the broken net: Improving enforcement of laws regulating cyanide fishing in the Calamianes Group of Islands, Philippines

Dante Dalabajan¹

"... in any society, many people will not comply with the law unless there are consequences of noncompliance."
(Wasserman 1994:31)

Abstract

Recent studies indicate a progressive degradation of the marine habitat in the Calamianes Group of Islands, Philippines, which is one of the most important sources of live food and aquarium fish in the country. A number of empirical studies have shown that the proximate cause of the degradation is the use of destructive fishing techniques, chiefly the use of sodium cyanide.

In theory, law enforcement is an effective means of curbing destructive and illegal fishing practices and can thereby help to regenerate degraded marine habitats. If effective, law enforcement mechanisms deter, persuade or punish violators, correct non-compliant conditions and create a norm of expected behavior (Eichbaum 1992). This is not occurring in the Calamianes. In the last four years, there has been no case in which a cyanide fisher was convicted. Clearly, changes are needed in order to make it prohibitively costly for fishers to conduct destructive fishing practices.

This study examines the socioeconomic context and the legal and political milieu in which the problems of cyanide fishing take root. Specifically, the study examines the infrastructure and logistical problems of detecting cyanide fishing activities and arresting violators and discusses the bureaucratic, procedural and other barriers to the prosecution and imposition of penalties. It concludes by proposing a law enforcement structure that would put the police agencies and the local government units in a better position to address the issue of cyanide fishing.

Introduction

The Calamianes Group of Islands is in the northern part of Palawan in the Philippines and comprises the municipalities of Coron, Busuanga, Culion and Linapacan (Fig. 1). The group's biophysical characteristics make it one of the most important sources of live fish in Palawan province, accounting for 55% of live fish exported from the country. Recent studies, however, point to a progressive decline in fisheries production in this area. The formerly large stocks of commercial species that sustained fisheries in the area are now in a severely depleted state (Werner and Allen 2000). Ingles (2000) estimated that coastal fisheries production in 1997 was only 50% of the 1991 level. Further declines are anticipated unless drastic action is taken.

A recent study by the World Wildlife Fund attributed the worsening condition of fishing

grounds in the Calamianes to serious overfishing, as evidenced by biological and economic indicators. For example, fishers go farther out and spend more time at sea than they did previously, and there has been a diminishing rate of return on capital and labour (Padilla et al. 2003).

The brisk market demand for live food and aquarium fish and the lack of effective law enforcement have fuelled the cyanide-fishing business (Barber and Pratt 1998). The present rate of extraction and consequent depletion of fish stocks, however, has driven the fishing industry, and the live fish trade in particular, to the brink of collapse. Padilla et al. (2003) argue that if fishers in the area choose to continue fishing, it is not because of the profitability of fishing so much as the absence of non-fishing alternatives. Given this stark reality, decision-makers cannot continue to turn a blind eye to the disastrous consequences of cyanide fishing.

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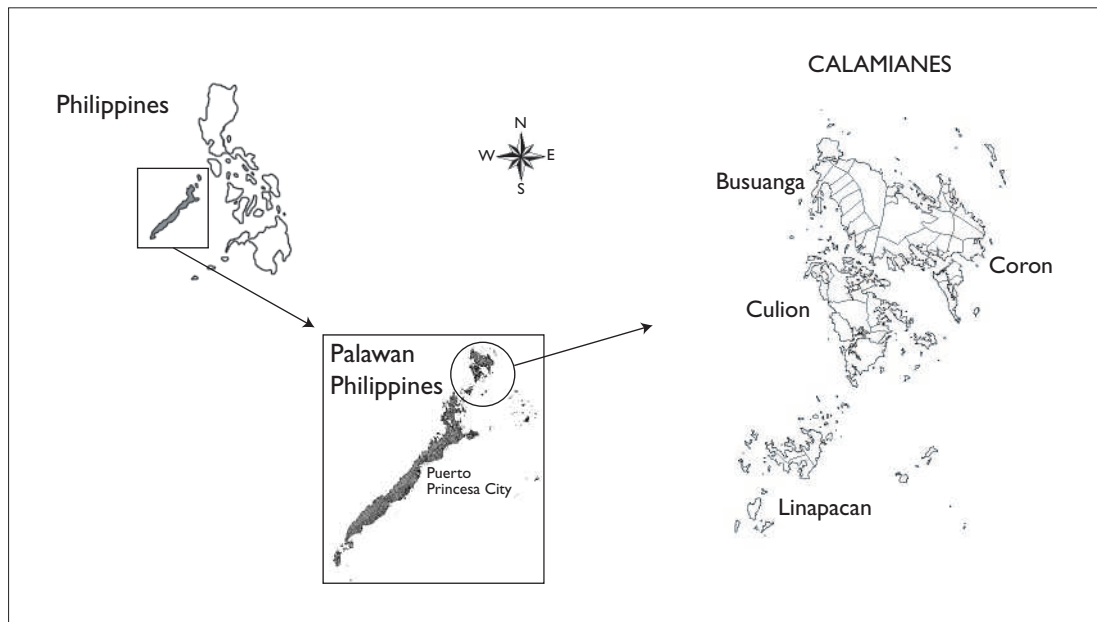


Figure 1. The Calamianes Group of Islands, Palawan Province, Philippines.

Legal framework for live fish and cyanide fishing

The response of both the national and local governments to the cyanide fishing problem has been tentative and ambivalent at best. In 1993, the provincial local government unit (LGU) of Palawan passed Provincial Ordinance (PO) No. 1993-02 banning the gathering, buying, selling and shipment of live fish in Palawan. The following year, the provincial legislative council bowed down to the strong lobbying efforts of live fish traders by passing PO No. 1994-29, which exempted all species from the ban other than Napoleon wrasse, or *mameng* (*Cheilinus undulatus*), panther grouper (*Cromileptes altivelis*) and aquarium fish in the Balistidae, or triggerfish, family. Later, the provincial council amended PO 1994-29 through the passage of PO No. 1998-332, providing further exemptions and installing a complicated certification system for shippers, traders, and catchers of live fish.² Given how weak these laws are, it is not surprising that in the last four years there have been no cases filed by law enforcement agencies in the Calamianes for violation of these provincial ordinances. Furthermore, the law is so confusing that some believe it was not intended to be enforced in the first place.

In 1998, the Philippine Congress enacted the New Philippine Fisheries Code, which explicitly provided, among other things, that “exportation of live fish shall be prohibited except those which are hatched or propagated in accredited hatcheries and ponds” (Sec. 61 [a], Republic Act 8550). This legal proviso has not impeded live fish catchers, traders and shippers, because according to them the



Figure 2. A fisherman squirts cyanide solution on corals while another waits for stunned fish to come out. Photo by Ferdinand Cruz of East Asia Seas Initiatives.

2. Provincial Ordinance No. 1998-332 further amended the previous ordinance by exempting the following from the ban: ornamental and aquarium fish of the families Pomacanthidae, Pomacentridae and Chaetodontidae. The law also allows the collection of *Cheilinus undulatus* provided that they: 1) weigh 50 to 300 grams or are between 3 and 7 inches in length, and 2) are subsequently cultured in pen or cages for at least eight months.

Bureau of Fisheries and Aquatic Resources has not passed an Administrative Order to implement the said prohibition. In 2000, the Palawan Council for Sustainable Development (PCSD), the legal body that exercises the “governance, implementation and policy direction of the Strategic Environmental Plan for Palawan,” passed Administrative Order No. 2000-05, providing an intricate accreditation system for culturing, catching, trading and transporting live fish species. According to Winston Arzaga, PCSD Staff Executive Director, the recurring problem of cyanide fishing prompted the Council in May 2002 to issue a moratorium on the award of live fish permits (Arzaga and Pontillas 2003).

Penalties for violations of regulations related to cyanide fishing in Palawan are considered severe by Philippine standards. Table 1 lists various applicable laws and prohibitions and the corresponding penalties. In addition to government actions, other concerned groups have also attempted to curtail the worsening problem of cyanide fishing. Their efforts include training fishers in environmentally-friendly methods of catching live food and aquarium fish and developing a certification system to guarantee that only fish caught using sustainable catching methods are available in the market.

Table 1. Prohibitions and penalties related to cyanide fishing.

| Categories of prohibitions | Specific prohibitions | Penalties |
|--|---|--|
| Prohibition on the use of noxious substances (<i>Section 88, Republic Act 8550; Fisheries Administrative Order No. 2001-206</i>) | Actual use of noxious substances | <ul style="list-style-type: none"> • Imprisonment ranging from five to ten years • Forfeiture of noxious substances, fishing vessels, fishing equipment and catch |
| | Mere possession of explosive, noxious or poisonous substances or electro-fishing devices (<i>Section 88</i>) | <ul style="list-style-type: none"> • Imprisonment ranging from six months to two years • Forfeiture of explosives, noxious or poisonous substances and electro-fishing devices |
| | Dealing in, selling or disposing of, for profit, illegally caught or gathered fish species (<i>Section 88</i>) | <ul style="list-style-type: none"> • Imprisonment ranging from six months to two years • Forfeiture of fish catch |
| Regulation of trade and exportation | Prohibition on the export of live fish except those which are hatched or propagated in accredited hatcheries and ponds (<i>Sec. 61 (a), Sec 100, Republic Act 8550</i>) | <ul style="list-style-type: none"> • Fine of 80,000 pesos (PHP) and imprisonment of eight years • Destruction of live fish and forfeiture of non-live fish • Violator banned from being member or stockholder of companies engaged in fisheries |
| | Prohibition on gathering, buying, selling or shipment of <i>Cheilinus undulatus</i> , ³ <i>Cromileptes altivelis</i> and ornamental or aquarium fishes in the family <i>Balistidae</i> (<i>PO No. 1993-02 as amended by PO No. 1998-332</i>) | <ul style="list-style-type: none"> • Fine of PHP 5000 and imprisonment of six months to two years • Forfeiture of paraphernalia and equipment used in fishing |
| | Prohibition on the culturing, catching, trading or transport of live fish without accreditation from the Palawan Council for Sustainable Development (PCSD) (<i>PCSD Administrative Order No. 2000-05</i>) | Fines: <ul style="list-style-type: none"> • Catcher (PHP 5000–100,000) • Trader (PHP 50,000–100,000) • Carrier (PHP 100,000–500,000) |
| Regulation of the use of paraphernalia identified with cyanide fishing | Prohibition on the use and mere possession of hookah compressor, the breathing apparatus used in cyanide fishing (<i>PCSD Resolution No. 2002-197, Department of Interior and Local Government Memorandum Circular No. 2002-129</i>) | Depends on the municipal ordinance of concerned municipality |

3. Provincial Ordinance No. 1994-29 erroneously identified *Cheilinus undulatus* as belonging to the family Scaridae.

Table 2. Fishery law enforcement institutions and their legal bases.

| National government | Local government | Civil society |
|---|---|---|
| <ul style="list-style-type: none"> • Municipal Philippine National Police (PNP) (<i>Republic Act (RA) 6975, RA 8550</i>) • PNP Maritime Group (<i>RA 6975, RA 8550</i>) • Philippine Coast Guard (<i>Presidential Decree (PD) 601, RA 8550</i>) • Department of Agriculture, Bureau of Fisheries and Aquatic Resources (DA-BFAR) (<i>Administrative Code of 1987, RA 8550</i>) • Palawan Council for Sustainable Development (PCSD) (<i>RA 7611; PCSD Administrative Order (AO) 2000-05</i>) • Presidential Commission on Anti-Illegal Fishing and Marine Conservation (PCAIIFMC) (<i>Executive Order 114, (1989)</i>) • Inter-agency Task Force on Coastal Environment Protection (IATFEP) (<i>Executive Order 117 91993</i>) | <ul style="list-style-type: none"> • All Barangay officials (<i>PD 1160, Letter of Instruction No. 550 (1977), RA 8550</i>) • Sangguniang Bayan or municipal councils (<i>Sec. 17 (b) (2) (i); Sec. 149 (b), RA 7160</i>) | <ul style="list-style-type: none"> • Citizens' Arrest (<i>Rule 113, Sec. 9 of the Revised Rules of Court</i>) • The use of tribal justice systems, conflict resolution institutions, customary laws and practices (<i>Sec. 15, RA 8371</i>) • Barangay and Municipal Fisheries and Aquarium Council members (<i>RA 8550, EO 240, Joint Department of Agriculture, Department of Interior and Local Government, Department of Environment and Natural Resources and Department of Justice Administrative Order No. 2, Series of 1996</i>) |

The government is not lacking in enforcement institutions to implement the laws and regulations related to cyanide fishing. Table 2 shows the institutions responsible for enforcing laws related to cyanide fishing at each of three jurisdictional levels, along with their legal bases.

Despite this plethora of laws and regulations and institutions charged with implementing the pertinent laws, cyanide fishing continues. Using the analytical tool and field data of Mayo-Anda et al. (2003) and the field data of Dalabajan et al. (2002), this paper traces the socioeconomic and political milieu in which cyanide fishing in the Calamianes Group of Islands continues to flourish. The paper proposes a law enforcement structure that is relevant to the area.

263,092 cyanide fishing incidents

It is easy to see that the laws and regulations described above have completely failed to achieve their objectives simply by looking at the data on the intensity of cyanide fishing. Mayo-Anda et al. (2003) provide an estimate of the intensity of cyanide fishing both for live food fish and aquarium fish in the Calamianes. According to Lasmarias (2002), cyanide fishers typically conduct about eight fishing trips per month during northeast monsoon months, which make up about seven months of the year, on average. During southeast monsoon months, which make up about five months of the year, the number of cyanide fishing trips per fisher increases to about

Table 3. Estimated numbers of cyanide fishers and cyanide fishing trips in three municipalities of the Calamianes Group of Islands, 1999 through 2002 (see text for estimates of the number of trips per fisher per year).

| Municipality and year | Number of fishers engaged in cyanide fishing | Number of cyanide fishing trips |
|-----------------------|--|---------------------------------|
| Coron | | |
| 1999 | 316 | 33,496 |
| 2000 | 328 | 34,768 |
| 2001 | 340 | 36,040 |
| 2002 | 353 | 37,418 |
| Subtotal | | 141,722 |
| Busuanga | | |
| 1999 | 113 | 11,978 |
| 2000 | 121 | 12,826 |
| 2001 | 130 | 13,780 |
| 2002 | 139 | 14,734 |
| Subtotal | | 53,318 |
| Culion | | |
| 1999 | 153 | 16,218 |
| 2000 | 158 | 16,748 |
| 2001 | 163 | 17,278 |
| 2002 | 168 | 17,808 |
| Subtotal | | 68,052 |
| TOTAL | | 263,092 |

ten per month. On average, therefore, each cyanide fisher makes about 106 trips per year. Using that rate, along with estimates provided by Lasmarias (2002) on the number of fishers engaged in cyanide fishing in each of three municipalities, Mayo-Anda et al. (2003) estimated the total number of cyanide fishing trips per year (Table 3). The study concluded that there were approximately 263,000 cyanide fishing trips in the Calamianes from 1999 through 2002. Astonishing as this figure is, it is likely an underestimate for the Calamianes Group as a whole, since the study did not cover the Municipality of Linapacan, which has the greater number of accredited live-fish catchers among the Calamianes's four municipalities (the numbers of accredited fish catchers, as provided by the PCSD, are not accurate measures of the numbers of fishers actually engaged in cyanide fishing). Linapacan's 800 accredited catchers can be compared with the 400 in Coron, 300 in Busuanga, and 600 in Culion (De Sagun 2003). Moreover, the Mayo-Anda et al. (2003) study leaves out cyanide fishing by seasonal fishers and fishing boats from neighbouring provinces, which will also lead to an underestimation.

Based on focus group discussions and key informant interviews conducted in January 2003 in 13 villages around the Calamianes, community members detected approximately 8102 cyanide fishing trips from 1999 through 2002 (Mayo-Anda et al. 2003). While some may contest the accuracy of this

figure due to the possibility of double-counting by community members (i.e. cases where more than one respondent observed the same incident), other evidence suggests that the number of incidents was in fact greater. This estimate covers all the Calamianes municipalities except Linapacan, where cyanide fishing is believed to be especially frequent. More importantly, the interviewed community members did not, generally, have the capacity to detect fishing activity in the offshore areas, where cyanide fishing activities are more pronounced.

While Barber and Pratt (1998) were correct when they argued that cyanide fishers are driven by both monetary and non-monetary inducements, the two experts may have grossly miscalculated the number of cyanide fishers when they described them to be a fairly small and discrete group.

Arrests

Among the 8102 incidents of cyanide-fishing detected by community members, police records show that only 15 arrests were made — a flabbergasting batting average of 0.002. One plausible reason why there were so few arrests despite the astronomical number of cyanide fishing incidents and despite the numerous law enforcement institutions is the limited number of law enforcement personnel on the ground. Table 4 lists the number of personnel in each of the relevant law enforcement agencies.

Table 4. Number of law enforcement personnel, by agency and municipality (January 2003).

| Agencies | Number of personnel, by municipality | | | |
|--|---|--|---------|-----------|
| | Coron | Busuanga | Culion | Linapacan |
| Coast Guard | 6 | 2 | 2 | unknown |
| Philippine National Police (PNP) | 20 (only 4 to 6 are involved in at-sea patrolling) | 12 | 8 | unknown |
| PNP-Maritime Group | 7 | | | |
| Bureau of Fisheries and Aquatic Resources (BFAR) | 2 | | | |
| Palawan Council for Sustainable Development (PCSD) | 4 (all office-based) | | | |
| Kilusan Sagip Kalikasan (KSK) | 3 | | | |
| Municipal Agriculture Offices (MAO) | 8 (only 2 are involved in fishery law enforcement) | 4 (primarily in charge of permitting and licensing) | unknown | unknown |

Law enforcement agents also cite the lack of equipment (e.g. patrol boats and an efficient communication system) and the absence of public support as reasons for their inability to actually arrest violators.

Even granting the paucity of the manpower and other resources available to law enforcement agencies, one still wonders why there is such a scandalously huge gap between the putative number of cyanide fishing offences and the number of arrests made. In fact, respondents in key informant interviews and focus group discussions are in agreement in saying that numbers of arrests are actually far higher than what the police records reflect. They allege that bribery occurs immediately upon arrest, in which case the said arrests do not appear in police records. An indication of this is the significant number of incidents in which cyanide tablets and boats were confiscated but no individuals arrested. The supposed inability of police officers to identify perpetrators is highly suspect considering that it is easy to trace the ownership of the confiscated boats through interviews, the municipal registry, and Coast Guard records.



Figure 3. Philippine National Police – Maritime Group (PNP-Maritime) seizes a boat at Delian Island, Coron, Palawan, loaded with live groupers and assorted aquarium fish.

Photo by Edward Lorenzo of Environmental Legal Assistance Center

No convictions, no jail time!

Even if numerous arrests were made, it does not necessarily mean that there would be a high number of cases filed. Cases are considered formally filed if the Office of the Provincial Prosecutor has established that “probable cause” exists and the prosecutor assigned to the case has filed the complaint in the trial court. In reality, there seem to be a lot of barriers, both practical and procedural, to filing complaints.

The public prosecutors filed complaints for only 12 of the 15 arrests related to cyanide fishing made from 1999 through 2002. Court records show that among those 12 cases for which complaints were filed, one was dismissed, nine are pending and two were archived. Cases are typically archived when the police fail to serve the warrants of arrest issued by the judge: when the police finally file the case and the judge issues a warrant of arrest, the offender usually cannot be located, forcing the judge to shelve the case.

The police also face the daunting task of prosecuting the cases at the Municipal Circuit Trial Courts (MCTC) because no public prosecutor can attend to them. It bears noting that Chiefs of Police have no formal training in prosecution. In fact, many people consider the MCTC proceedings to be farcical because the judge dictates to the Chief of Police the questions to ask, which objections to raise and the oral motions to file in open court. Because of the police chiefs’ lack of experience in litigation, they cannot prove that the accused is guilty beyond reasonable doubt, which is what the law requires for a conviction.

In rare cases in which the police successfully make an arrest, the court system poses another hurdle. The current system makes it very difficult to file cases. For example, the police need to file the criminal case in Puerto Princesa City, where the Office of the Prosecutor is situated. The case could actually be filed at the MCTC in Coron or Culion if the judge were present. However, the judge is in the area for only two weeks per year. This is because the judge assigned to the MCTCs of Coron/Busuanga and Culion concurrently sits on five other trial courts (the Municipal Trial Courts of Puerto Princesa City, Roxas/ Dumarán, Cuyo/Agutaya, Aborlan/Narra, and Brookes Point).

Another recurring problem in prosecuting cases is the waning interest of complainants and witnesses. The government does not provide financial support to complainants and witnesses for attending court proceedings. When a case drags on, especially when a favourable judgment does not appear to be forthcoming, complainants and witnesses tend to avoid the proceedings. This is also the case when a law enforcement officer who is directly involved in the case has been assigned to other

areas, making him or her unavailable when the case is called. In situations like these, the accused invokes his or her right to a speedy trial, consequently prompting the judge to dismiss the case.

The problems cited above illustrate why in four years there were no convictions, and consequently, no jail time served for violating the prohibitions on cyanide fishing.

Compliance and deterrence

There is a growing body of literature on enforcement that links compliance behaviour and deterrence to certain economic factors and the probability and weight of sanctions. For example, Becker (1968) postulated that an individual will commit a crime if the expected utility of committing the crime exceeds the utility of engaging in legitimate activity. Kuperan and Sutinen (1998) label this the instrumental perspective, as opposed to the normative perspective, which is the view that fairness of regulations and the legitimacy of institutions, not economic incentives or disincentives, are what drive individuals to comply. Following Becker (1968), Sutinen and Gauvin (1987) argued that:

The incidence of compliance is directly related to the perceived probability of detection and conviction and the penalty for non-compliance, and inversely related to the expected gain from violating a regulation. The perceived probability of detection and conviction, in turn, is directly related to the resources and practices of the enforcement program.

More recently, Nielsen and Mathiesen (1999) asserted that:

...the individual fisher primarily responds to the immediate benefits and deficits of compliance or non-compliance. Such behavior is assumed to be based on the fishers' calculations of the economic gain to be obtained from by-passing the regulation compared to the likelihood of detection and the severity of sanctions.

Inspired by Becker and his cohort's model, Mayo-Anda et al. (2003) assessed the estimated value of enforcement disincentives for cyanide and dynamite fishing activities in Palawan by applying the probabilities of detection, arrest, case-filing, prose-

cution and conviction. The replacement costs of forfeited fish catch and fishing paraphernalia (e.g. fishing boats, nets, compressors and other materials confiscated at the time of arrest) of four decided cases were computed and added to the expected loss of fishing income of offenders during the minimum incarceration period. The authors arrived at the figure of 223,166 Philippine pesos (PHP) as the average value of the effective penalty per case, equivalent to 4463 US dollars (USD) (based on an exchange rate of USD 1 to PHP 50). Using the average time elapsed from detection to conviction of 0.58 years, or about 7 months, and a 12 per cent annual discount rate, the value of the penalty in present value terms is about PHP 206,807, or USD 4136.

When the probability of being convicted upon detection was factored in, the present value of the enforcement disincentive was estimated to amount to a meagre PHP 461, or approximately USD 9. Contrast this with the expected net income from cyanide and dynamite fishing per fishing trip, which in 2002 were about PHP 4084 (USD 82) and PHP 2973 (USD 59), respectively, and it is apparent that the net enforcement disincentive is negative (i.e. the illegal fisher gains a large net benefit from destructive fishing practices). Following the theories of Becker (1968), Sutinen and Gauvin (1987), Kuperan and Sutinen (1998) and Nielsen and Mathiesen (1999), a fisher in the Calamianes would naturally use either cyanide or dynamite in his or her fishing activity for the simple reason that the net value of the deterrent to commit the crime is negative.



Figure 4.
Philippine Coast Guard (PCG) seizes 25 kg of cyanide tablets at Malapuso Island, Busuanga, Palawan.
Photo by Evan delos Santos of PCG

It is significant to note that the four decided cases that Mayo-Anda et al. (2003) used to determine the enforcement disincentive all related to dynamite fishing. The logic behind the enforcement disincentive is that the lower the probability of occurrence of any of the elements of the chain, the lower would be the value of the disincentive to commit a crime. Applying the logic to cyanide fishing cases, the enforcement disincentive would be equal to zero because some elements of the enforcement chain (conviction and value of the penalty) appear, at least based on the experience in the Calamianes from 1999 through 2002, to have zero value.

If the objectives of law enforcement are to deter, persuade or punish violators, correct non-compliant conditions and create a norm of expected behaviour, as Eichbaum (1992) has argued, then the preceding discussion clearly shows that there is no way that the present law enforcement structure in the Calamianes could achieve these objectives.

To ban or not to ban: That is not the question

For many years now, decision-makers have had the mistaken notion that the live fish trade and the accompanying problem of cyanide fishing are basically policy issues. Consequently, they vacillate between imposing a blanket ban on trading live fish and establishing severe restrictions through accreditation, monitoring and cyanide testing. Surprisingly, there is little critical reflection on the capacity of institutions to enforce either of these approaches. To this, the words of Wasserman (1994:31) in addressing the 1994 International Conference on Environmental Enforcement are very relevant: "... in any society, many people will not comply with the law unless there are consequences of noncompliance."

Whether there is a ban or restriction, the government and key stakeholders are faced with the same question: How do they enforce the law, given the stark and obvious failure of the entire law enforcement structure? The Fisheries and Aquatic Resources Management Councils (FARMCs) of both barangays (BFARMCs) and municipalities (MFARMCs) fail to live up to the task assigned to them because there is no equipment, (practically) no budget for patrolling, and nothing to compensate for the huge enforcement responsibilities. Some citizens' groups, as revealed during focus group discussions and interviews, are not keen on performing enforcement functions because of the persistent corruption and lack of governmental support.

Fixing the broken net

Law enforcement in the Calamianes is like a broken fish net: it fails to serve its fundamental pur-

pose because its targets are able to escape from the net. Given the practical problems in the Calamianes, this broken net needs fundamental changes. Police and court records vividly depict a law enforcement system that is miserably flawed. It is unable to detect and arrest cyanide fishers and it fails to prosecute and convict offenders on the rare occasions that arrests are made. While the government grapples with the question of banning or putting severe restrictions on the live fish industry, it fails to give equal attention to law enforcement — the vital link in an effective public policy.

The first step needed to strengthen law enforcement is to put in place a detection mechanism such that cyanide fishing would be detected outright and arrests can be made where and when violations are committed. To this end, the government needs to mobilize citizens' groups (e.g. B/MFARMCs and the *barangay tanod*, a quasi-police force composed of village residents), because formal law enforcement institutions cannot undertake this enormous task alone. Citizens' groups have extensive knowledge about the area and can pinpoint the location of cyanide fishers. They can help in profiling destructive fishing practices (i.e. where and when they tend to happen, which social groups commit them, and their monetary and non-monetary motivations for doing so). This information can be fed into a database to better understand the dynamics of illegal fishing so that appropriate enforcement strategies can be established. In addition, the government must address corruption, which breeds cynicism and reluctance among citizens' groups.

The second step is to increase the technical and logistical capacity of law enforcement institutions. Police agencies are visibly lacking in the facilities and legal skills that are needed in order to translate detection into actual arrest. Law enforcement agencies should also settle among themselves the jurisdictional overlaps that exist between their respective units, which will prevent duplication of efforts in certain areas, and thereby minimize operating costs. Ideally, geographical assignments should be agreed upon by different agencies so as to allow for coherent and comprehensive enforcement coverage. The law enforcement agencies must also be equipped with communication and transportation devices to increase their response rates and speed up response times.

The third step is to install an administrative adjudication mechanism in lieu of criminal courts, which would hear cases on cyanide fishing and other destructive fishing practices. An administrative adjudication body is perfectly legal but is a largely untapped tool. The Local Government

Code (LGC), for example, allows LGUs to pass "...ordinances for the protection of coastal and marine resources and imposition of appropriate penalties for dynamite fishing and other activities which result to ... ecological imbalance" (Sec. 447 (a) (1) (vi), Republic Act 7160). Moreover, the Fisheries Code mandates LGUs to manage municipal waters (Sec. 16, Republic Act 8550) and such management functions are similar in nature to national executive agencies carrying out functions established by congress. Hence, the LGC and the Fisheries Code confer upon LGUs broad and extensive powers, including the imposition of administrative sanctions.

Ruling on the authority of the LGUs, the Philippines Supreme Court found that:

... under the general welfare clause of the LGC, local government units have the power, inter alia, to enact ordinances to enhance the right of the people to a balanced ecology... (I)t imposes upon the Sangguniang Bayan, the Sangguniang Panlungsod, and the Sangguniang Panlalawigan the duty to enact ordinances to protect the environment and impose appropriate penalties for acts which endanger the environment [underscoring added].⁴

This ordinance-making power is broad enough to include administrative procedures for meting out administrative penalties. In determining and imposing administrative sanctions, LGUs can be as creative as needed in order to ensure effective enforcement of their ordinances. One important caveat is that assigning penalties that involve jail time is beyond the authority of the LGUs. Moreover, LGUs can impose a maximum penalty of only PHP 2500 (USD 50) for each offence. However, the LGUs can impose sanctions such as the confiscation of fishing paraphernalia related to the offence and require the offender to repair and/or rehabilitate the affected area of the coastal environment to offset the damage done.

Finally, the government needs to establish an on-site cyanide detection testing (CDT) laboratory in the Calamianes Group (in the municipality of Coron) so that the municipal administrative body (MCTC) can easily procure a copy of test results. One of the most frustrating experiences for law enforcement agencies since 2002 has been the difficulty in putting together a strong case against cyanide fishers. In many instances, a suspected seller or buyer of cyanide-caught live fish was asked for fish samples, which were sent to the Bureau of Fisheries and Aquatic Resources CDT

laboratory in Manila for testing. When the result turned out positive for cyanide a few days later, the buyer/seller had disappeared. A laboratory examination is not a be-all-end-all solution, but it is the best technical tool available to identify fish caught using cyanide and dynamite, and provides hard evidence with which to prosecute cyanide and blast fishers.

Closing notes

The fishing industry, and the live food fish and aquarium fish industries in particular, depend on law enforcement for their survival in the same way that ordinary fishers depend on their fishnets for daily survival. Signs of a collapsing fishing industry are becoming evident to everyone. Unless something drastic is done to make law enforcement more effective, the cyanide fishing problem will inevitably kill the fishing industry.

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A review of the movements of fish held in captivity in the Reunion Island Aquarium over a five-year period

Thierry Mulochau¹ and Patrick Durville^{1,2}

Introduction

For about 20 years, the marine aquarium fish trade has been showing continuous growth and now involves major movements of wild reef fish all over the world (Dufour 1998; Wood 2001; Sadovy and Vincent 2002; Sadovy 2003; Wabnitz et al. 2003). Also, the number of public aquaria displaying coral reef organisms is constantly expanding, while the size of display tanks is steadily increasing. To remain attractive to the public, aquarium managers find they must adopt innovative approaches, and display ever bigger and scarcer living organisms. There is no accurate measure of the quantity of marine fish caught for such purposes. Given this context, there seemed to be merit in publishing a review of fish movements into and out of Reunion Island Aquarium (as recorded over a five-year period of aquarium operations), as well as an assessment of the capacity of the various fish families to adapt to captivity under the conditions found at the aquarium.

Materials and methods

Reunion Island Aquarium is situated on the west coast of the island of Réunion, which lies in the western Indian Ocean. This private venture displays the marine flora and fauna of Réunion in a group of 14 tanks varying in volume from 1 to 320 cubic meters (m³). The total volume of seawater in all the tanks is 700 m³. This water is pumped in directly from the natural environment and treated in a 100 m³ buffer tank where it undergoes decantation, mechanical filtering, cooling (the temperature is regulated at 26 °C) and oxygenation.

All fish in Reunion Island Aquarium come from the waters around the island and all are captured at depths between 0 and 50 meters. Eighty per cent of them are caught by the aquarium's divers and biologists, while 20% are captured by professional fishers. Various techniques are used for capturing the fish: nets, daytime and night-time dives, anaes-

thetizing products, basket traps, bottom fishing, and scoop nets. These highly selective capture activities are only carried out three to four times monthly and concern only two to three specimens on average per operation.

During the transport phase, which lasts less than an hour, the fish are placed in tanks with water agitation and aeration systems. They are then kept in quarantine for two to eight weeks, depending on their capacity to adapt. This obligatory stage allows parasites to be removed from the fish, allows fish to become accustomed to a different diet from that of their natural environment, and helps mitigate the stress associated with captivity. The next step is to place the fish in the display tanks. Depending on their size and liveliness, they may need to be anaesthetized for this step.

Fish movements are recorded in a register of "arrivals and departures of animals of non-domestic species held in captivity" and another known as the "register of movements of animals held in captivity".³ This accounting system makes it possible to monitor the number of incoming (caught, donated, born) and outgoing (died, reintroduced, donated) specimens. In this study, we have limited our assessment to captured fish ("arrivals") and mortalities ("departures"). In other words, the study included only individual fish that were captured and at the end of the five-year study period either remained in the aquarium or had died. We have looked at all fish families over the five-year period.

We sought to identify the families that best adapted to captivity under the aquarium's conditions and fish management practices. A "success rate", expressed in terms of the number of fish present at the end of the five-year study period as a proportion of the total number of arrivals during that period, was computed for each family. The results were divided into three categories: families offering "easy" management (success rate greater than 50%), those "difficult" to manage

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3. These are in accordance with prevailing French regulations as set down in Act No. 79-629 dated 10 July 1976 relating to nature conservation, the relevant implementation order No. 77-1297 dated 25 November 1977 and a ministerial order dated 23 November 1988.

(success rate between 26 and 50%) and those with “complex” management needs (success rate between 0 and 25%).

We also recorded the mean “length of stay” for each family; that is, the mean length of time spent by all specimens from a given family in the aquarium from arrival to departure. This value can help us gain a better understanding of the capacity of various families to adapt to the aquarium’s conditions.

Results

Over five years, 990 fish from 43 families were caught (Table 1). The best represented families were Serranidae with 10.4% of arrivals, followed by Acanthuridae (7.2%), Labridae (7.1%), Pomacentridae (7.1%) and Chaetodontidae (6.8%). In contrast, others such as Sphyrnidae were represented by a single specimen only. Of these 990 fish, 451, or 45.5% of the total number of arrivals, were subsequently recorded as departures in the register. Syngnathidae (10.4%), Chaetodontidae (9.7%), Apogonidae (8.2%), Labridae (6.7%) and Holocentridae (6.4%) were the families with the most departures.

The mean length of stay for all families combined was 25 months. Seventeen families stayed for more than 30 months out of the 60-month study period. The best results were obtained with the families Pomacentridae (56 months), Serranidae (53 months), Carangidae (52 months) and Sphyrnidae (51 months). In contrast, some families could only be kept for a few months, such as Pempheridae (3 months), Monacanthidae (5 months), Plotosidae (5 months) and Diodontidae (5 months).

A detailed examination of arrivals and departures on an annual basis shows that 518 specimens were caught during the first year, when the aquarium was opened, which represents more than half of the total arrivals. Over the following four years departures stabilized at a mean of about 117 fish per year. The total stock size showed an upward trend, increasing from 370 at the end of 2000 to 539 in 2005, while the annual number of departures as compared to arrivals fell, with 28.6% of the fish departing in 2000 compared to 12.1% in 2004: that is, an annual mean rate of 17.2% (Table 2).

Examination of success rates for each family represented in the aquarium’s tanks shows that 15 families can be considered as “easy” to handle, including the families Pomacentridae (90%), Kuhliidae (86.7%), Monodactylidae (84.6%), Serranidae (84.5%) and Carangidae (82.4%); 16 families are “difficult”, particularly the families Mulli-

Table 1. Arrivals and departures (in number of specimens) and mean length of stay (in months) from a study of 43 families of reef fish over a 60-month period at Reunion Island Aquarium.

| Family | Arrivals | Departures | Mean length of stay |
|-----------------|----------|------------|---------------------|
| Carcharhinidae | 7 | 4 | 12 |
| Sphyrnidae | 1 | 1 | 18 |
| Dasyatidae | 5 | 4 | 24 |
| Muraenidae | 5 | 1 | 48 |
| Plotosidae | 11 | 7 | 5 |
| Antennaridae | 5 | 3 | 35 |
| Holocentridae | 46 | 29 | 26 |
| Aulostomidae | 5 | 4 | 23 |
| Syngnathidae | 65 | 47 | 13 |
| Dactylopteridae | 2 | 2 | 14 |
| Scorpaenidae | 39 | 21 | 47 |
| Serranidae | 103 | 16 | 53 |
| Cirrhidae | 12 | 6 | 27 |
| Apogonidae | 47 | 37 | 14 |
| Kuhliidae | 45 | 6 | 36 |
| Priacanthidae | 7 | 7 | 6 |
| Malacanthidae | 5 | 3 | 13 |
| Carangidae | 17 | 3 | 52 |
| Lutjanidae | 43 | 25 | 34 |
| Caesionidae | 6 | 4 | 38 |
| Haemulidae | 3 | 2 | 16 |
| Lethrinidae | 23 | 21 | 10 |
| Mullidae | 19 | 14 | 19 |
| Pempheridae | 8 | 8 | 3 |
| Ephippidae | 10 | 5 | 22 |
| Monodactylidae | 26 | 4 | 49 |
| Chaetodontidae | 67 | 44 | 13 |
| Pomacanthidae | 28 | 6 | 33 |
| Pomacentridae | 70 | 7 | 56 |
| Labridae | 70 | 30 | 32 |
| Sphyrnidae | 3 | 1 | 51 |
| Blennidae | 21 | 4 | 35 |
| Microdesmidae | 8 | 5 | 11 |
| Gobiidae | 11 | 3 | 15 |
| Zanclidae | 11 | 9 | 10 |
| Acanthuridae | 71 | 18 | 41 |
| Siganidae | 3 | 2 | 14 |
| Bothidae | 5 | 2 | 38 |
| Balistidae | 14 | 4 | 41 |
| Monacanthidae | 14 | 13 | 5 |
| Ostracidae | 11 | 9 | 7 |
| Tetraodontidae | 14 | 6 | 25 |
| Diodontidae | 4 | 4 | 5 |
| Total | 990 | 451 | |

idae (26.3%), Syngnathidae (27.7%), Caesionidae (33.3%), Haemulidae (33.3%) and Siganidae (33.3%); and, 12 families are “complex”, including Sphyrnidae (0%), Dactylopteridae (0%), Priacanthidae (0%), Pempheridae (0%) and Diodontidae (0%) (Fig. 1).

Table 2. Initial stock of fish, number of arrivals, number of departures and annual summary expressed as the number of departures as a proportion of the sum of the year's initial stock and arrivals.

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|----------------------|------|------|------|------|------|------|
| Initial stock | - | 370 | 426 | 410 | 450 | 539 |
| Arrivals | 518 | 120 | 85 | 104 | 163 | - |
| Departures | 148 | 64 | 101 | 64 | 74 | - |
| Summary (%) | 28.6 | 13.1 | 19.8 | 12.4 | 12.1 | - |

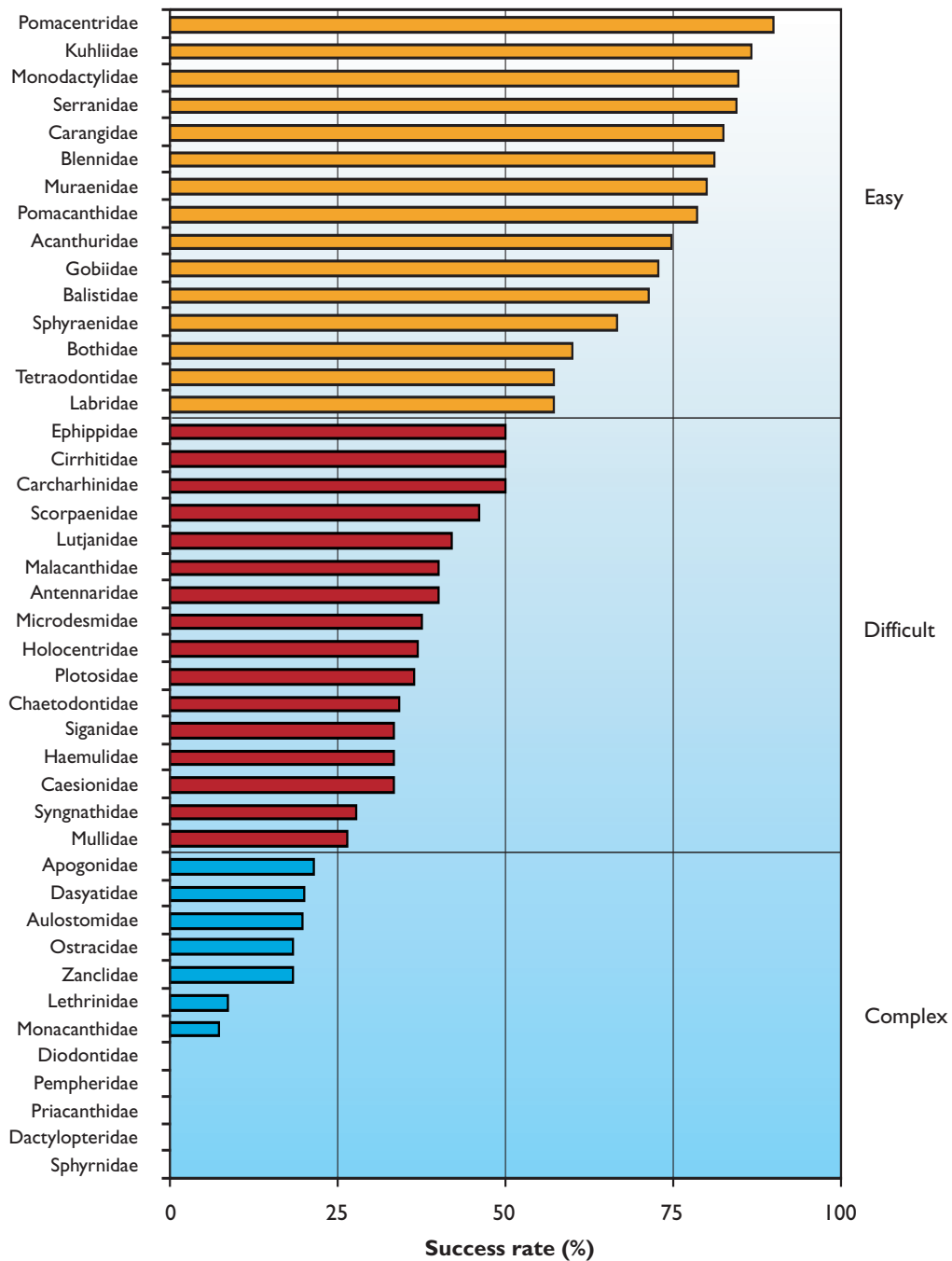


Figure 1. Success rate (expressed as the number of fish present at the end of the five-year study period as a percentage of the number of arrivals during that period), by family.

Discussion

It is difficult to generalize from these results because the aquarium's conditions and management practices are specific and not necessarily easy to reproduce elsewhere. In addition, with some families, only one or two specimens could be reared and the success or failure of their time in captivity is therefore not significant, even if their length of stay can yield information for the family. Many factors need to be taken into consideration and sometimes a detail about the capture, transport, diet, or introduction of a fish, or a change in a technical factor, can modify the balance of a population and make the management of a species a success or failure. Five years of experience have allowed us to better understand our stock's needs and consistently improve our success rates.

Of the 43 families we have handled, Pomacentridae seem the best suited to life in the aquarium. We find it easy to manage *Abudefduf vaigiensis*, *A. sexfasciatus*, *A. margariteus*, *A. sordidus*, *A. sparoides*, *Amphiprion chrysogaster*, *Chromis viridis*, *C. nigrura*, *C. chrysurus*, *Dascyllus aruanus*, *D. carneus*, *Stegastes pelicierii* and *Pomachromis richardsoni*. We have more difficulties with *Dascyllus trimaculatus*, which is often attacked by parasitic protozoans. *Pomacentrus caeruleus* is easy to handle but readily loses its colouring in captivity.

The families Kuhliidae (*Kuhlia mugil* and *K. marginata*) and Monodactylidae (*Monodactylus argenteus*) pose no particular problem.

Serranidae such as *Pseudanthias evansi*, *P. squamipinnis*, *P. cooperi*, *Gracila albomarginata*, *Cephalopholis argus*, *C. urodeta*, *C. sonnerati*, *Epinephelus fasciatus*, *E. faveatus*, *E. flavocaeruleus*, *E. longispinis*, *E. merra*, *E. multinotatus*, *E. hexagonatus*, *E. radiatus*, *Variola louti* and *Grammistes sexlineatus* adapt easily to our conditions; the only difficulties occurred with *Pogonoperca punctata*.

Carangidae such as *Caranx ignobilis*, *C. melampygus*, *C. sexfasciatus*, *C. papuensis* and *Carangoides orthogrammus* also adapt but need large tank volumes from early in their stay; only *Trachinotus bailloni* and *Seriola rivoliana* pose parasite-related problems.

Blennidae, *Cirripectes polyzona* and *Ecsenius midas* in particular, are easy to manage.

Muraenidae seem fairly hardy and we put *Gymnothorax undulatus*, *G. flavimarginatus* and *Siderea grisea* together in the same tank.

Pomacanthidae (*Pomacanthus imperator*, *Centropyge acanthops* and *C. bispinosus*), which are

often viewed as difficult to manage, also adapt easily to our conditions, except *Apolemichthys trimaculatus*, which is more fragile.

Similarly, Acanthuridae (*Zebrasoma velifer*, *Z. scopas*, *Z. gemmatum*, *Paracanthurus hepatus*, *Acanthurus dussumieri*, *A. mata*, *A. xanthopterus*, *A. tennentii*, *A. nigrofuscus*, *A. nigricauda*, *Ctenochaetus striatus*, *Naso lituratus*, *N. vlamingi*, *N. unicornis*, *N. brevirostris*, *N. brachycentron* and *N. hexacanthus*), which have a reputation of being difficult, progress very well in our tanks. Some difficulties have been encountered with *Acanthurus guttatus*, *A. lineatus*, *A. triostegus* and *A. polyzona*.

The management of Gobiidae such as *Valencienna strigata*, *Gnatholepis* sp., *Fusigobius* sp. and *Asterropteryx semipunctatus* remains easy.

Balistidae (*Odonus niger*, *Balistoides conspicillum*, *Pseudobalistes fuscus*, *Abalistes stellatus*, *Rhinecanthus aculeatus* and *R. rectangulus*) are generally very hardy, but some difficulties have been recorded with *Xanthichthys auromarginatus*, *Sufflamen chrysopterus* and *S. bursa*.

Sphyraenidae, particularly *Sphyraena barracuda*, adapt very well and we have kept a male and a female for the past four years.

Bothidae, particularly *Bothus mancus*, are problem-free, although weaning onto inert food can take a very long time.

Tetraodontidae such as *Canthigaster valentini*, *C. janthinoptera*, *C. smithae*, *Arothron nigropunctatus*, *A. hispidus* and *A. immaculatus* are easy to handle, but problems of interspecific territoriality within this family have caused losses in *Arothron stellatus* and *A. meleagris*.

Labridae are the most diversified and we display to the public *Bodianus anthioides*, *B. axillaris*, *Cheilinus trilobatus*, *Epibulus insidiator*, *Novaculichthys taeniourus*, *Anampses meleagrides*, *Anampses lineatus*, *Coris aygula*, *C. africana*, *Halichoeres hortulanus*, *H. marginatus*, *H. cosmetus*, *Gomphosus caeruleus*, *Stethojulis albobittata*, *Thalassoma genivittatum*, *T. hardwicke*, *T. mascarenum*, *T. purpureum*, *T. trilobatum*, *Labroides bicolor* and *L. dimidiatus*; only a few species like *Bodianus diana*, *B. bilunulatus*, *B. macrourus*, *Oxycheilinus bimaculatus*, *Pseudocheilinus hextaenia*, *Anampses caeruleopunctatus*, *Halichoeres scapularis*, *H. nebulosus* and *Hologymnosus doliaetus* have proved demanding.

Of the difficult families, Cirrhitidae, including *Paracirrhites arcatus*, *P. forsteri*, *Cirrhitops fasciatus*, *Cyprinocirrhites polyactis* and especially *Cirrhitus*

pinnulatus, are very demanding in terms of diet and require a tank all to themselves.

Carcharhinidae are found in every aquarium, but remain difficult where some species are concerned. Our collection contains *Carcharinus albi-marginatus*, which is the most common coastal shark in Réunion, but only young specimens less than 1.5 m in length can be handled. Each year, we reintroduce into the wild all the specimens that have outgrown our capacity and replace them with smaller individuals.

Scorpaenidae are relatively easy to handle, especially *Pterois miles*, *Synanceia verrucosa*, *Scorpaenopsis diabolus*, *S. oxycephala*, *Taenianotus triacanthus*, *Dendrochirus biocellatus*, *D. zebra* and, to a lesser extent, *Pterois antennata*. The losses we recorded in this family were due to an over-rich diet.

Lutjanidae such as *Aprion virescens*, *Lutjanus kasmira*, *L. fulvus* and *L. argentimaculatus* are hardy and adapt to captivity easily, but are aggressive and territorial. We lost more than 50% of these fish because of technical mishaps during the first year of operations.

With Malacanthidae, only *Malacanthus brevis* underwent extended trials, which finally led to a successful conclusion and the survival of a couple for more than 12 months at the time of this writing. *Malacanthus latovittatus* seems easier to rear but it is unusual and difficult to catch.

The Antennariidae (*Antennarius commersonii*, *A. striatus* and *Histrio histrio*) demand a great deal of attention because of chronic parasitic diseases.

Microdesmidae, with *Nemateleotris magnifica*, are challenging and do not adapt well to a tank in which various families are mixed together; *Ptereleotris evides* performs better in the same tank.

With Holocentridae (*Myripristis berndti*, *M. murdjan*, *Sargocentron diadema* and *S. spiniferum*), the most frequent problems were with exophthalmus (bulging of the eye).

With Chaetodontidae, a difficult family to manage, we only work with species offering broad dietary habits such as *Chaetodon melannotus*, *C. vagabundus*, *C. auriga*, *C. madagaskariensis*, *C. kleinii*, *C. guttattissimus*, *Hemitaurichthys zoster*, *Forcipiger longirostris*, *Heniochus acuminatus* and *H. monoceros*; only *Chaetodon lunula* regularly develops parasitic diseases.

Haemulidae such as *Plectorhinchus picus* are difficult, although *P. gibbosus* is easy to handle.

With Caesionidae, *Pterocaesio tile* and *Caesio teres* have been managed with a few difficulties, especially just after capture.

With regard to Syngnathidae, species such as *Corythoichthys flavofasciatus*, *C. schultzi* and *Doryrhamphus excisus* adapt relatively easily especially if live food is available. For others such as *Hippocampus kuda* or *Trachyrhamphus bicoarctatus*, management is more difficult because of their susceptibility to bacterial and viral attacks, especially in males (gas bubble disease). In contrast, management remains feasible and the aquarium is currently displaying fourth generation seahorses.

Mullidae such as *Parupeneus trifasciatus*, *P. indicus*, *P. rubescens* and *P. macronema* have caused problems; *Parupeneus cyclostomus*, however, adapts better to our conditions.

Of the complex families, some are no longer caught because of difficulties encountered with their management. This is the case with the families Dactylopteridae, Pempheridae, Diodontidae, Monacanthidae, Lethrinidae, Ostracidae, Siganidae and Ephippidae, which were only kept for a limited period at the aquarium (see Table 1).

As regards to the other families, a high degree of skill in capture and management techniques enables us to constantly improve our results. With Apogonidae (*Apogon apogonides*, *A. kallopterus* and *A. cookii*), the main problems observed were predation in the mixed tanks, but their management remains straightforward. Dasyatidae such as *Dasyatis violacea* adapt easily, while *Taeniura melanospilos* is more problematic, especially with parasites. With Aulostomidae (*Aulostomus chinensis*), management is complex because of their feeding habits and issues of interspecific territoriality. Fish in the Zanclidae family (*Zanclus cornutus*) are challenging because of their highly specific dietary needs. Management of a Sphyrnidae, *Sphyrna lewini*, for 18 months, was not difficult, but this specimen was accidentally wounded by another fish of the same species during feeding. This species remains, however, very difficult to manage, in particular around the time of capture and introduction into the mixed tank.

In order to remedy management difficulties met with some species, we directed capture activities towards post-larvae or juveniles, which adapt better to captivity than adults (Dufour 2002; Durville et al. 2003). This is the case for the families Monodactylidae, Serranidae, Carangidae, Microdesmidae, Pomacanthidae, Pomacentridae, Haemulidae and some Labridae. In addition, it is easier to catch younger specimens and so they experience less

stress than do captured adults, which increases success rates. According to Wabnitz et al. (2003), this kind of capture, which affects only new recruits, also has less impact on coral reef fish populations already present on the reef.

Conclusion

This review of fish movements at the Reunion Island Aquarium shows 45.5% departures as compared with the total number of arrivals over a five-year period, with a significant drop in recent years (28.6% in 2000, down to 12.1% in 2004). These results take into account the first year of operations for the facility, which is a very difficult period because of the many biological, physical-chemical and technical factors that need to be mastered when a facility such as this is opened. The first year should, therefore, be considered as different from other years but it does yield important information on the development of an aquarium's opening population. Stress, diseases, territoriality and technical mishaps are all factors that limit the lifespan of fish in captivity. Their natural life expectancy should also be borne in mind. It is usually no more than a few years in coral reef fish (Froese and Pauly 2004), although greater longevity has been observed under farm conditions (Condé 1982).

This annual monitoring arrangement helped us gradually shift towards families seen as "easy" to manage under our conditions, thus reducing wild catch activities and associated costs. Of the "difficult" families, some really are difficult and remain so, while others are now understood and their survival rates have improved substantially. We believe that it is important for aquaria to optimize their stock management techniques as much as they possibly can by working on species that adapt to the conditions prevailing in their facility, rather than trying to show certain fragile species to the public at all costs. The recent development of coral reef fish nurseries will probably reinforce this trend and, in future, it will be possible to limit and control capture activities in the wild, gradually replacing specimens taken this way with species reared in captivity.

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Hobbyists' preferences for marine ornamental fish: A discrete choice analysis of ecolabeling and selected product attributes¹

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Introduction

The Marine Aquarium Council (MAC) certification program is a means to promote the sustainability of marine ornamental fish populations and coral reef ecosystems through market mechanisms. MAC has created a third-party certification program to assure compliance with standards designed to support sustainability. Certified parties, which include collectors, exporters, importers and retailers, can display a label proclaiming their environmentally sound practices for marine ornamental fish. This program brings together all elements of the production and distribution channels to accomplish the common goal of resource sustainability. This effort became operational in late 2001, and by 2002 some certifications were already conferred. The initial scope of the program extends only to the collection of fish from the wild, but it is expected to include aquaculture practices in the future. Possible perceived benefits of certification of cultured specimens could be assurance of humane treatment during production, handling and transit, as well as reduced harvesting pressures on wild populations.

The ultimate purpose of the MAC ecolabel is to inform consumers (i.e. hobbyists) about reduced environmental effects caused by certified activities, and empower them to promote sustainability through their purchase decisions. According to information published by MAC, the most important objectives of the program are to:

- develop core standards to assess marine ornamental practices;
- create a system to verify the implementation of standards and certify qualified products and practices;
- provide a framework that allows the industry to conduct responsible collection, handling and transporting practices as well as to generate accurate data for the management of marine ornamental activities; and
- support responsible management through education and training for industry participants.

Three sets of criteria for certification, or “core standards”, have been developed by MAC and are used in assessments by accredited independent certifiers. The criteria deal with coral reef conservation, as well as with the health and sustainability of wild fish stocks. The core standards applied in this program are:

- *Ecosystem and fisheries management:* addresses “in-situ” habitat, stock and species management and conservation in the collection area by verifying that management is conducted according to principles ensuring marine ecosystem conservation and stock sustainability.
- *Collection, fishing and holding:* focuses on harvesting fish, coral, live rock and other coral reef organisms and related activities (e.g. handling, holding, packaging and transport prior to export) by verifying that the collection, fishing, and pre-exporter handling, packaging and transport of marine aquarium organisms do not harm the health of the collection area, the sustainable use of the marine aquarium stocks or the optimal health of the harvested organisms.
- *Handling, husbandry and transport:* addresses the handling, husbandry, packing and transport at points along the commercialization chain in an attempt to ensure the optimal health of organisms during the commercialization process, as well as the differentiation of labeled products and practices from uncertified ones. (One important point is that a certified product must pass from one MAC certified industry operator to another.)

Additional details of the MAC certification program can be found on its Internet website (www.aquariumcouncil.org).

Costs and benefits of MAC certification to United States marine aquarium retail operations were examined in a case study of four firms in 2002, and the study concluded that the program had “definite financial advantages for retailers”. The advan-

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tages were derived from lower mortality rates and through increased levels of efficiency with respect to store operations (MAC 2002). The stores cooperating in the case study did not charge price premiums for MAC certified specimens.

Although the MAC program has been initiated and is continuing, little is known about consumer preferences for ecolabeled marine ornamental organisms and consumers' willingness to pay price premiums for such products. To fill this void, researchers at the University of Florida conducted a survey of marine aquaria hobbyists to gain information about influences of the ecolabeling program in the marketplace. The information from this survey can be used to help assess the potential effectiveness and success of the program (Alencastro 2004). The study also sought to obtain information about the influence on consumers of specific fish attributes, including whether it was brought to market in a sustainable manner (i.e. whether the fish was "ecolabeled", meaning in this context that it satisfied the requirements of the MAC certification program), and the impact of individual respondents' characteristics on preferences for marine ornamental fish at the retail level. This article briefly summarizes the information obtained from that survey, which was conducted on the Internet in early 2004.

Methodology

The survey sample comprised marine aquaria hobbyists that were members of online discussion boards relating to marine ornamental fish. They were recruited using a convenience sampling approach. Thus, this group was likely to be more involved in the hobby and more knowledgeable about the marine aquaria industry in general than the broader population of hobbyists. Considering that this sample is unlikely to represent the entire

population of aquaria hobbyists, the validity of the reported results is limited to this specific market segment. Survey responses are analyzed using discrete choice modeling, which is a survey-based technique that is being increasingly used to determine preferences for new environmental products and services (Adamowicz et al. 1998; Haaijer 1999).

Two discrete choice experiments were conducted to analyze the importance of product attributes on a consumer's decision on which product to buy. The first experiment involved a high-value specimen, the blue-faced angelfish, *Pomacanthus xanthurus*, and the second involved a more affordable specimen, the maroon clownfish, *Premnas biaculeatus* (Fig. 1). These species were selected for the experiment because they are popular with hobbyists and because both originate in areas that have experienced varying degrees of ecological damage. Accordingly, respondents were told the angelfish and clownfish were from the Philippines and Indonesia, respectively, countries where some collectors are known to utilize collection practices that harm marine ecosystems (Bunting and Meyers 2002). Both experiments were used to examine the individual and interactive effects of the price of the fish and whether it was ecolabeled. In addition, the effects of a longer post-purchase survival guarantee and whether the fish was collected from the wild or tank-bred (cultured) were examined in the angelfish and clownfish experiments, respectively. Thus, the results from each experiment are specific to the species examined.

Statistical models were first used to determine the factors that had a significant effect on the probability that a particular fish would be purchased. Then the estimated models were used in simulations to obtain the probabilities that a fish with given characteristics would be purchased in the marketplace by a particular type of consumer (Alencastro 2004).

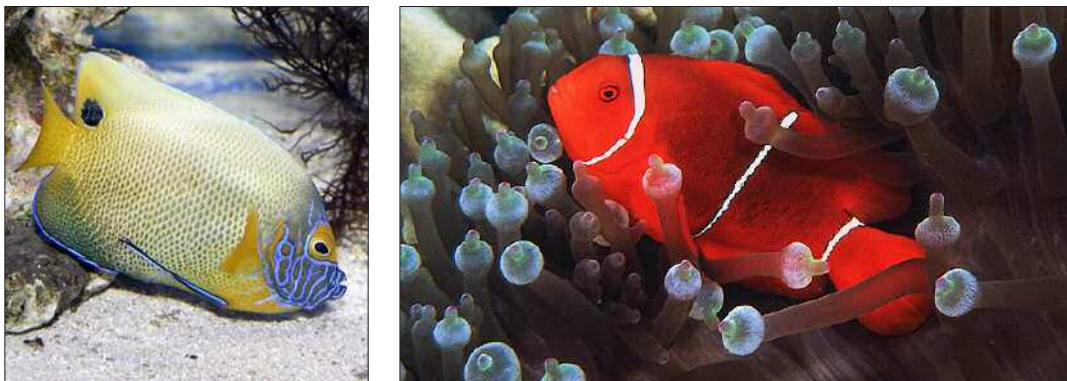


Figure 1.

Blue-faced angelfish, *Pomacanthus xanthurus* (printed with permission of Jeff's Exotic Fish) and maroon clownfish, *Premnas biaculeatus* (printed with permission of John E. Randall).

Results

Descriptive analysis showed that this segment of the market is very homogeneous in general. Most respondents were males aged between 24 and 44 years, with above-average levels of education and annual income. Respondents gave considerable importance to conservation of coral reefs and wild stocks, and showed a particularly high level of involvement in, and knowledge about, their hobby. About 80% reported keeping marine ornamental fish as their primary hobby, 59% were members of an aquarium society, 88% had researched the specimens they keep, and more than 60% had paid more than 50 US dollars (USD) for a single fish. Contrary to expectations, about 50% were not familiar with the MAC ecolabeling program.

Results from both choice experiments showed interesting and unexpected findings. Price was found to be a relatively unimportant factor affecting purchasing behaviour, as expected. However, price was positively related to increases in the likelihood of purchase, meaning that respondents indicated they would be more likely to buy the higher priced fish. This type of market behaviour indicates that higher-priced marine ornamental fish may be viewed as being of higher quality. Other product attributes were also found to be important to the purchase decision. For example, an extended life warranty and identification as tank-bred specimens were found to be close substitutes for MAC certification. Contrary to expectations, MAC certification had weak or even negative effects on the likelihood that a particular fish would be bought, especially among respondents professing some degree of familiarity with the program. An important observation is that respondents' comments revealed a strong lack of credibility for the MAC program and a higher confidence in alternatives such as tank culture as a means to avoid harmful consequences related to collection from the wild.

For the maroon clownfish experiment, an extreme preference for tank-bred fish was observed. When compared with a wild-caught fish with the same selling price, tank-bred fish as the source of supply dramatically increased the probability of purchase for this species. This preference for the tank-bred source was observed regardless of whether the fish was ecolabeled, although the preference was higher for an uncertified fish. Since the certification (ecolabel) did not increase the probability that a tank-bred maroon clownfish would be purchased, the hobbyists that responded to the survey may perceive tank-bred fish as equally sustainable to, and thus equally substitutable with, ecolabeled fish of this species in the marketplace. Simulations also

showed that respondents were increasingly willing to buy tank-bred maroon clownfish at higher prices, although at a diminishing rate.

The effect of MAC certification at a constant price was negative; that is, the probability that an ecolabeled maroon clownfish would be purchased was lower than that of a non-ecolabeled fish of the same price. In addition, this finding was robust to the source (i.e. independent of whether the fish was wild-caught or tank-bred). The probability of purchase was lowest for a tank-bred, ecolabeled maroon clownfish. Simulations with price increases showed that respondents' willingness to pay for certification increased at an increasing rate if the maroon clownfish was wild-caught. Such observations suggest that avid hobbyists would be increasingly likely to pay price premiums associated with MAC certification if a fish is supplied from the wild. Respondents seemed to be concerned with ecosystem conservation and a higher price may indicate a healthier ecosystem as a result of the program. However, they would not pay price premiums for certification if the maroon clownfish were tank-bred. Thus, it may be that respondents viewed tank culture as a means of conserving marine ecosystems and that they judged certification to be an unnecessary expense. This result suggests a low market potential for an extension of the MAC program to tank-bred specimens, at least among this segment of hobbyists. Furthermore, since several clownfish species are available from culture, this observation could be applicable to other clownfish species.

Results of the blue-faced angelfish experiment revealed that an extended survival guarantee (from 5 to 14 days) and an ecolabel were perceived as close substitutes to the consumer in terms of ensuring better quality fish collected from the wild. However, the positive influence of extended life warranties on purchase decisions was higher than the effect of the MAC ecolabel for this species. In addition, it was again observed that this specific segment of hobbyists did not weigh price considerations as heavily as other attributes, especially those related to environmental issues.

The effects of respondents' characteristics on preferences for MAC certification were also analyzed in both experiments. Increasing the level of familiarity with the MAC program and the association of effective prevention of coral reef and wild stock damage with the MAC ecolabel showed highly significant positive influences on preferences for certification by avid hobbyists. This confirms the initial hypothesis that marine ecosystem protection has a high influence on preferences for marine ornamental fish for this group of hobbyists.

Demographic variables such as age, income level, education and geographic distribution also showed significant influences on preferences for certification, but only in some of the blue-faced angelfish scenarios. Results showed that respondents older than 44 years who had at least a college education or an annual income between USD 25,000 and USD 75,000 were more likely to choose a certified fish at the specified price premium, which ranged from USD 2 to USD 7.

On the other hand, and contrary to initial expectations, there were no significant regional differences in the US with respect to preferences for certified (ecolabeled) fish. However, in comparison with international hobbyists, respondents from the US were less likely to purchase a certified fish. Such a result suggests a stronger perception of survival guarantees as a substitute for certification (ecolabeling) when considering fish quality. Further research to confirm this finding is needed.

Conclusions

Considering the observed negative perception of the MAC ecolabel, the market potential of the program for this group of hobbyists looks limited. However, since only 50% of respondents had some level of familiarity with MAC, efforts to improve the level of knowledge and perceived credibility of the program are recommended. In order to broaden the program's appeal to hobbyists, MAC must address not only coral reef conservation but also sustainability of fish stocks and efficient post-harvest activities (i.e. handling, holding and transportation of marine ornamentals). Such information could be very useful and successful in improving preferences for a MAC ecolabel.

It is important to note that results from this research may not apply to the entire population of marine aquaria owners or all ornamental fish species. An understanding of the preferences of this sample of hobbyists could, however, be very useful for creating increased demand for certified specimens. Due to their high level of involvement in the hobby and high exposure to information, these avid hobbyists

should be easier, faster and cheaper to reach with educational and promotional efforts. In addition, due to the secondary role that price plays in influencing purchase behaviour and the capacity to afford price premiums, this group would be very likely to react positively to price increases and to contribute to support of the program if their perceptions of the MAC ecolabel can be improved. Lastly, a survey of the general population covering additional species would be useful in obtaining a better estimate of overall demand for ecolabeled ornamental marine specimens. Further study of expected costs of certification could also help estimate premiums associated with the ecolabel.

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The International Standard for the Trade in Live Reef Food Fish: From voluntary code to certification

Geoffrey J. Muldoon¹ and Peter G. Scott²

Introduction

The Asia-Pacific region is home to approximately 45% of the world's coral reefs. These coral reef systems provide livelihoods and food for millions of people in coastal communities. According to a study by the World Resources Institute (Bryant et al. 1998), 80% of Southeast Asia's reefs are at serious risk of degradation and 56% are at high risk, with the situation being slightly better in the Western Pacific and the Indian Ocean. One of the most serious threats to coral reef ecosystems and biodiversity in the Asia-Pacific region is the use of destructive fishing practices. The term "destructive fishing" has been widely used to describe the impacts arising from the regional trade in live reef food fish, including the use of poisons such as cyanide, the use of destructive fishing gear, targeting of spawning aggregations, and most importantly, overfishing of fish stocks (Sadovy et al. 2003; Sadovy and Vincent 2002; Warren-Rhodes et al. 2003).

The live reef food fish trade (LRFFT), which involves mainly grouper species (family Serranidae), has been satisfying the growing Asian demand for high quality fish, especially in Hong Kong and southern China, for more than three decades. In recent years, the trade has become much more widespread throughout the region (Sadovy et al. 2003). Because it is lucrative³, the trade is regarded as a serious and expanding driver of destructive fishing in the region. In meeting the demands of the LRFFT many traditional supply economies, such as Indonesia, Vietnam, Thailand and the Philippines, have progressively depleted their inshore reef fish resources, usually to the detriment of coastal communities adjacent to these reefs. Continued overexploitation of reef resources in the Asia-Pacific region, in concert with the ongoing use of harmful fishing practices, has endangered the sustainability and future of what could be a profitable industry benefiting many people in the region.

Recognition of the need to mitigate the trade's destructive impact on coral reef systems and to

provide a foundation for enhancing the industry's sustainability led to a workshop in Honolulu in 2001 to develop appropriate strategies (Graham et al. 2001). The workshop was attended by representatives of all key non-governmental organisations (NGOs) involved in the LRFFT. One of the strategies identified at this meeting was the development of industry-wide "best practice standards" for the trade, covering the chain of custody from reef to restaurant.

With the endorsement of the Fisheries Working Group of the Asia-Pacific Economic Cooperation (APEC) and funding from APEC and the MacArthur Foundation, a multi-organisational effort to develop an environmentally and socially responsible standard of best practice for the trade was launched in 2002. The goal was to bring together stakeholders, and build consensus on what "best practices" were needed to enhance industry sustainability. The project was headed by The Nature Conservancy (TNC) and the Marine Aquarium Council (MAC). MAC, which is the only organisation to have developed industry standards for a live reef fish trade (i.e. the marine ornamental industry), took responsibility for coordination of the project and delivery of outcomes.

The International Standard for the Trade in Live Reef Food Fish (the Standard), which was finalised in late 2004, is the result of an iterative collaborative process. In order to gain broad acceptance for the idea of a standard, to understand the boundaries and limitations of any such standard, and to produce robust and credible best practices, the cooperation of all industry members was essential. This process of multi-stakeholder engagement involved:

- extensive informal consultations with individuals and organisations with experience in and knowledge of the trade;
- participation of APEC member economies with a history of involvement in the LRFFT;
- formation of a 100-plus member "Standards Advisory Group" made up of a broad range of

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3. The regional LRFFT has an estimated retail value of 450–500 million US dollars annually (Sadovy et al. 2003).

stakeholders in source and market countries, to review and comment on various iterations of the Standard;

- ongoing dialogue with all participants in the live reef food fish industry (fishers, suppliers, buyers, importers, wholesalers, distributors, restaurants and consumers) through in-country workshops, seminars and other fora; and
- field-based assessment of the standard to evaluate in-country capacity to attain the proposed benchmarks for capture, farming and distribution of LRFF and management of the trade.

The Standard was initially developed as a voluntary code of conduct for use by industry, government, and marine conservation organisations to improve the operation of their live reef fish food fisheries. The aim of the Standard was to make these high-value fisheries more sustainable and, specifically, to make them more capable of providing improved livelihoods for local fishers, providing a stable and healthy supply of live reef food fish to the market, and supporting the conservation of reef habitats.

The following sections: discuss the relationship between collaborative management models and the Standard, provide a brief overview of the Standard structure, and set out a proposed plan for taking the Standard from a voluntary scheme to a third-party certification program.

Collaborative management models

Fisheries resources around the world are declining at alarming rates. From large-scale industrial operations to small-scale artisanal fleets, fisheries are suffering from failures in the three fundamental areas of biological, social and economic sustainability. Collaborative management approaches are being seen as playing an increasingly essential role in fisheries management (Martin-Smith et al. 2004). Involving stakeholders in decisions affecting the fishery is seen as increasingly important for successful management of fisheries resources (Pomeroy 1995; Pomeroy et al. 2001).

The rationale for such participation by stakeholders is that collaboration among the various parties with a vested interest in a resource is likely to lead to better management and more sustainable trade and development. A number of management programs based on agreed-upon principles have indeed succeeded in protecting resources, guaranteeing product quality, and promoting trade. As a result, environmentalists, industry participants and end users alike have embraced such methods, recognising the mutually beneficial objectives and results of these programs.

One suite of collaborative approaches that is becoming more widely accepted is the use of common principles and standards of best practice as a means to conserve resources, regulate product quality and promote more responsible trading. A number of different collaborative models based on such standards and principles have been proposed for achieving improved resource management, including:

- industry standards,
- voluntary codes of conduct, and
- certification and ecolabeling.

Each of these approaches is ascribed varying levels of credibility and acceptance by end users and governmental or implementing agencies. Industry standards entail self-declaration by industry members (sometimes known as first-party certification). As industry members both choose the criteria for inclusion and certify themselves, this approach usually has no national or international credibility. Industry standards can also describe national or regional management schemes. This approach entails compliance with an agreed-upon standard that has been developed via collaborative input from relevant stakeholders, including industry, governments and NGOs, and is often referred to as second-party certification. Compliance in this instance is usually overseen by an independent body comprising one or several stakeholder groups. While this approach has more credibility than first-party certification, that credibility usually only extends as far as applicable national or regional borders.

Voluntary codes of conduct and certification and ecolabeling schemes represent successive steps in the third-party certification process. While both are developed through an international consultative process, each requires different levels of accordance or compliance. Codes, such as the FAO (Food and Agriculture Organization of the United Nations) Code of Conduct for Responsible Fisheries, provide frameworks for coordinated national, regional and international efforts relating to sustainable use of resources. While participation is voluntary, these codes can carry international weight in the form of "signatory membership" or through governmental interventions. Codes of conduct and industry standards can be given more authority when brought under a third-party certification program. While such certification programs carry the endorsement of governments, these programs are usually born out of strategic partnerships between business and environmental groups and are often brokered by conservation-oriented NGOs. The goal of achieving sustainable resource use is primarily achieved

through an incentive-based approach that aims to reward businesses for compliance with an agreed-to set of principles or standards.

Hybrid models of the above approaches are also possible. For example, the production end of the market chain could be subject to compliance with nationally or internationally agreed-upon principles enforced through national or provincial governments, leading to certification, while the demand end of the market chain is subject to a nationally or internationally endorsed voluntary code of compliance enforced through consumer preferences.

The need for an international standard for the LRFFT

Although a number of government agencies, regional agencies, industry bodies and NGOs have made important and effective efforts to address the impacts of the LRFFT, many of these activities have been undertaken in isolation or have only addressed specific aspects of the industry's impact on fish resources. No single government or other agency has been in a position to work with the industry's full "chain of custody" with a view to effecting industry-wide transformation.

The LRFFT comprises two distinct sectors involving LRFF supplied from approximately 20 countries: that which supplies markets in Hong Kong and China with wild-caught reef fish, and that which supplies these markets with "cultured" fish. In the case of cultured fish, it has been recognised that a large proportion of the total volume traded (15–40%) comes from the capture and grow-out of wild-caught juveniles, while only a small percentage (10–15%) is reared from eggs to market-sized fish through full-cycle mariculture (Sadovy et al. 2003). This dependence on juvenile wild-caught fish for grow-out highlights the need for the Standard to address both the wild-caught and mariculture sectors of the trade simultaneously.

Accordingly, the Standard encompasses all aspects of the production and management of both wild-caught and cultured fish entering the LRFFT. It also addresses the distribution, trade and consumption of LRFF. Intentionally, the scope of the Standard embraces the whole chain of custody for LRFF products, and includes fishers, traders, exporters, importers, wholesalers, restaurateurs and consumers.

The primary objective in developing the Standard was to have it serve as a comprehensive guide to assist governments, NGOs and regional agencies engaged in LRFFT-related activities in their work with stakeholders at various stages along the market chain. Moreover, it was hoped that the Standard would be a tool for promoting partnerships and/or collaboration between multi-sector stakeholders (communities, governments, NGOs and the private sector) in order to improve the management of the LRFFT.

Collaborative management models and the Standard

Successful management programs are usually based on agreed-upon standards developed through a collaborative process involving the participation of as broad a range of stakeholders as possible. The Standards project team reviewed possible collaborative management frameworks under which the Standard could be applied. Consensus was reached that a voluntary code of conduct approach was the most suitable starting point for developing the Standard. The FAO Code of Conduct for Responsible Fisheries provided an obvious model for the LRFFT.

Many codes of conduct are criticized for being overly vague, for failing to be adequately implemented and for lacking sufficient monitoring of compliance. Any code of conduct must address these issues in order to be truly effective. In developing the Standard, the project team adopted a principle-type approach⁴ in recognition that the Standard should be a concise document that is relatively easy to understand rather than the complex text that makes up some of the other international standards or codes that have been developed. This approach was also preferred to a more prescriptive stance, as it provides a framework whereby national management agencies are able to incorporate these universal principles into their national management plans in a way that suits their needs (Cochrane 2000; Peacey 2001).

Like the FAO Code of Conduct, the Standard was initially conceived as a set of key principles and criteria, compliance with which would be voluntary. However, throughout the Standard development process, it was recognised that the Standard might eventually form the basis for an international third-party certification program (Graham et al. 2001). Thus, from the beginning of the Standard develop-

4. A principle-type approach is a top-down approach whereby overarching principles highlight key considerations accepted as critical to devising or improving the operation and management of the fishery in terms of biological, ecological, social and economic considerations. Under each principle a number of sub-principles and sub-sub-principles are added which put flesh on the bones of these principles in the form of specific guidelines or criteria as to how fishery managers can fulfil their responsibilities in terms of adhering to these principles (see Cochrane 2000).

ment process, consideration was given to the structure and content of the Standard with that in mind (see the following section and Fig. 1). The ultimate intention was to both develop a standard and create a system for independently verifying compliance with the Standard, which is the approach taken in the Marine Stewardship Council (MSC) and MAC models.⁵ It was felt that the best method of ensuring compliance and implementation of the Standard would be by using the Standard within an independent third-party certification program.

The unique characteristics of the LRFFT as a tropical small-scale fishery did, however, present valid arguments for the unsuitability of implementing a certification program within the trade. Such characteristics included: the large volume and number of species traded, the remoteness of fishing grounds, the large number of landing sites and data limitations (Pauly 1997). Moreover, the limited institutional and financial capacity to undertake resource assessment and monitoring to manage the fishery and achieve compliance and to overcome issues such as corruption and the potential for fraudulent reporting was a major concern with respect to the feasibility of a certification system within the LRFFT (Gardiner and Viswanathan 2004). A number of other limitations and challenges of the certification approach in developing-country fisheries have been identified. These include the potential for distorting existing practices and livelihoods, for creating market incentives that favour the export of certified fish and the need for establishing criteria that are equally achievable for fishers in developing and developed countries (Gardiner and Viswanathan 2004). Certification programs can be tailored to accommodate such characteristics, however, and a community-based certification program presented one alternative approach for dealing with the small-scale artisanal nature of the LRFFT (Civic Exchange 2001).

The challenges inherent in introducing a third-party certification program into the LRFFT are not restricted to the supply end of the market chain. The critical factor that determines the success or failure of any certification scheme is consumer acceptance and participation. Empirical studies have shown that consumers in the US and Europe are willing to pay more for food that is certified as coming from a sustainable source (Wessels et al. 1999; Johnston et al. 2001).⁶ Results from these studies suggest, however, that consumers will continue to prefer certified products only so long as

the price premium associated with that product is not excessively large. The response of consumers to eco-labeling schemes varies greatly among regions and countries. Most future expansion in demand for fishery products is anticipated to occur in Asia and Latin America, where consumers are presently not very responsive to eco-labeling of fish and fishery products (Gardiner and Viswanathan 2004).

The scope for using certification in a fishery such as the LRFFT appears limited in the short to medium term and will require considerable consumer education and outreach to alter current consumer preferences. Although the main consumers of LRFF may not exhibit "green" preferences, countries from which LRFF are sourced are under increased international scrutiny. To this end, pressure can be placed on supply country governments by other governments and NGOs to encourage them to impose greater controls on LRFF fishery participants. For example, they can require that fishery participants comply with specific export requirements.

One of the downsides of certification programs is the sometimes high costs of compliance. On the supply side, an important question is the extent to which producing a sustainable product would increase production costs. In addition to production costs there are downstream costs associated with maintaining the "chain of custody" required to ensure certified commodities are not contaminated with non-certified commodities (Sedjo and Swallow 2002). It can be argued that a price premium paid by consumers may defray these additional costs. However, this is contingent on the product being sold into a receptive consumer market. Alternatives have been suggested for developing-country fisheries, including labels of geographic origin and fair trade labeling schemes. The latter ensure that artisanal fishers' livelihoods are maintained and that fishers are rewarded for non-destructive, environmentally selective fishing methods (Gardiner and Viswanathan 2004).

The issue of cost has particular resonance in fisheries such as LRFF fisheries, which are mostly artisanal in nature and which have complex market chains involving numerous agents and intermediaries (Sadovy et al. 2003). Based on the experience of MAC, it is anticipated that the costs of certification would be minimal in relation to the high values of LRFFT products. Also, the participatory approach involving fishing communities

5. MAC and the MSC are organizations that promote responsible fishing via third-party certification programs. "Core Standards", in the case of the MAC and "Principles and Criteria for Sustainable Fishing", in the case of the MSC, comprise the standards used in their respective programs.

6. Fishery products are traditionally certified as being from a more sustainable source through the use of eco-labeling.

and NGOs, as practiced by MAC, offers a cost-effective means of certification. Furthermore, targeting the efforts at specific points along the market chain can redistribute the costs of certification more equitably.

One area of the LRFFT where the Standards project team deemed certification to be more immediately feasible was in the mariculture sector. While mariculture is often not conducted in an environmentally responsible manner, and is consequently branded as an unsustainable industry, the structure of the LRFF mariculture industry appears to lend itself more easily to a certification framework than does the wild-caught sector. For example, the various stages of culturing LRFF (hatchery, nursery, grow-out and distribution), the proximity of farms to distribution centres and the generic and replicable production processes all suggest a reasonable likelihood of successful implementation of a certification program.

The International Standard for the Trade in Live Reef Food Fish

As previously noted, the Standard encompasses all aspects of the supply and demand for LRFF and includes both the capture of wild fish and the culture of LRFF, as well as the handling, holding, distribution and marketing of these fish. While the Standard addresses wild-caught and cultured supplies separately, it does recognise the relationship between them. Under each of the sections of the Standard pertaining to the supply of LRFF, sub-sections address management and the operational practices of fishers and farmers identified by stakeholders as essential to ensuring a more responsible and sustainable trade. From the demand end, sub-sections addressed the trading and consumption of LRFF.

The Standard itself is comprised of key criteria that were agreed-upon through multi-stakeholder consultations as being those best practices needed to improve the conduct of the industry and enhance industry sustainability. These criteria are referred to as "Requirements". Attention was paid to ensuring that these requirements were practical and specific to the LRFFT. Moreover, these requirements recognized the importance of conducting LRFF fisheries in a manner consistent with relevant local and national laws and standards.

While the Standard document itself was deliberately concise, it was recognised that more prescriptive best practice guidance would be needed to clarify and augment each of the requirements. It was further recognised that more specific manuals and handbooks would be needed to explain how

these requirements could be implemented or complied with. Together, these best practices and implementation guides would ensure that the meaning and intent of the requirements were clear and describe how participants in the LRFFT could satisfy each of the criteria (Fig. 1).

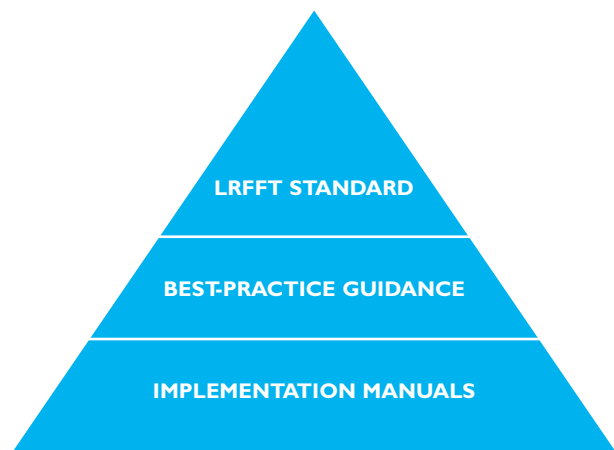


Figure 1. The structure of the Standard

It was recognised early on by the project team that there was an abundance of existing training and instructional manuals available, but acquiring these materials would be ponderous and time-consuming for stakeholders and industry participants. There was thus a need for a more efficient and accessible alternative.

Considerable time was spent looking at alternative ways of improving access to these materials, and it was decided that the best-practice guidance should take the form of an "implementation toolkit". Eventually it was decided that the toolkit should take the form of a world wide web-style CD-ROM containing all the relevant information pertaining to the Standard, including a library of existing papers, reports, manuals and toolkits in electronic format.

Subsequently the Standards project team agreed to supplement the CD compendium with the establishment of a website dedicated to LRFFT issues in general. Initially, however, the website would comprise only the Standard and all the best-practice and implementation guidelines that accompany it on the CD. The website address is <http://www.livefoodfishtrade.org>. The home page for the website and as it appears on the CD-ROM compendium is shown in Figure 2.

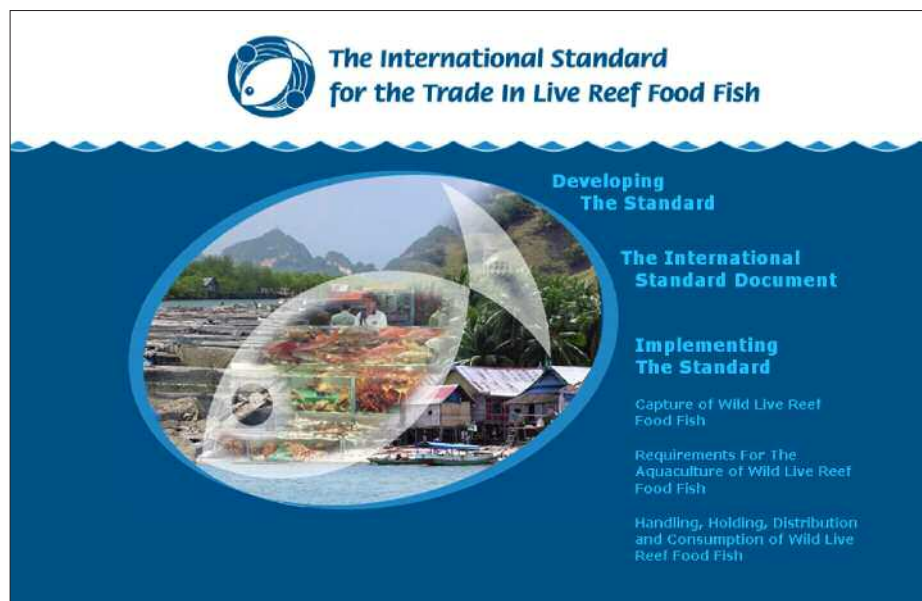


Figure 2. The website home page for The International Standard for the Trade in Live Reef Food Fish.

The Standard: A proposed plan of implementation

As noted above, the purpose of the Standards project was to produce a credible and robust international standard for the trade in live reef food fish. Having produced the Standard, the project team considered possible options for broader implementation. These included self-declaration by industry participants (first-party certification), compliance to the Standard within a program operated by a LRFF trade association (second-party certification), and third-party certification analogous to that being undertaken by MAC for the international trade in ornamental fishery products.⁷ While the nature and characteristics of the LRFFT certainly make certification a challenging option, it is contended that a third-party certification program represents the best way forward for transforming the trade. The remainder of this article outlines a program for implementing the Standard under such a program.

The demand from informed consumers for environmentally sound products provides incentives for industries to adopt and adhere to standards for quality and sustainability. While the idea of effecting positive change in the LRFFT through the application of third-party certification has not yet garnered industry-wide support, responsible stakeholders are able to see the need and opportunity for certification to ensure a more sustainable and environmentally sound LRFFT.

For example:

- Governments and coastal communities in exporting countries want a sustainable, environmentally sound trade that provides income generation and support for reef stewardship, conservation and management.
- Governments in importing countries want their consumers, policies and legislation to support a sustainable, environmentally sound trade that provides incentives for reef stewardship, conservation and management.
- LRFFT industry participants want an industry that produces safe, high quality products using sustainable practices. The industry also wants minimal mortality, healthy animals, a healthy bottom line (there is no profit in a dead fish), a sustainable supply (i.e. healthy, productive reefs) and standards that codify best practices and create a level playing field for all participants.
- Conservation organisations want a sustainable, environmentally sound trade that provides incentives for reef stewardship, conservation and management.

By encouraging compliance with credible, international, multi-stakeholder standards of best-practice, certification can assist the LRFFT in becoming more responsible and sustainable. Certification will allow the industry and market to reject unsustainable, sub-standard practices and products. Sub-standard

7. That is, compliance with a standard is assessed and verified by an accredited third-party certifier.

operators will be encouraged by the market to either improve their practices or lose market support and leave the trade. Certification can also promote sustainable financing from industry for conservation, whereby the industry supports the monitoring, conservation and management of reefs.

Developing countries, and even developed countries, often do not have the funds to create, implement and enforce laws and management plans that are capable of protecting all reefs all the time. Coastal communities with incentives to manage and conserve reefs may be the best hope for widespread, ongoing, effective and financially sustainable reef conservation and management. With market incentives and independent certification, coastal communities involved in the LRFFT would have greater motivation to engage in the management and conservation of their reefs, often in remote areas rarely visited by government.

The LRFFT involves more than 20 countries with a range of capabilities for managing and conserving their LRFF resources, for effecting change through improved practices and for ensuring compliance with the Standard. For example, in a country such as Australia, fishery participants would find it relatively easy to comply with the requirements of the Standard if a certification program were in operation. In other countries, such as Indonesia and the Philippines, it would require extensive outreach and capacity building for the LRFF industry to meet the minimum requirements of the Standard.

It is anticipated that because the Standard is a “living document”, subject to continuing revision and elaboration, it would be best to employ a two-phased approach for the adoption of a third-party certification program within the LRFFT. During the first phase the industry and local, national and regional agencies and organisations would be consulted, with the aim of creating a network of supply-side and demand-side industry participants and trade associations that are committed to complying with the requirements of the Standard. During this initial phase, various stakeholders would participate in a gap analysis whereby their activities would be assessed against the requirements of the Standard. An action plan would then prescribe remedial action to be undertaken to bring those stakeholders into compliance with the Standard.

At the end of phase 1, a detailed and comprehensive review would be undertaken to objectively measure the interest and involvement of industry members and local, national and regional agencies and other stakeholders in moving forward to a formal independent third-party certification program. A second phase, should it be supported, would entail outreach,

capacity building and training, designing a third-party certification program, undertaking pre-certification audits in participating countries and training and accrediting third-party certifiers (Table 1).

It is proposed that a LRFFT Council be formed to oversee the two phases of implementation of the Standard. The Council would be comprised of certification organisations (e.g. MSC and MAC), industry associations, and local, national and regional agencies and organisations, with no single interest predominating. The Council would have the following roles and responsibilities:

- Oversee the endorsement of the Standard, ensuring that all relevant governments and industry organisations are included in a fully transparent process (see Appendix for a list of such entities).
- Conduct annual meetings to address proposals for changes to the LRFFT Standard, on the understanding that no such changes would be put into effect without endorsement by relevant industry groups and local, national and regional agencies and organisations (see Appendix).
- Oversee the various activities in support of the Standard and its implementation, including communications and promotion.
- Represent the Standard in dealings with government agencies and international bodies.

The question of the continuing need for the LRFFT Council would be assessed at the end of the initial phase of the project. Should the project proceed to the second phase, it is envisaged that at some point, responsibility for project implementation would shift from the Council to an independent body that would continue to run the certification program.

It is important to avoid the creation of a separate certification program just for the LRFFT. Should there be sufficient consensus for certification to the Standard, it would be appropriate to consider integrating this into an existing fish certification program. There is no organisation offering independent third-party certification of food fish solely in the artisanal fishing sector or that addresses both mariculture and wild-capture fisheries. However, two organisations introduced previously in this article, MSC and MAC, collectively offer sufficient certification experience to cover these aspects of the LRFFT. They also oversee outreach, capacity building and extension training activities with fishers and fishing communities and exporters and importers. One fillip for the introduction of a certification program for the LRFFT is that many LRFF harvesters are already familiar with MAC certification programs, since many harvesters of LRFF also collect marine ornamental organisms.

Table 1. Proposed implementation plan for establishing a certification program for the LRFFT Standard.

| Year | Activity | 1st Qtr | 2nd Qtr | 3rd Qtr | 4th Qtr |
|---------------|--|---------|---------|---------|---------|
| 1 | Establish LRFFT Council | | | | |
| 1 | Undertake review of organisations that could act as secretariat to the LRFFT Council | | | | |
| 1 | Appoint LRFFT Council secretariat | | | | |
| 1 | Hold discussions with donors and private foundations with respect to continued funding of the LRFFT Council | | | | |
| 1 | Establish relations with enabling agencies; that is, organisations and bodies capable of putting the Standard into practice (e.g. APEC, NACA, STREAM, SPREP, SPC, COREMAP) | | | | |
| 1 | Form LRFFT industry network comprising suppliers and purchasers of LRFF | | | | |
| 1 | Undertake awareness programs with industry members and other organisations that have committed to complying with the Standard through formal certification, as and when appropriate | | | | |
| 1 | Work with each APEC member economy to develop a LRFFT policy and implementation plan | | | | |
| 2 | Agree on gap analysis criteria and program | | | | |
| 2 | Undertake gap analysis on industry members throughout the whole chain from demand side through to supply side | | | | |
| 2 | Agree to remedial action plans with each industry member | | | | |
| 2 | Design outreach, capacity building and extension training program | | | | |
| 2 | Work with each APEC member economy to sign up to the LRFFT policy and implementation plan | | | | |
| End of Year 2 | Detailed review to objectively measure buy-in from industry members and local, national and regional enabling agencies to ascertain whether outreach, capacity building and extension training should be undertaken as a precursor to formal certification under an independent third-party certification program. If the review is positive then the implementation continues into a second phase as follows: | | | | |
| 3 | Undertake outreach, capacity building and extension training programs with industry members in various countries | | | | |
| 4 | Design third-party certification program | | | | |
| 4 | Undertake pre-certification audits of industry members in various countries | | | | |
| 4 | Plan certification program, and train and accredit independent third-party certifiers to LRFFT certification program | | | | |
| 4 | Shift commences from LRFFT Council secretariat to the body that will manage LRFFT certification program | | | | |
| 5 | Undertake LRFFT certification audits | | | | |
| 5 | Issue certification to successful LRFFT industry members | | | | |

Abbreviations:

APEC – Asia-Pacific Economic Cooperation
NACA – Network of Aquaculture Centres in Asia-Pacific
STREAM – Support to Regional Aquatic Resource Management
SPREP – South Pacific Regional Environment Programme
SPC – Secretariat of the Pacific Community
COREMAP – Coral Reef Rehabilitation and Management Program

Conclusions

Adoption of management programs based upon common principles and standards is a growing global trend. From protected species to non-endangered products, such programs have been put into place to conserve resources, regulate product quality and promote trade. Such principles and standards are representative of collaborative approaches to the management of fisheries resources that involve all stakeholders along the chain of custody for those resources.

This article has used the recently developed International Standard for the Trade in Live Reef Food Fish as an example of how collaborative resource management strategies can be applied to the LRFFT. The Standard in its current form is a voluntary code, fashioned around the key principles of the FAO Code of Conduct for Responsible Fisheries. It was developed with input from all LRFFT stakeholders, including industry, government agencies, NGOs, regional agencies and researchers and academics, as well as individuals with experience in developing fishery codes of conduct and standards. It is possible that this voluntary standard could, given sufficient stakeholder support, become the template for establishing an independent third-party certification program for the LRFFT.

Although the unique aspects of the LRFFT make implementing a certification program difficult, the LRFFT is not unsuitable for such a program. Given the current threats to the world's coral reef ecosystems, collaborative resource management appears to be critically needed; a certification program to implement the recently developed Standard might be both possible and an important step forward in the management of the LRFFT and the region's coral reef ecosystems.

It is hoped that this article provides information useful for stimulating thinking and discussion and facilitating the development of a collaborative management scheme suitable for the live reef food fish trade.

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Appendix

Following is a list of industry groups and local, national and regional agencies and organisations that were involved in the development of the LRFFT Standard and that could be among those that endorse the Standard and any future changes to it.⁸

- Agriculture, Fisheries and Conservation Department, Hong Kong
- Asia-Pacific Economic Cooperation
- Balai Budidaya Laut, Lampung (National Seafarming Centre, Lampung)
- Bureau of Fisheries and Aquatic Resources, Philippines
- Badan Pengkajian Dan Penerapan Teknologi (Agency for the Assessment and Application of Technology), Indonesia
- Department of Fisheries, Ministry of Agriculture and Cooperative, Thailand
- Department of Fisheries, Vietnam
- Forum Kerapu Indonesia
- Great Barrier Reef Marine Park Authority
- Gondol Research Institute for Mariculture
- Hong Kong Chamber of Seafood Merchants
- Hong Kong Federation of Restaurants and Related Trades
- Hong Kong Food and Environmental Hygiene Department
- Industriya Sa Dagat Association of Exporters, Philippines
- Marine Aquarium Council
- Marine Resource Industry Association, Philippines
- Marine Stewardship Council
- Ministry of Marine Affairs and Fisheries, Indonesia
- Network of Aquaculture Centers in Asia-Pacific
- Palawan Council for Sustainable Development
- National Fisheries Authority, Papua New Guinea
- Queensland Department of Primary Industries
- Queensland Fisheries Service
- Queensland Seafood Industry Association
- Seafood Services Australia
- Society for the Conservation of Reef Fish Aggregations
- Secretariat of the Pacific Community
- Taiwan Fish Breeding Association
- The Nature Conservancy
- University of the South Pacific
- WWF Hong Kong
- WWF Philippines
- World Resources Institute

8. This list does not include the numerous individuals and industry representatives who provided valuable input into the development of the LRFFT Standard.



Economic and market analysis of the live reef food fish trade in the Asia-Pacific region

Brian Johnston¹ and Being Yeeting²

Introduction

The Australian Centre for International Agricultural Research (ACIAR) and the Secretariat of the Pacific Community (SPC) hosted a workshop on the economics of the live reef food fish (LRFF) trade. The workshop was part of a three-year research project funded by ACIAR to study the economics and marketing of LRFF fisheries and trade and to identify the necessary conditions for sustainability of supply and the overall trade in the long term. The purpose of the project is to assist countries involved in the trade to ensure they secure adequate returns for fish supplied to the market, and to ensure that supply is sustainable in the long term, both from wild-caught sources and aquaculture. The project is being closely coordinated with a related ACIAR project on marine finfish aquaculture in the Asia-Pacific region, headed by Dr Mike Rimmer of the Queensland Department of Primary Industries and Fisheries (Australia).

The aim of the workshop was to familiarize and involve Pacific Island countries in the project, including through the sharing of information among fishery managers, and to evaluate the usefulness of the modelling approaches being developed by the project. A second workshop is planned for 2006 at the WorldFish Center in Penang, Malaysia.

The workshop was attended by participants from six Pacific Island countries (Fiji, Papua New Guinea, Kiribati, Solomon Islands, Federated States of Micronesia and the Marshall Islands) and by researchers from SPC, Australian National University, University of Western Australia, James Cook University, Bogor Agricultural University, ACIAR, Indonesia Research Center for Marine and Fish Product Processing and Socioeconomics, Queensland Department of Primary Industries and Fisheries and the WorldFish Center. Indonesian researchers were encouraged to provide the perspective of Asian countries involved in the trade.

Background to the trade

Marine fish are an important component of the diet in Asia and the Pacific, and their capture and culture are important sources of income in coastal communities throughout the region. In Asia, including Hong Kong and mainland China, a number of higher value species are transported live to the market and freshly cooked. These products are often consumed on celebratory occasions, such as special family occasions and successful business events. In restaurants, the live fish are chosen from tanks by the customers just prior to cooking and serving. Restaurant prices are 100–200% higher than reported wholesale prices, with the preferred size being plate-sized, or 0.5–1.0 kilograms.

The demand for LRFF is substantial, with recent estimates valuing the trade at the retail level for Hong Kong and mainland China at more than 400 million United States dollars (Sadovy et al. 2003). Currently, approximately 20,000–25,000 tonnes (t) of LRFF are traded through Hong Kong annually. The rate of trade was substantially higher during the mid-1990s, prior to the Asian economic crisis. Both wild-caught and aquaculture-raised fish enter the trade and a substantial portion of LRFF entering Hong Kong is subsequently transshipped to mainland China. This proportion is currently estimated at 40–50%, according to the Hong Kong Chamber of Seafood Merchants (pers. comm. E. Lai, General Manager, Fish and Vegetable Marketing Organizations, Hong Kong, February 2005).

It has proved difficult to accurately quantify the volume of trade because fishing vessels operating out of Hong Kong that are licensed by China have been exempted by the Hong Kong government from the need to declare their imported fish. Consequently, the trade statistics supplied by the Hong Kong government exclude the catches from these vessels (although some traders have voluntarily reported their imports via these vessels; Sadovy et al. 2003). It appears that the absence of LRFF imported via China-licensed vessels in the

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database may lead to approximately 3000 t per year, or about 15% of total LRFF imports to Hong Kong, not being accounted for (Agriculture, Fisheries and Conservation Department 2003). Also, prior to 1997 it was not possible to identify individual species or even species groups, as live fish imports were recorded only as either food fish or ornamental fish.

Hong Kong has been the centre of demand for LRFF for many years. Demand for these fish increased strongly from the 1960s as personal incomes rose. Total annual reported imports of LRFF peaked in 1998 at approximately 22,000 t (Sadovy et al. 2003). In terms of the fish categories used by Hong Kong's Agriculture, Fisheries and Conservation Department (2003), "high value species" comprised approximately 1000 t, "other groupers" (medium priced) 5000 t, "snooks and basses" 1200 t and "other marine fish" 15,000 t. With the Asian economic crisis in 1999 and the eventual downturn in personal incomes in Hong Kong, reported imports declined by approximately one-third by 2003, to just under 15,000 t (Agriculture, Fisheries and Conservation Department 2003).

The Asian economic crisis caused some lasting changes in the market. Imports to Hong Kong of high value species grew steadily from approximately 1000 t in 1998 to 2500 t in 2003. During the same period, imports of lower value species (snooks and basses, and other marine fish) declined from 15,000 t to approximately 5000 t per year. LRFF prices have fallen steadily since early 2002 and different groups of consumers have reacted in different ways to the changing market conditions. Higher income consumers appear to have continued to demand the higher priced LRFF in increasing quantities, while lower income consumers have reduced consumption of LRFF.

Key issues raised during the workshop

Pacific Island countries are seeking more timely access to data on the market conditions in Hong Kong and southern China so that they can assess the fairness of prices being paid to local fishers. Market chain analysis is a valuable tool to enable countries to assess the fairness of returns being received by local fishers in price negotiations. This issue is central to their consideration of requests for access to their fishing grounds by foreign traders, as they have an interest in capturing resource rents that are commensurate with the benefits accrued by non-local fishing companies when accessing local fishery resources.

Another challenge for Pacific Island governments is ensuring that the benefits of this access are equi-

tably shared amongst fishing communities. The underlying legal basis of access may need to be clarified in national fishery legislation in order to better recognise the various tiers of resource ownership. Access to LRFF by foreign traders can adversely affect local subsistence catches of reef fish as well. There is need for a "balance sheet" approach that looks at both the potential benefits and the potential costs to the community of providing access.

The workshop participants agreed that the Pacific Islands should take a risk management approach to their wild-caught fisheries. For example, they should permit conservative access to the stock, but only as long as they include regular stock status monitoring (via vessel observers and fishery-independent resource surveys) as part of the management regime and recoup the costs of management from the fishing operations. They were also encouraged to clarify any legal ambiguity about fish stock ownership and management in legislation before granting licenses, to ban destructive fishing practices (penalized by the automatic loss of a license), and to close fishing grounds during spawning aggregation periods.

The question of how to determine sustainable levels of utilisation of wild fish stocks was recognised as being the key to establishing any long-term sustainable LRFF fishery in the Asia-Pacific region. Fishery managers require tools that enable them to assess optimal catch levels — that is, levels that are both sustainable and profitable — but the data needed to do this are currently unavailable. It was therefore considered worthwhile to develop some rules of thumb (ROT) on sustainable catch rates for guidance for Pacific and Asian fisheries. The need for such ROT was first brought up during the LRFF Trade Industry Standards Workshop organised by The Nature Conservancy (TNC) and the Marine Aquarium Council (MAC) in Townsville, Australia, in 2002. Some preliminary discussions on the appropriate rules that should be included in the LRFF Trade Standards took place during that workshop, but no such ROT appear to have been included in the Standards that were ultimately developed. The participants in this 2005 workshop reiterated the importance and need for such ROT. This project will review the work that has been done on this and continue the development of ROT that can serve as a useful tool for fishery managers.

The Pacific Islands have occasionally supplied small numbers of ciguatera fish to Hong Kong, resulting in ciguatera poisoning incidents that have affected dozens of consumers. These incidents have been well publicised in Hong Kong and internationally, resulting in the Pacific Islands acquiring

a reputation for supplying ciguatoxic fish. This has impacted the supply of LRFF from Pacific Island countries, as Hong Kong distributors have become cautious about importing fish from the region. In response, strategies for avoiding ciguatoxic fish in the supply of wild-caught LRFF from the Pacific Island region need to be developed.

Aquaculture technology is advancing rapidly, and higher value LRFF species such as the humpback (or highfin) grouper (*Cromileptes altivelis*) and coralgroupers (*Plectropomus* spp.) are now being raised from hatchery-reared seed stock in Taiwan. Monitoring the production effects of this development should be a priority over the next few years, as prices for wild product could be significantly lowered by production surges of cultured product.

There is a need to more closely examine LRFF trade flows into southern China, as it is anticipated that most of the growth in demand will occur there. Aquaculture production of LRFF in southern China is also increasing rapidly. The quality of demand and supply statistics for China is poor and will need to be improved in order to allow better tracking and understand of both these trends in the future.

Next steps in the project

The papers presented at the workshop are currently being prepared for publication as workshop proceedings, which are expected to be available in late 2005. The proceedings will also include relevant papers that are available on the website of the Network of Aquaculture Centres in Asia-Pacific (NACA: www.enaca.org).

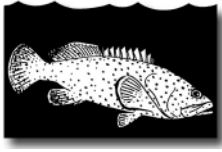
The ACIAR project will be conducted over the period July 2004 to December 2006. The principal researchers involved in the project are developing further papers on key aspects of the trade, including:

- Econometric analysis of the demand for LRFF in Hong Kong and mainland China.
- Analysis of supply relationships for wild-caught and cultured LRFF supply from the main supplying countries (Indonesia, Hong Kong and mainland China, Malaysia, Philippines, Vietnam, Pacific Island countries, Australia).
- Analysis of the cost components and risks of the market chain and development of spreadsheet models for cooperating countries (wild-caught and aquaculture models).
- Market chain analysis to test for market power and whether any part of the supply chain can set prices along the chain from fisher to retailer.
- Integration of demand and supply through development of models for projections.
- Assessment of consumer preferences for wild-caught versus cultured product.
- Use of bio-economic models and other econometric tools to identify policy options for future management of the LRFF trade to ensure it is sustainable in the longer term.

The expected outcome of the research is a better understanding of the marketing chain for LRFF, including how prices are set in the chain and how Pacific and Asian fishery managers can use the tools of economics to ensure — as far as is practicable — that fishers and their communities receive a fair return for the sustainable utilisation of their fishery stocks. As noted in the introduction, the purpose of the overall project is to assist countries involved in the trade to ensure that they secure adequate returns for fish supplied to the market and that supply is sustainable in the long term, both from wild-caught and cultured sources. Should readers seek further background information on this project, please contact the authors.

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News and events

live reef fish

Sixteen new boats for Sri Lankan ornamental fishermen

Source: Ornamental Fish International (<http://www.ofish.org/>, accessed 17 November 2005)

Directly after the tsunami hit the Sri Lankan coasts, last December, several members of OFI [Ornamental Fish International] asked the OFI secretariat to launch a campaign to help the fishermen in Sri Lanka. Thanks to generous support of the OFI members, the first ever campaign in OFI history raised more than 12,000 Euros.

After thorough consultations with the OFI Advisors located in the respective countries, it was quite early established that it was in Sri Lanka that aquarium industry operators had suffered the largest losses. In a large area around the east, south and west coast of the island, many fishermen who make their living collection ornamental marine specimens had lost their homes, boats and collecting gear. Many had also lost family members.

OFI Executive Board member Vibhu Perera, based in Sri Lanka, assisted in supplying information on the needs of the Sri Lankan fishermen affected by the disaster. On this basis 16 fishing boats, built in fibre glass by Gulf Star Marine and Diyakawa Marine, were procured for ornamental fish collectors in Sri Lanka.

Since boats are shared by as many as 12 divers in Sri Lankan fish collecting communities, around 190 families will benefit from OFI's donation.

The first two boats were handed over to fishermen in Dehiwala, South of Colombo, by OFI President Svein A. Fosså and Vice President Pauline Teo in a small ceremony on 6 June. The remaining 14 have subsequently been handed over by Vibhu Perera.

[For more information on Ornamental Fish International's Tsunami-help-fund, see the announcement on OFI's web site: <http://www.ofish.org/data-area.asp?aid=14474&gid=5353>]

Tsunami news

For information about the effects of the December 2004 tsunami on fisheries and coastal communities, as well as recovery efforts, useful web sites include those of the Network of Aquaculture Centres in Asia-Pacific (<http://www.enaca.org/>) and the Food and Agriculture Organization of the United Nations (<http://www.fao.org/tsunami/fisheries/index.htm>).

Asian Fisheries Forum presentations on mariculture

Source: *Marine Finfish Aquaculture e-News*, No. 19 (11 January 2005)

NACA organized a special session on mariculture for the 7th Asian Fisheries Forum, (Penang, Malaysia, Nov 29-Dec 3, 2004) in partnership with FAO, WFC, ACIAR, TDH and others. There were a total of eight presentations delivered for this special session:

- An overview of marine finfish aquaculture in the Asia-Pacific region
- Environmental trends and constraints in mariculture development in the Asia-Pacific region
- Health management practices in Asian mariculture — current status and challenges
- Escapes of farmed fish: Ecological and genetic impacts on natural populations and how to manage them
- Mariculture in the Pacific
- Salmon farming: A global success story with focus on the impact of vaccines on the Norwegian industry
- Economic aspects of marine fish culture in the Asia-Pacific region
- Industry standards for responsible fishing practices: The live reef food fish trade in Southeast Asia and the Pacific

Grouper production increasing

Source: *Asia-Pacific Marine Finfish Aquaculture e-News*, No. 23 (28 March 2005)

The Food and Agriculture Organization of the United Nations (FAO) has released an updated dataset on aquaculture production and value. For the first time, the FAO data set disaggregates grouper production from marine finfish production from China. In 2003, China produced 26,790 tonnes of grouper (*Serranidae*). This represents just over half of the total global aquaculture production of groupers, which was around 52,000 tonnes in 2003. Although this is a substantial increase from the reported grouper aquaculture production of 23,000 tonnes in 2002, most of this increase can be attributed to the inclusion of Chinese production in the 2003 figures. Grouper production from aquaculture was valued at around US\$238 million in 2003, up from US\$120 million in 2002. The updated FAO datasets are available from: <http://www.fao.org/fi/statist/FISOFT/FISHPLUS.asp>

Improvements in live rock assessment and management under development

Source: *MAC News*, 1st Quarter 2005

The MAC [Marine Aquarium Council] Pacific team is working with the industry, communities and other stakeholders in Fiji to develop and test improved methods for assessing live rock resources, creating management plans for collection areas and managing live rock extraction practices, following on from Fiji workshops on the coral and live rock trade in 2004. They conducted the initial research by familiarizing themselves with the techniques of live rock collection, observing village collectors and conducting interviewing collectors on their expertise in identifying the collectable live rock. In the second step, the live rock was examined, weighed and categorized after it had been delivered to a facility for screening and curing before export.

MAC participated in several multi-stakeholder workshops that were conducted to develop improvements to methods for assessing and managing live rock. A first comprehensive live rock assessment using the revised methods was carried out at a collection site along the Viti Levu coast near Suva, Fiji, in partnership with the company operating in that area, Water Life Exporters Fiji Ltd (WEF), and with active involvement of the company and enthusiastic assistance from the collectors in the community. The assessment was designed to provide baseline information as a requirement for the development of a Collection Area Management Plan (CAMP), initiate MAQTRAC monitoring with recommendations for an on-going Monitoring Assessment and improve the site-based resource management of live rock collection.

Canadian supported Pacific Marine Ornamentals Certification project comes to a close

Source: *MAC News*, 1st Quarter 2005

The Marine Ornamentals Certification project, funded by the Canadian-South Pacific Ocean Development program, administered by the South Pacific Forum Secretariat and implemented by the Marine Aquarium Council (MAC), came towards the end of its project cycle in late 2004. Through the generous support of the Canadian government significant progress has been made in beginning to harness market forces to transform the marine ornamentals industry in the four targeted Forum Island countries of Fiji, Solomon Islands, Cook Islands and Vanuatu into one based on quality and sustainable use of coral reefs. The project achieved greatest success in Fiji where all five marine ornamentals companies have signed the MAC Statement of Commitment. One of the companies had been MAC Certified and another is very close to achieving MAC Certification. Three other companies in Fiji are committed to becoming certified and have made, to varying degrees, substantial efforts towards this. In Vanuatu, Cook Islands, and Solomon Islands, all operating companies in each country also signed the MAC Statement of Commitment and/or made similar levels of progress towards certification. MAC continues to work with these Pacific countries, and others, to the extent that resources are available and there is interest on the part of the companies.

Ornamental fish certification in Christmas Islands, Kiribati

Source: *MAC News*, 3rd Quarter 2005

During July and August, the MAC [Marine Aquarium Council] Pacific team of Cherie Morris, Greg Bennett and Chris Beta focused their efforts on the major supply region of Christmas Islands, Kiribati.

Part of the work involved resource assessment as the basis for developing a Collection Area Management Plan (CAMP). A baseline survey using MAQTRAC was adapted to the Christmas Islands situation by developing an indicator fish species list and using timed swims. Fifty fish species were chosen as indica-

tors. The survey team of two MAC staff and two fisheries officers conducted 14 transects over five days, within safe scientific survey depths. Results showed high coral cover and a high diversity of fish species. The team found a particularly high abundance of golden gregory damsel (*Stegastes aureus*), Bartlett's anthias (*Pseudanthias bartlettorum*), lemonpeel angel (*Centropyge flavissima*), flame angel (*Centropyge loriculus*), leopard wrasse (*Macropharyngodon meleagris*) and Niger trigger (*Odonus niger*) species.

The MAC team held meetings with all seven of the exporting companies and with officials from the Department of Fisheries, Environment, Tourism, Wildlife and Conservation, and the Ministry of the Line and Phoenix Islands. All stakeholders were in favor of a management plan for the aquarium trade as sustainability was a concern. In addition, the Kiribati National Environment legislation is currently under review in order to comply with requirements of the Convention of Biodiversity (CBD) and the need to ensure that fisheries are sustainable and responsible.

The MAC team also met with 40 Christmas Islands fish collectors to explain best collection and handling practices using the booklet developed by the Pacific team in Kiribati language. Collectors appreciated information in their own language and were generally interested in how they could improve collection and handling of fish. MAC met with the seven companies to explain MAC Certification, provide feedback on collection and handling situations they had observed and suggested improvements to these. The team identified major needs for training/coaching of collectors and operators to address quality maintenance and control. Awareness was raised about the health consequence issues of deep diving. Buyers were informed about other valuable shallow water species that are available from Christmas Islands.

Recommendations were also developed on improving basic post-harvest handling, husbandry and transport techniques, and improvements in the design of operator's facilities and the cold storage facility at the airport.

APEC adopts plan of action to guide ocean policy

Indonesia hosted the 2nd Oceans Related Ministerial Meeting of the Asia-Pacific Economic Cooperation (APEC) on 16-17 September 2005, in Bali. Participants produced a Joint Ministerial Statement (http://www.apec.org/apec/ministerial_statements/sectoral_ministerial/ocean-related/2005_ocean-related.html) and the Bali Plan of Action (http://www.apec.org/apec/ministerial_statements/sectoral_ministerial/ocean-related/2005_ocean-related/bali_plan_of_action.html). The latter, titled "Towards Healthy Oceans and Coasts for the Sustainable Growth and Prosperity of the Asia-Pacific Community", is intended to guide APEC's ocean-related work towards three objectives: (1) ensuring the sustainable management of the marine environment and its resources; (2) providing for sustainable economic benefits from the oceans; and (3) enabling sustainable development of coastal communities. With respect to the third objective, the plan specifically calls for actions to mitigate the impacts of natural disasters and climate extremes.

Farming success with barramundi cod

A commercial hatchery in Bowen, Queensland, Australia, has succeeded in producing 100,000 juvenile barramundi cod (*Cromileptes altivelis*), according to the Queensland Government. See the article at: <http://www.dpi.qld.gov.au/aquaculturenews/17314.html>.

Waterless transport of live fish

According to the Government of the Philippines, an aquaculturist has developed a method to transport fish alive with no water. The method involves conditioning the fish by withholding food, controlling the water temperature, and immersing the fish in a liquid solution called "Buhi Blend", which stuns the fish. Groupers that underwent this treatment were reported to regain consciousness after eight hours of travel. See the article at: <http://www.da.gov.ph/updates/waterless.html>.

Live fish farming in the Marshall Islands?

According to an 18 April 2005 story in the *Marianas Variety*, aquaculture experts in Taiwan are urging their government to invest in a pilot live grouper culture project in the Marshall Islands. The project would initially set up a hatchery, followed by development of a cage culture system to produce live groupers for export to Asia.

Live fish in encyclopedia

There is a new entry called “live food fish trade” in Wikipedia, an online free-content encyclopedia. Anybody can contribute and edit articles in Wikipedia, making it a rapidly growing and fluid resource. It currently has almost 2 million articles in more than 100 languages. Articles are not necessarily attributed to specific authors and they are not subject to “peer” review (but they may be edited by anybody who wishes to, and their history of edits can be viewed). See the encyclopedia at http://en.wikipedia.org/wiki/Main_Page and look up “live food fish trade.”

Marine Ornamentals 2006

Marine Ornamentals 2006, the fourth in a series of conferences for the marine ornamentals community, will take place 13–16 February 2006 in Las Vegas, Nevada, USA. The conference will be held as a special session of Aquaculture America 2006, the Annual Meeting of the US Aquaculture Society.

The goal of the conference is to contribute to the worldwide goal of creating an economically and environmentally viable future for the dynamic marine ornamentals industry and its diverse clientele by:

- improving the methods for the collection, distribution, and management of wild marine ornamental species;
- increasing the variety, quantity and availability of cultured marine ornamental species; and
- encouraging education and outreach activities in the husbandry and conservation of marine ornamental species.

Conference information can be found at: <http://www.hawaiiacquaculture.org/marineornamentals06.html>

Workshop on the future of mariculture in the Asia-Pacific region

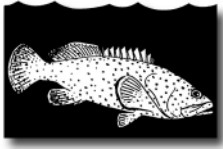
Source: *Marine Finfish Aquaculture e-News*, No. 28 (23 September 2005)

The Network of Aquaculture Centers in Asia-Pacific (NACA) has just agreed formally with Food and Agriculture Organization of the United Nations (FAO) to arrange a regional mariculture development workshop.

The tentative title of the workshop is “The Future of mariculture: A regional approach for a responsible development of marine farming in the Asia-Pacific Region”, planned to be held in Shenzhen, Guangdong Province, China from March 6–10, 2006.

The mariculture workshop will bring together expertise from major producing countries in the region to identify common issues in mariculture development, and establish a collaborative research and development program to support responsible mariculture, and social and economic development, among coastal communities in the region.

For more information, please contact Koji Yamamoto at: grouper@enaca.org



Noteworthy publications

live reef fish

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Original text: English

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