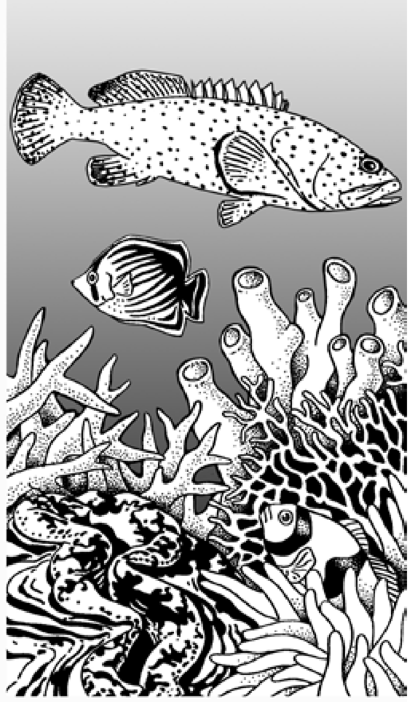

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LIVE REEF FISH
information bulletin

Inside this issue

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Editor's note

It's been almost five years since the previous *Live Reef Fish Information Bulletin* was published. That's a long hiatus. The gap certainly does not reflect a lack of live reef fish activity in the region. Fisheries for ornamentals continue to be active in about a dozen Pacific Island countries. Fisheries for live food fish are, as usual, more volatile than those for ornamentals, but they are occurring in a number of locales in the Pacific Islands region.

The lack of bulletins is due to a lack of contributions, and because of that lack of interest, this might be the final *Live Reef Fish Information Bulletin*. Although I'm not excited about it being the last, I'm pleased to introduce what I think is a well-rounded final bulletin. It includes articles on both live food fish and ornamentals. It covers the trade from fishermen to consumers. And true to the scope of this bulletin, the range of topics and disciplines is broad, from trade policies to laboratory techniques.

The first article, by Gregg Yan, looks at the international trade in marine ornamental fish and recommends ways to shift the trade to hardy species and from wild to cultured products. In the next article, Nicole Herz and colleagues focus on one of the problems highlighted by Yan – the widespread use and ill effects of cyanide to capture fish, and they reveal the difficulties in developing a cost-effective method of detecting whether live fish were caught with cyanide. In Gregg Yan's second contribution, he focuses on the outsized role of the leopard coral trout in the region's live reef food fish trade, particularly in the Philippines, and envisions a transition from a trade based on wild fish or grown-out wild-caught juveniles to one based on full-cycle mariculture. The final two articles in this bulletin are devoted to the humphead wrasse, which has populated many pages of this bulletin over the years. The first of the two articles, by Robert Gillett, is taken from a report he prepared six years ago. Although six years old, it is far from out of date. It offers practical ideas for improving monitoring and management of the species, particularly from the perspective of source countries and in the context of their varied management objectives. The final article, by Joyce Wu and Yvonne Sadovy de Mitcheson, is taken from their just-released report on the trade of humphead wrasse into and through Hong Kong. Twelve years after the species was listed on Appendix II of CITES, the authors reveal that the systems for documenting and monitoring the trade of humphead wrasse need considerable work. They offer ways that Hong Kong and mainland China can strengthen trade monitoring and improve compliance with the laws of exporting and importing countries.

I believe that the contributions to this bulletin over the last 20 years have improved the management of export fisheries for live reef products in the region and the broader trade. In the case of ornamental products, many countries have sustained export fisheries over many years, and although they are not problem-free, my perception is that the main challenges are mostly a matter reducing adverse environmental impacts and improving efficiency so that greater benefits are available throughout the chain of custody. For live food fish products, we have yet to answer – at least for many countries in the region – the more fundamental question of whether export fisheries are viable. Twenty years ago, Bob Johannes, whose work revealed the need for this bulletin, and who edited it for its first six years, set the stage for a huge wave of research and policy work by asking: Can fisheries for live reef food fish be put on a sustainable footing, and what would it take to do so? Some Pacific Island countries have answered the first question for themselves by shutting down exports of live food fish. Others are still exploring the possibility of developing sustainable fisheries. In both cases, the tremendous body of work behind the contributions to this bulletin have helped inform those decisions. And because many countries and locales are still working on the best ways to manage the trade of live reef products, I believe the 20-year collection of these bulletins will be useful for some time to come.

Tom Graham

Saving Nemo – Reducing mortality rates of wild-caught ornamental fish

Gregg Yan[1]

Although the films *Finding Nemo* and *Finding Dory* introduced millions of viewers to the beauty of saltwater fish, Nemo, Dory and many of their friends might literally end up down the drain.

The Best Alternatives Campaign estimates that in the Philippines, as much as 98% of wild-caught marine ornamental fish die within one year of capture.

Due to current capture, transport and shipping practices, about 80% of all marine fish die even before they are sold to hobbyists. As much as 90% of all ornamental marine fish that are sold die within the first year. Only the hardiest – clownfish, damselfish, wrasses, gobies and blennies – or those lucky enough to be bought by elite hobbyists with more know-how, survive beyond their first year in captivity.

Trade in living jewels

Three basic types of fish are kept as pets: 1) saltwater fish from the sea, 2) freshwater fish from rivers or lakes, and 3) brackish water fish from zones where fresh and saltwater mix. Because of the extreme fluctuations in water flow and the amount of silt in rivers throughout the year, most fresh and brackish water fish have learned to adapt to dramatic environmental changes..

Freshwater fish can, for example, rapidly adapt to waters that during monsoon rains engorge rivers with mud and silt. In contrast, brightly hued saltwater or marine fish live in the single most stable environment on Earth – the ocean – where large-scale changes occur not over days, but over

Figure 1. A shop attendant dutifully inspects a holding tank of brightly hued butterflyfish, angelfish and surgeonfish. Despite the hopeful efforts of many hobbyists, most of the fish will die within a year (photo by Gregg Yan/Best Alternatives Campaign).

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millennia. Because of this, most marine fish species are unprepared for life in the average home aquarium, where water parameters fluctuate daily.

In the 1970s, the development of new technologies such as canister filters, ultraviolet sterilizers, protein skimmers and artificial sea salt finally allowed hobbyists to keep the sea's living jewels. By 1992, the annual trade in marine ornamentals soared to USD 360 million, involving 36 million fish. Today the trade is valued at more than USD 1 billion, with 40 nations supplying some 2,000 marine fish species and 650 marine invertebrate species to a host of countries, primarily the United States (which imports half the world's marine ornamental fish), Japan and western Europe.

Figure 2. In the five years since *Finding Nemo* first aired, rising demand in the marine aquarium trade has forced some clownfish populations to decline by as much as 75% (photo by Gregg Yan/Best Alternatives Campaign).

Today, the Philippines and Indonesia remain the world's top exporters of wild marine fish and invertebrates, supplying about 85% of the global demand. In 1998, the Philippines exported an estimated USD 6.4 million worth of marine aquarium fish and invertebrates, slightly buoying the lives and livelihoods of around 4,000 collectors based throughout the country.

However, 40 years of lightly regulated collection compounded by cyanide use has decimated many reefs. In many fish collection sites, high-value ornamentals such as emperor angelfish (*Pomacanthus imperator*) and clown triggerfish (*Balistoides conspicillum*) are conspicuously absent. Since *Finding Nemo* premiered, soaring demand caused clownfish populations to plunge by as much as 75% in some areas (Fig. 2).

Steps to a sustainable trade

The vast majority of wild-caught ornamental marine fish are taken from coral reefs. A 1994 study found that only 5% of the Philippines' coral reefs were in excellent condition (Gomez et al. 1994).

Under a system pioneered by Filipino scientists Ed Gomez and Angel Alcala (1981)[2], coral reefs with less than 25% hard coral cover are considered to be in poor condition, those with 25–50% are classified as being in fair condition, those with 50–75% are considered to be in good condition, and those boasting more than 75% are considered to be in excellent condition.

A recurring issue is the use of sodium cyanide, thought to have originated in the Philippines in the 1950s. An efficient nerve toxin, cyanide is squirted into coral heads or rock crevices to stun hard-to-catch fish. Unfortunately, the mixture burns both corals and the vital organs of fish, resulting in the deaths of up to 75% of all living things exposed to it.

Regulated collection of aquarium fish and invertebrates using nets and not poisons, better stocking and shipping techniques, plus imposing sensible size, catch and species limits can provide collectors both sustainable livelihoods and a strong incentive to protect instead of exploit coral reefs.

In the Pacific Island nations of Fiji, Tonga and the Solomon Islands, local communities are learning to sustainably farm hard and soft corals, giant clams and live rock (compacted corals or reef rock encrusted with marine life) for export to western markets. Community members physically watch over plots where the high-value invertebrates are farmed, thereby providing a layer of protection from blast fishers and poachers.

The Best Alternatives Campaign was established in 2014 to promote a shift from threatened seafood and ornamental fish to more sustainable alternatives, thereby allowing dwindling stocks breathing room to recover. Simple solutions to transform the trade include the following:

1. **Hobbyists should avoid purchasing hard-to-keep fish**, especially cleaner wrasses (Fig. 4), Moorish idols (Fig. 5), mandarin fish (Fig. 6), and all types of seahorses (Fig. 7), which are protected under the Convention on International Trade in Endangered Species of Wild Fauna and Flora. Unless kept by specialists or scientists, captive mortality rates for these fish are estimated at 99% so it is best to avoid them entirely. By convincing hobbyists to steer clear of these types of fish in favor of hardier fish, alarming mortality rates for captive marine fish would be reduced.

2. **Hobbyists should shift to keeping hardy fish**. Many of the world's most beautiful aquaria feature hardy but still colorful clownfish, damselfish, gobies, wrasses and surgeonfish. Survival rates are far better with these species and hobbyists spend much less for upkeep and stock replacement.

3. **Hobbyists should shift to keeping artificial corals and invertebrates**. Unless armed with cutting-edge equipment and a bottomless bank account, the Best Alternatives Campaign recommends that hobbyists steer clear of all stationary invertebrates such as corals, sponges and sea anemones. Because their care is dramatically more complex than already difficult-to-keep reef fish, captive mortality rates are staggering. Moreover, harvesting wild hard corals for both the pet and curio trades is illegal in the Philippines. If tank-raised corals are unavailable, then artificial corals or reef blocks are excellent alternatives. They will last decades and require only occasional cleaning.

4. **Hobbyists should shift to aquacultured fish and invertebrates**. In stark contrast to freshwater aquarium fish, 95% of all marine ornamental fish and invertebrates are wild-caught. Fortunately, the Philippines Bureau of Fisheries and Aquatic Resources recently approved a programme whereby fish farmers can apply for wildlife ranching permits, allowing them to collect a specified number of wild individuals as broodstock for inland rearing facilities. In exchange, 30% of the reared juveniles must be released back into the wild. Farmed seahorses and clownfish are already popular in western countries.

Figure 3. The end of the line. As many as 98 out of every 100 wild-caught marine ornamental fish die within one year. "Marine fish are not expendable décor. They have lives and important ecological roles to play in coral reefs," explains veteran aquarist Joseph Uy. The Best Alternatives Campaign works to minimize alarming mortality rates for marine fish and invertebrates (photo by Gregg Yan/Best Alternatives Campaign).

Figure 4. Once a common sight on Philippine coral reefs, cleaner wrasses perform an important service by picking reef fish clean of parasites, sometimes swimming into the gaping jaws of large predators to clean their teeth. Unfortunately, their extremely specialized diet makes them difficult aquarium inhabitants. They are best left in the wild (photo by Gregg Yan/Best Alternatives Campaign).

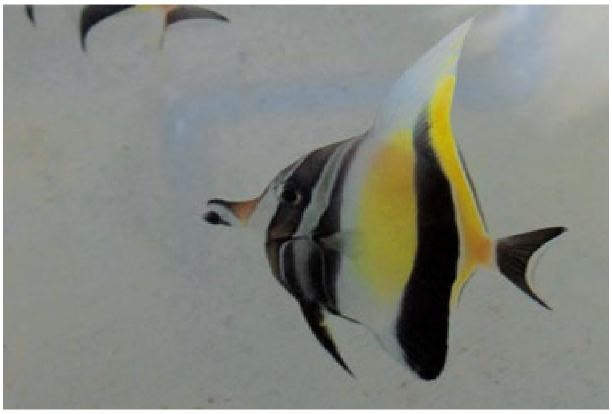

Figure 5. Despite being one of the most iconic marine fish, "Gil" (a Moorish idol) from *Finding Nemo* rarely eats in captivity and almost always succumbs to a slow death. Sadly, it remains one of the trade's most common offerings (photo by Gregg Yan/Best Alternatives Campaign).

Figure 6. Possibly the world's most colorful fish, mandarinfish take poorly to captivity and are usually overpowered by more aggressive tank mates (photo by Gregg Yan/Best Alternatives Campaign).

Figure 7. Specialist feeders, all seahorse species are difficult to keep. Mortality rates are estimated to breach 90%. Certified Philippine tank-raised seahorses are good alternatives (photo by Gregg Yan / Best Alternatives Campaign).

5. **Suppliers should raise the prices of marine ornamental fish and invertebrates.** Higher prices limit the hobby to those with the financial resources to keep the animals alive. Aside from curbing volume-based trade, higher prices would translate to better incomes for local fishermen, who would in turn earn more from catching fewer fish.

The marine aquarium trade certainly has its merits. A growing list of fish can now be cultured not just for profit, but someday might help restock Earth's denuded reefs. More importantly, the hobby cultivates a love and understanding of nature and its myriad processes.

Replacing delicate marine fish and invertebrates with hardy, or even aquacultured alternatives, will reduce captive mortality rates, which is a good step toward making the billion-dollar ornamental marine fish and invertebrate trade more sustainable.

For more information on the Best Alternatives Campaign, please contact Gregg Yan on Facebook.

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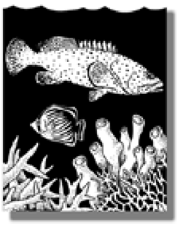
Gomez E.D., Aliño P.M., Yap H.T. and Licuanan W.Y. 1994. A review of the status of Philippine reefs. Marine Pollution Bulletin: 29(1–3):62–68.

Figure 8. A copperband butterflyfish is pressed against the glass for assessment at a marine fish export facility in Manila (photo by Gregg Yan/Best Alternatives Campaign).

Figure 9. Marine fish form a swirling melee of color inside an aquarium in Cartimar, Manila (photo by Gregg Yan/Best Alternatives Campaign).



High-performance liquid chromatography to detect thiocyanate in reef fish caught with cyanide: A practical field application

Nicole Herz[1,2,3], Sebastian Ferse[1], Yustian Rovi Alfiansah[1,4] and Andreas Kunzmann[1]

Introduction

The marine aquarium trade uses some of the most destructive fishing methods to coral reefs, which has evoked concerns for more than 30 years (Barber and Pratt 1998; Johannes and Riepen 1995; Jones 1997; Mak et al. 2005; Sadovy and Vincent 2002; Wabnitz et al. 2003). Yet, the worldwide trade in ornamental reef fish is flourishing. Import and export data suggest that marine ornamentals are worth USD 200–300 million annually, although complete trade statistics and current economic data are not available (Wabnitz et al. 2003; Larkin and Degner 2001).

Ornamental fish are often captured illegally using cyanide, an effective but very destructive fishing method (Barber and Pratt 1997; Johannes and Riepen 1995). The practice is meant to immobilize the fish, but if too much cyanide is applied, both targeted and non-targeted fish can die from overdoses (Cervino et al. 2003). The use of cyanide to capture fish is illegal in many Southeast Asian countries (Barber and Pratt 1998; Mak et al. 2005). In Indonesia, the use of cyanide has been illegal since 1985.[5] Between 1995 and 2005 the ornamental fish trade and its relationship to destructive fishing practices received much attention, both from scientists and the mass media. However, it is difficult to efficiently detect the presence of cyanide in captured fish, and in recent years there has been a reduced interest from the media and science, despite a flourishing trade.

There are several methods of detecting cyanide, using colorimetry, titrimetry or cyanide ion selective electrodes (ISEs) (Ikebukuro et al. 2013). Yet none of these techniques seem to be suitable for detecting cyanide in illegally caught ornamental fish because they are very time-intensive methods and require sacrificing the fish. Furthermore, the methods require a pre-treatment of the samples that involves acidification, heating and refluxing to evolve hydrogen cyanide (HCN) (Mak et al. 2004). The most prominent and promising cyanide detection test (CDT) until now was developed by the International Marinelife Alliance (IMA), Philippines and the Philippine Bureau of Fisheries and Aquatic Resources (BFAR) in 1992 (International Marinelife Alliance 2006). The test uses ISEs to detect concentrations of cyanide in homogenized organs of cyanide-captured reef fish (Bruckner and Roberts 2008). Although the half-life of cyanide is relatively short and it is quickly converted into thiocyanate (Mak et al. 2005), the CDT proved to be successful; 19% of 3,950 samples tested positive for cyanide (Barber and Pratt 1997). Despite the success, the testing method was abandoned in 2001 because like all other methods, the test required sacrificing the fish and was relatively time consuming (Mak et al. 2005; Graber and Siegel 2012).

Recently, a high-performance liquid chromatography (HPLC) technique was developed at the University of Aveiro in Portugal by Silva et al. (2011) to detect thiocyanate (SCN^-). Thiocyanate is a metabolite of HCN, converted by the enzyme rhodanese (thiosulfate sulfurtransferase; EC 2.8.1.1) and excreted by fish that are poisoned with cyanide (Isom et al. 2010). Another research group at the University of Aveiro was able to show that the modified HPLC technique can detect SCN^- levels of greater than 3.16 mg L^{-1} excreted by fish kept in artificial seawater (Vaz et al. 2012). Cyanide-poisoned clownfish (*Amphiprion clarkii*) were incubated in 1-L glass jars to depurate for 4 weeks. Water samples were collected on a daily basis and analyzed. Each day the fish were fed to satiation and the water from the jars was replaced by newly prepared seawater. Analysis of the collected water samples showed that each fish excreted a total of about 7.0 to 9.8 μgL^{-1} of SCN^- in the 28 days of depuration, on average. The newly developed method

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[5] Fisheries Regulation Act: UU No. 9 tahun 1985 juncto UU no. 31 tahun 2004 Tentang Perikanan

seems to be very successful in detecting low concentrations of thiocyanate. However, many questions remain unresolved. Under field conditions, when fish are captured by fishermen, factors such as cyanide concentration and duration of exposure are variable, and these factors might affect the excretion rates of fish. The depuration rate of thiocyanate can depend on the species and on the size and weight of the fish. It is known that various species of fish have different metabolisms and respiration rates, and the same is true for fish of different sizes (Jobling 1994). This leads to the conclusion that different species and sizes of fish incorporate different amounts of cyanide and have different cyanide conversion rates, thus leading to different SCN^- excretion rates. Additionally, parameters of natural seawater such as pH, salinity, levels of nutrients and traces of heavy metals (Gerdes 2001; Greenwood et al. 1997), as well as cyanide and thiocyanate (Silva et al. 2011), can vary on different reefs. The extent to which these factors limit the performance of the HPLC technique is not known.

The investigation reported on here aimed to extend the work of Vaz et al. (2012) and was designed to test a modified HPLC technique under field conditions, where cyanide exposure concentrations and exposure durations are unknown and natural seawater is used. Two distinct studies were conducted: Study 1 aimed to investigate the effects of varying field conditions on the thiocyanate excretion rates of five species of fish captured by fishermen. Study 2 was designed to compare thiocyanate excretion rates of two different fish species under controlled aquaria conditions and to investigate whether natural seawater influences the performance of the HPLC analyser.

Materials and methods

Study 1

Sampling was conducted in January 2013 in the region of Banyuwangi in east Java, Indonesia, in the facilities of a large-scale exporter. Cyanide is still widely used in the country due to a lack of effective law enforcement. Fish are brought to the facility on a daily basis by fishermen from the nearby villages and are held in tanks until packed into plastic bags for further transport to the main facilities in Bali and Jakarta. Fish species were selected for the study according to their capture rates and likelihood of being captured with cyanide. Cyanide is mainly used for solitary, fast-swimming fish and small fish that can hide in coral crevices (G. Reksodihardjo-Lilley, LINI, the Indonesian Nature Foundation, 19 December 2013, pers. comm., and a fisherman from Bali). Thus, the species *Pomacentrus vaiuli* (ocellate damselfish), *Centropyge bicolor* (bicolor angelfish), *Gobiodon quinquestrigatus* (five-lined coral goby) and *Amphiprion ocellaris* (clown anemonefish) were chosen.

The sampling procedure for thiocyanate detection followed that described by Vaz et al. (2012). Each fish to be tested for thiocyanate excretion was placed in its own aerated glass jar filled with filtered seawater and placed in a tank with a flow-through system to ensure stable water temperatures (Fig. 1). The fish were exposed to a natural day-and-night rhythm

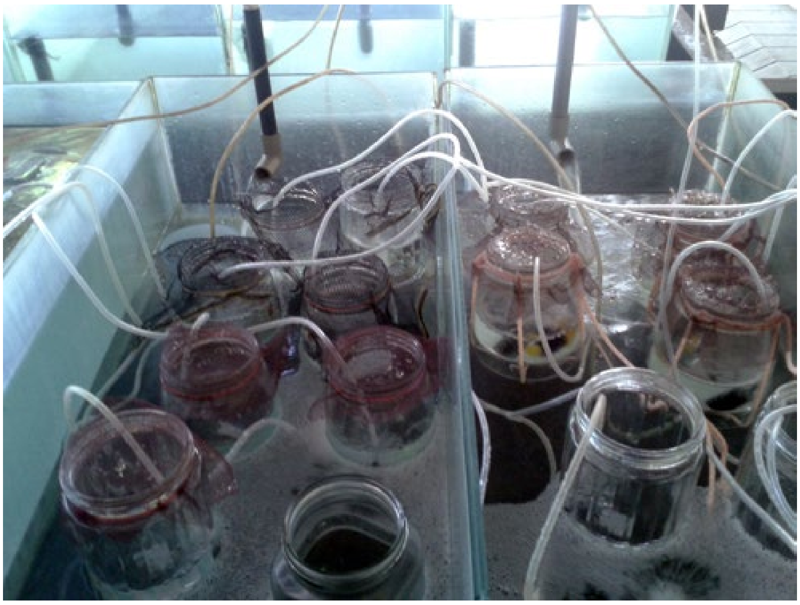

Figure 1. Experimental set up in Banyuwangi, Indonesia. All glass jars were placed in a narrow tank with a flow-through system and each jar was equipped with an aeration hose (photo by N. Herz).

of about 12.5 hours of sunlight in a semi-open hall. All fish were incubated for six days, which corresponded to one sampling round. Each day a water sample of 1.5 ml was taken and stored in a freezer at -20°C. Each day the fish were fed to satiation with "Sera Marin Granules" and *Artemia* nauplii (from Mackay Marine, USA) and the water was completely exchanged with fresh seawater. Due to the limited availability of fish, three sampling rounds of six days each were performed. In each round, three to four individuals per species were incubated; 8 ocellate damselfish, 8 bicolor angelfish, 11 five-lined coral gobies, and 10 clown anemonefish were tested for thiocyanate excretion (Fig. 2).

Study 2

The second experiment was performed at the MAREE aqualab of the Leibniz Center for Tropical Marine Ecology (ZMT) in Bremen, Germany. The aim was to compare thiocyanate excretion rates of two different fish species and to determine the effects of natural seawater on the performance of the HPLC technique. *Amphiprion frenatus* (tomato clownfish) served as a reference species to the experiment conducted by Vaz et al. (2012), and *Pterapogon kauderni* (Banggai cardinalfish) was included as a species from a different genus, because so far only fish from the genus *Amphiprion* had been tested. All fish used in this study were captive-bred in Germany to ensure that no fish had been exposed to cyanide. Two different treatments were applied to 10 individuals each from both species, plus a control with no cyanide application. In the treatments fish were exposed to a cyanide solution (KCN, 97% purity) of 12.5 $\mathrm{mgL^{-1}}$ for 60 seconds and to 50 $\mathrm{mgL^{-1}}$ for three times for 5 seconds, respectively (Fig. 3). The second treatment was intended to mimic the conditions under which fishermen stun and capture reef fish. After the treatments, all fish were placed in two consecutive cleaning baths and separately placed into 1.7-L glass jars for depuration (Figs. 4 and 5).

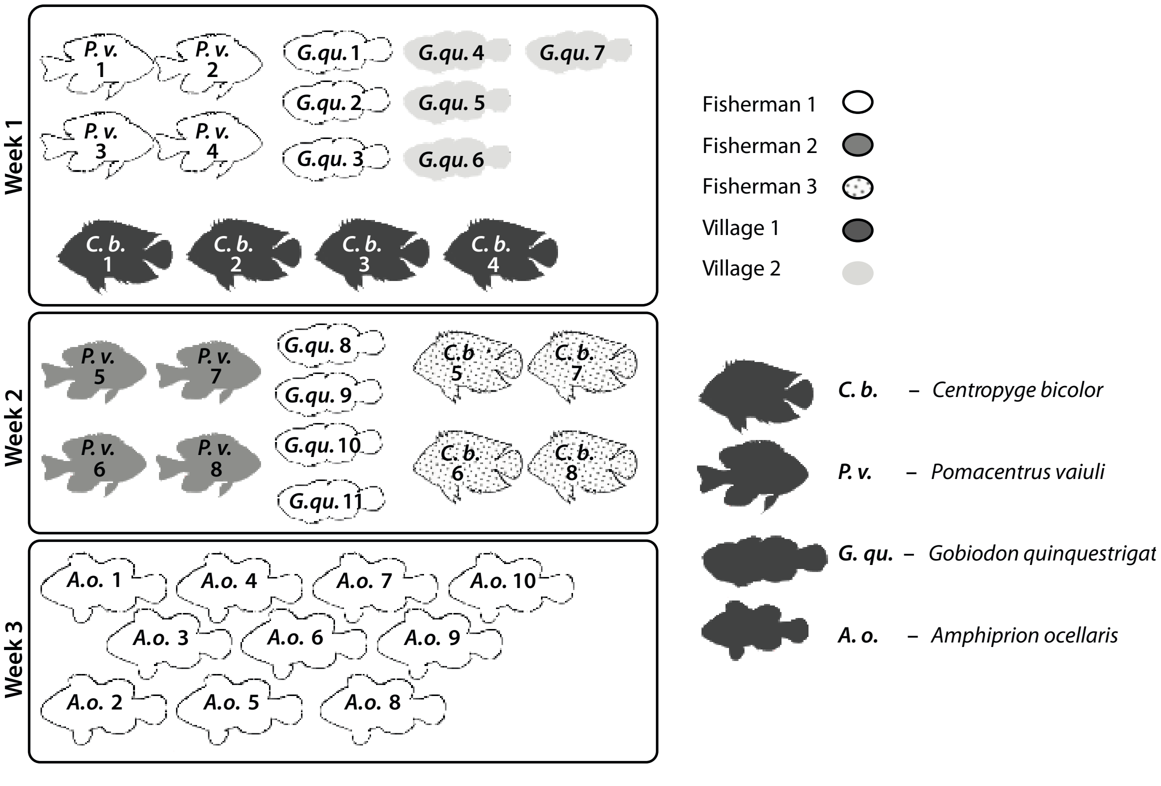

Figure 2. Over a period of six days, individuals of *Pomacentrus vaiuli* (P. v.), *Centropyge bicolor* (C. b.), *Gobiodon quinquestrigatus* (G. qu.) and *Amphiprion ocellaris* (A. o.) were incubated and water was sampled on a daily basis. Fish were captured by Fisherman 1, 2 or 3 from Village 1 or 2. During three sampling rounds (Week 1, 2 or 3) 8 individuals of each of the species P. v. and C. b., 11 individuals of G. qu., and 10 A. o. were sampled.

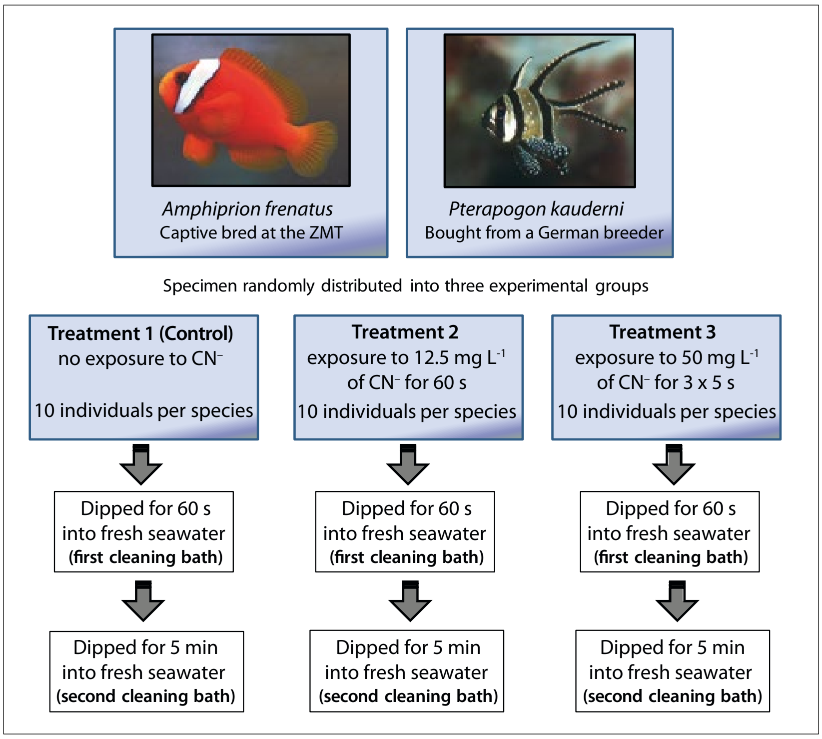

Figure 3. Graphical illustration of the experimental design of Study 2. Individuals in Treatment 1 were not exposed to CN-; individuals in Treatment 2 were exposed to 12.5 mg L^{-1} of CN- for 60 s; and individuals in Treatment 3 were exposed to 50 mg L^{-1} of CN- for three times for 5 s.

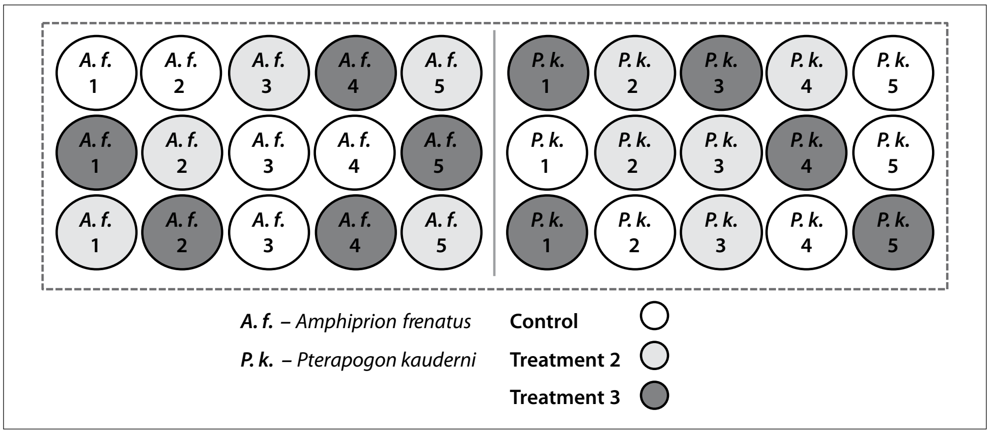

Figure 4. Illustration of the set up in the climate room of the Leibniz Center for Tropical Marine Ecology. All individuals from all three treatments were placed separately and randomly in 1.7-L glass jars, allowing them to depurate for two weeks.

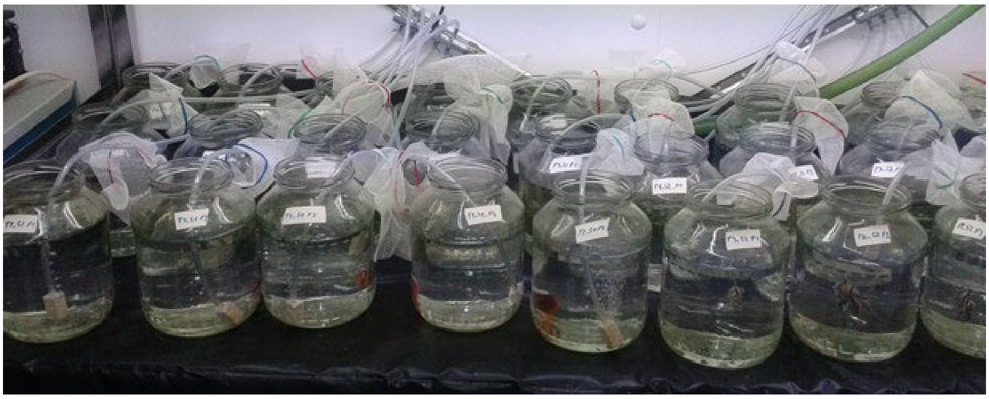

Figure 5. Experimental set up in the climate room of the Leibniz Center for Tropical Marine Ecology. In total, 60 glass jars with 30 individuals per species (10 fish per species and treatment) were incubated for 14 days. Each glass was equipped with an aeration hose. Water samples from the fish and a blank sample of seawater were taken at days 2, 5, 8, 11 and 14 (photo by N. Herz).

Following the cyanide exposure, all fish were randomly distributed among glass jars filled with 1,225 ml of natural filtered seawater from Wilhelmshaven. Each jar was equipped with an aeration hose for oxygen supply and placed in a climate room that was set at 26°C (± 1°C) (Fig. 5). Artificial light with a rhythm of 8:00–12:00 and 14:00–20:00 was used. Fish were kept for a period of 14 days. On a daily basis the fish were fed to satiation and the water was exchanged.

On days 2, 5, 8, 11 and 14, water samples from each glass jar and a blank water sample from the seawater tank were taken with a syringe and stored at -20°C.

At the end of the 14-day sampling period all fish were measured for length and weight (PLS 1200-3A scale by Kern & Sohn GmbH, Bahlingen, Germany). One-way ANOVA tests were performed to determine whether there were significant differences between the two species in terms of length or weight for each of the two experimental treatments. P-values of less than 0.05 were considered significant.

Water parameters

Parameters of the Wilhelmshaven water were tested twice, at the beginning and end of the incubation, using a colorimetric test for phosphate (PO_4) and nitrate (NO_3) and a DR/2010 spectrophotometer (Hach Company, Loveland, CO, USA). Temperature, salinity and pH were tested using a digital multimeter (Multi 3430 Set F by WTW GmbH, Weilheim, Germany).

Thiocyanate analysis

The water samples from both studies were analysed with an HPLC, including a Waters 2695 Separations Module and a Waters 2487 Dual Absorbance Detector (Waters Portugal, Lisbon, Portugal). The C30-column was slightly modified with 5% polyethylene glycol (PEG) and a more sensitive photodiode detector. The water samples were transferred to 1.5 ml glass vials and introduced into the injector unit. The column used a mobile phase of 300 mM sodium sulfate and 50 mM sodium chloride.

As described by Vaz et al. (2012), standard solutions of SCN^- (4, 50, 100, 200, 300 and 400 gL^{-1}) were used to calibrate a standard curve. The calculated detection limit lies at 3.16 mgL^{-1}; the retention time of thiocyanate is between 4.0 and 5.5 minutes.

Each sample was tested three times to calculate the standard deviation (SD) of the SCN^- peak. If the SCN^- peak of a sample turned out to be very small, the sample was spiked with a known amount of a thiocyanate solution and tested once more. The added amount of thiocyanate was then subtracted from the output value to calculate the actual amount of thiocyanate of the un-spiked sample.

Results

None of the water samples from the two studies could be analysed for thiocyanate. Instead, the HPLC analyser produced inconclusive chromatograms. In contrast to the samples from artificial seawater, which were spiked with thiocyanate (Fig. 6), no thiocyanate peak at minute 4.5 was detectable in the samples

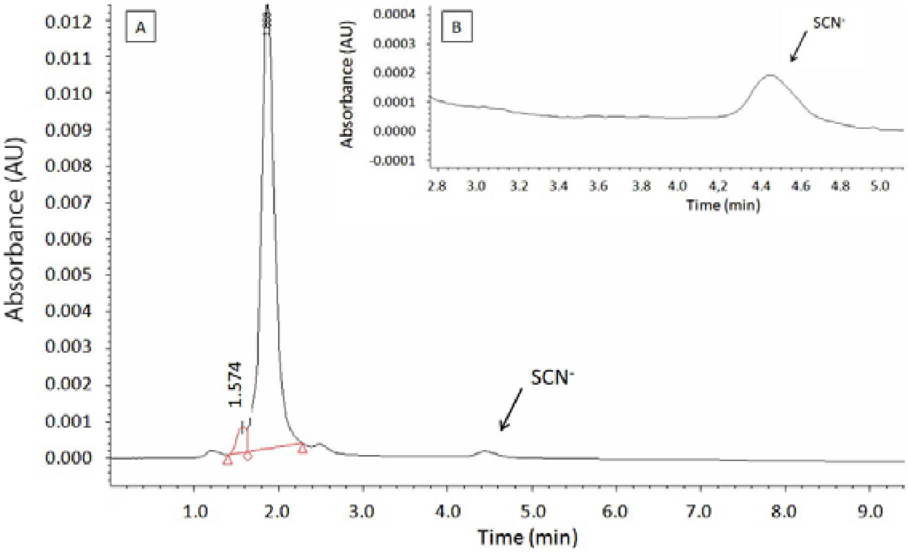

Figure 6. HPLC chromatogram of artificial seawater enriched with a certain amount of a thiocyanate solution (KSCN). Diagram (A) shows a chloride peak at minute 2.0 and a thiocyanate peak at minute 4.5; diagram (B) shows a higher resolution of the chromatogram and the SCN- peak.

from natural seawater, either in Study 1 or Study 2. All analysed samples resulted in chromatograms showing a huge peak of 0.822 absorbance units (AU) between minutes 6.5 and 9.0, which could not have been related to any substance (Fig. 7). Some of the samples from both Study 1 and Study 2 were spiked with a known amount of thiocyanate. Yet, no additional thiocyanate peak could be detected. Several tests were performed in order to determine factors that might have interfered with the SCN^- samples. A sample with a known thiocyanate concentration was spiked with an iron (III) chloride solution (Merck S.A., Algés, Portugal) to see if water contamination could influence the thiocyanate results (Fig. 8). Thiocyanate, being a pseudohalide, is able to form complexes with metals that might have prevented the detection of thiocyanate. However, the chromatogram revealed a clear thiocyanate peak at minute 4.5 (Fig. 8). The water parameters pH, salinity, PO_4 and NO_3 tested in Study 2 were all in the normal range.

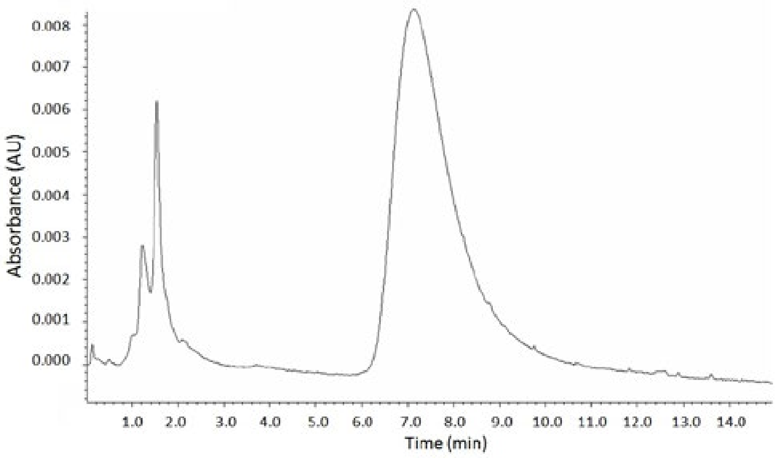

Figure 7. The absorbance profile of a sample, taken on 17 January 2013, generated by the HPLC. The sample contained water from day 6 of incubation of an *Amphiprion ocellaris* that was most likely captured with cyanide. It shows a biased chloride peak at minute 1.5 and an unknown peak at minutes 7.0–8.0. The expected SCN^- peak at minute 4.5 is missing.

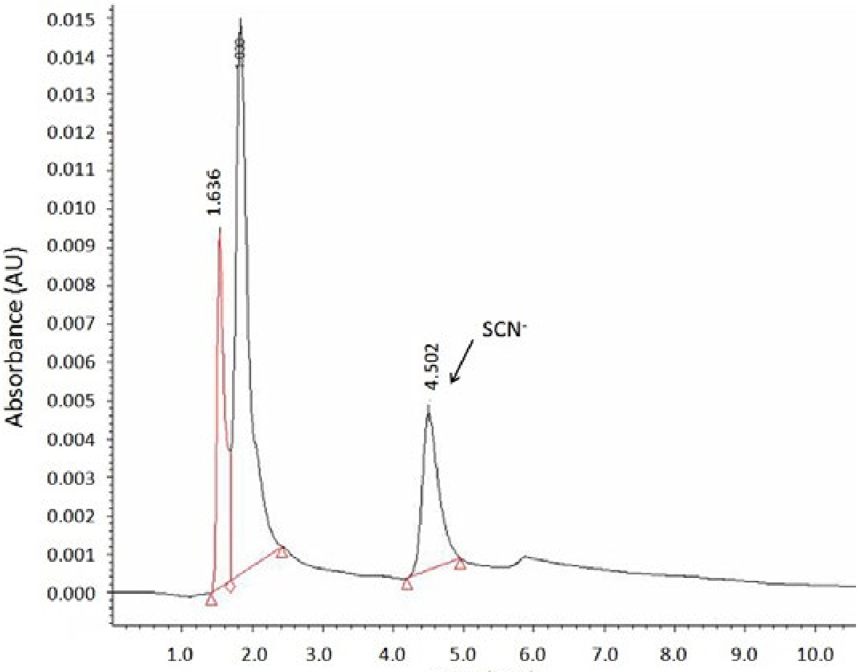

Figure 8. HPLC chromatograph showing the absorbance profile of an artificial seawater sample that was spiked with a known concentration of thiocyanate and ferric ions (Fe^{3+}). Thiocyanate still comes up as a peak at minute 4.5.

Discussion

Previous studies by Rong and Takeuchi (2004) and Silva et al. (2011) showed that the HPLC method can detect thiocyanate as an excretory byproduct of fish, provided that concentrations are higher than 3.16 mgL^{-1} and that artificial seawater is used. There may be reasons why the HPLC chromatographs of the analysed samples in this study did not show any thiocyanate. The main reason, however, might be that natural seawater is too complex with its many compounds and varying parameters to be suitable for the analysis of SCN$^-$.

Contaminations, unknown water contents or varying parameters might influence the performance of the HPLC, hindering the detection of SCN$^-$, as it might have formed complexes with transition metal ions, such as iron (III) (Gerdes 2001; Greenwood et al. 1997). Besides iron, SCN$^-$can also react with cobalt (Co(II)), copper (Cu(I)), gold (Au(I)), mercury (Hg(II)) or silver (Ag(I)) (Greenwood et al. 1997). SCN$^-$ in such a bound form might not be detectable by the UV-Vis detector at l=220 nm or simply has an unknown retention time and unknown behaviour towards the C30-column (M.C.M. Vaz, University of Aveiro, 4 August 2013, pers. comm., and B. Meyer-Schlosser, University of Bremen, 11 December 2013, pers. comm.). Thiocyanate and iron (Fe^{3+}), for example, form thiocyanatoiron (III) (FeSCN^{2+}), which has a deep red colour, absorbing maximally at l=447 nm (Hovinen et al. 1999). In both experiments in this study the water that was used for the incubation came from the nearby harbour sites Banyuwangi and the Bay of Wilhelmshaven. Becuse both are harbour areas, pollution by ship ballast waters and agricultural and industrial sewage run-off is likely.

HPLC results also could have been influenced by the half-life of thiocyanate in seawater and its decomposition by bacteria. The half-life of thiocyanate in seawater is not known (V. Esteves and M.C.M. Vaz, University of Aveiro, 4 August 2013, pers. comm.). Plumlee et al. (1995, cited in Chaudhari and Kodam 2010) state that thiocyanate is a stable, non-hydrolysable, quite persistent compound. But it has yet to be determined what this implies for its detection by HPLC. It is known, however, that the amount of cyanide in a sample can change during storage, depending on the storage temperature (Calafat and Stanfill 2002; Lindsay et al. 2004; Lundquist et al. 1987), and the same could apply to thiocyanate. In the case of the samples from Study 1, problems in detecting the thiocyanate were expected because the samples were stored for a long time–from January to August, and they had to be transported for long distances several times. Samples from Study 2, however, were stored for only three months. The thiocyanate chromatograms of those samples should look different than those from Banyuwangi. Additionally, thiocyanate in seawater can be degraded by several species of bacteria, including Thiobacilli, Pseudomonads, Escherichia, Methylobacteria, Pseudomonas, *Klebsiella pneumoniae* and *Arthrobacter* spp. (Ahn et al. 2004; Chaudhari and Kodam 2010; Ebbs 2004). However, it is not known to what extent and at which rates microorganisms degrade thiocyanate in natural seawater. Studies to date have dealt with the artificial reduction of thiocyanate from mining wastewaters only (Akcil and Mudder 2003; Boucabeille et al. 1994; Chaudhari and Kodam 2010; Vu et al. 2013).

For Study 1 there are several other possible sources of inconclusive HPLC results. The amounts of cyanide used by fishermen might have been too small to detect, or six days of depuration might not have been sufficient. However, in Study 2 cyanide concentrations were the same or similar to the ones used by Vaz et al. (2012). Furthermore, fish were incubated for 14 days, which has been demonstrated to be a sufficient period for the excretion of thiocyanate.

Another factor possibly responsible for the absence of SCN$^-$ peaks might be the HPLC method itself. The finding of such small thiocyanate peaks (Fig. 6) as were found in the studies by Silva et al. (2011) and Vaz et al. (2012) is not common. Their detection is difficult and the peaks could be part of background noise rather than true signals (K. Bischof and B. Schlosser-Meyer, University of Bremen, 12 November 2013, pers. comm.). Therefore, using the HPLC method to detect low concentrations of SCN$^-$ requires further refinement. This study clearly revealed that it is not yet suitable for field use.

Conclusions

The results of the HPLC analysis made it clear that the method described by Vaz et al. (2012) is not yet suitable to detect illegally caught fish in the field or to prosecute poachers. Too many factors that might influence the results remain uncertain and the methodology is unable to detect thiocyanate in natural seawater.

Further investigation is also needed to determine the extent to which excretion of cyanide products varies by species, fish size, and method of fish capture. Apart from multiple factors of uncertainty, the HPLC method is quite expensive and requires a high level of expertise. Thus, it will be difficult for most institutions to acquire and maintain an HPLC instrument. For all of these reasons, it seems unlikely that a standardised HPLC methodology for thiocyanate detection can be developed in the near future. Other strategies and approaches to diminish cyanide use need to be considered.

Ethics statement

All experiments at the laboratory facilities of the Leibniz Center for Tropical Marine Ecology in Bremen were carried out in strict accordance with the German law (§ 8 Abs. 3 of the Animal Protection Law (TierSchG)) and permission to conduct them was granted by the ethics committee of the German health authority ("Senator für Gesundheit" in Bremen). The research in Indonesia was approved by the Indonesian Ministry for Research and Technology (Permit number: 4299/FRP/SM/IX/2012).

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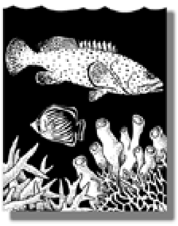

Farming leopards at sea: Paving the way for full-cycle grouper mariculture

Gregg Yan[1]

Have you ever seen a Chinese restaurant without a bubbling tankful of groupers? These lethargic fish are among Asia's most sought-after reef fish. In the Philippines, large numbers are plucked from the sea to sate the soaring demand for fish kept alive until just minutes before being served.

Although there are 161 grouper species, one reigns supreme in the market for live reef food fish. The leopard coral trout (*Plectropomus leopardus*) is a colourful crimson fish that, according to Hong Kong Chamber of Seafood Merchants Chair Lee Choi-wah, can fetch up to HKD 1500 (about USD 200) per kilogramme in Hong Kong's wholesale market (Wei 2013).

Palawan Island hosts 40% of the Philippines' coral reefs, and generates 55% of the country's seafood exports (Padilla et al. 2003), chief of which is the highly valued leopard coral trout. In Taytay, a municipality of Palawan, a fisherman earns about 50 times more from a kilogramme of leopard coral trout than he would from other common fish species (Salao et al. 2013).

Locally called *suno*, the tasty red fish are exported to Hong Kong, Singapore, Malaysia, mainland China and other seafood hubs. Many Asians believe that eating fish kept alive just moments before cooking is not only more savory, but the secret to a long and prosperous life.

Figure 1. In an offshore grow-out cage in Palawan, an adult leopard coral trout (*Plectropomus leopardus*) is held prior to export (photo: Gregg Yan).

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Figure 2. A typical grouper grow-out facility in southern Palawan, Philippines. Operators must feed and protect the fish, which are held in submerged cages beneath and around the central hut for up to 10 months. There is no electricity, and food and water are supplied exclusively by boat (photo: Gregg Yan).

The annual export value of Palawan's grouper trade is USD 25 million, buoying the local economy and supporting the livelihoods of at least 100,000 people (Matillano 2013).

Wild-caught or farmed?

Most high-value grouper species are wild-caught because the technology to breed and raise delicate marine fish such as leopard coral trout and the CITES-protected[2] humphead wrasse (*Cheilinus undulatus*) at commercial scales is – at least in the Philippines – several years off.

The use of grow-out systems based on juvenile capture and known colloquially as "ranching" remains the most popular method for leopard coral trout culture. To fuel the trade, millions of juveniles are caught using traps or baited hooks, and fattened in guarded offshore cages where the fish endure temperature fluctuations, overcrowded conditions, diseases, and the occasional sneaky fish cage poacher. Up to 10 months of constant feeding and protection are needed to produce a batch of marketable fish – each around a foot long and weighing from 500 to 700 grams. Currently, a single fish head retails for about USD 60.

Buyers then classify and rate the fish before shipping or flying them to consumer nations. A steaming plate of leopard coral trout can fetch upwards of USD 200 in a high-class Chinese restaurant, especially during the Chinese New Year. Less than 5% of Philippine-caught groupers are sold locally, and often, these have been rejected by foreign importers. "Unfortunately, the cycle is not yet 'closed', meaning ranchers still catch juveniles from the wild, fatten them up, and sell them. The fish are not allowed to reproduce," says Philippines Biodiversity Management Bureau Director Theresa Mundita Lim.

"Surveys have shown that over half of all groupers taken from Palawan's reefs are juveniles, a clear indication that adults have been heavily depleted," notes Dr Geoffrey Muldoon, an international expert on the live reef fish trade. "A good solution is to move towards full-cycle mariculture, freeing suppliers from having to catch wild groupers to give Palawan's reefs a breather from half-a-century of fishing."

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[2] CITES is the Convention on International Trade in Endangered Species of Wild Fauna and Flora. The humphead wrasse was listed on Appendix II of CITES in 2004, indicating that the species is not necessarily threatened with extinction but its trade must be controlled in order to avoid utilization incompatible with its survival.

Full-cycle mariculture (the production of fish or invertebrates in seawater, as opposed to freshwater aquaculture) entails the generation of seafood while minimizing or eliminating the need to harvest wild stocks. Tougher but cheaper species such as tiger grouper (*Epinephelus fuscoguttatus*) and green grouper (*Epinephelus coioides*) have been successfully bred and reared in captivity since 2000. A major issue in cultivating carnivorous fish is that about seven kilogrammes of low-grade fish, usually termed "trash-fish", are required to produce a kilogramme of grouper meat.

"Full-cycle mariculture has the potential to feed millions, while minimizing natural impacts. It is a better path to unmanaged wild-capture fisheries and is the natural evolution of seafood production," concludes Muldoon.

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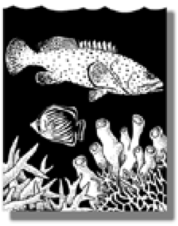
Figure 3. Hundreds of market-grade leopard coral trout are prepared for export to Manila and other Asian hubs. In Hong Kong, Singapore and mainland China, a single leopard coral trout can be sold for as much as USD 150 (photo: Gregg Yan).

Figure 4. Leopard coral trout grow-out paraphernalia in Quezon, southern Palawan. It takes up to 10 months of continual protection and feeding to produce a marketable grouper, known locally as *suno* (photo: Gregg Yan).



Monitoring and management of the humphead wrasse, *Cheilinus undulatus*[1]

Robert Gillett[2]

The humphead wrasse, *Cheilinus undulatus*, is a small but important part of the international trade in live reef food fish, being one of the highest species in unit value. The main threats of the live reef food fish trade to the sustainability of the species are overfishing and the effects of destructive fishing on target species, non-target species, and on the reef environment. In 2004, the humphead wrasse was listed on Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). With this listing, international trade is only permitted if the export will not be detrimental to the survival of the species in the wild. For fisheries resources in general, this requirement has been interpreted to mean that in the exporting country there must be a functional management plan and associated monitoring. In this context this report discusses the core elements of a management system for humphead wrasse, making considerations about major fisheries management objectives, management measures, enforcement, monitoring and fisheries assessment.

Live reef fish fisheries

Fisheries for live fish from coral reefs have received much attention in recent years. This increased interest is largely due to concerns over the sustainability of the target species, destructive fishing techniques, expansion of the fishery to new areas, negative interactions with marine tourism, and the prospects of developing new fisheries with large earnings for rural fishers. Except for Australia, this fishery is little managed.

Some features of fishing for the humphead wrasse

Important aspects include:

- Other than activities oriented to the live reef food fish trade, there are few directed fisheries for the humphead wrasse. This is due to its natural rarity and to the inherent difficulty of capturing the fish.
- In most countries where the fish occurs, most of the catch of this species is for domestic use. Fishing for the live fish trade is relatively important only in Southeast Asia.
- A large number of fishing techniques are used for capturing humphead wrasse in Southeast Asia.
- There is much illegal fishing of this fish, especially the use of cyanide, and considerable illegal trade.
- Spearfishing is one of the important techniques for capturing the humphead wrasse in the non-live fisheries.

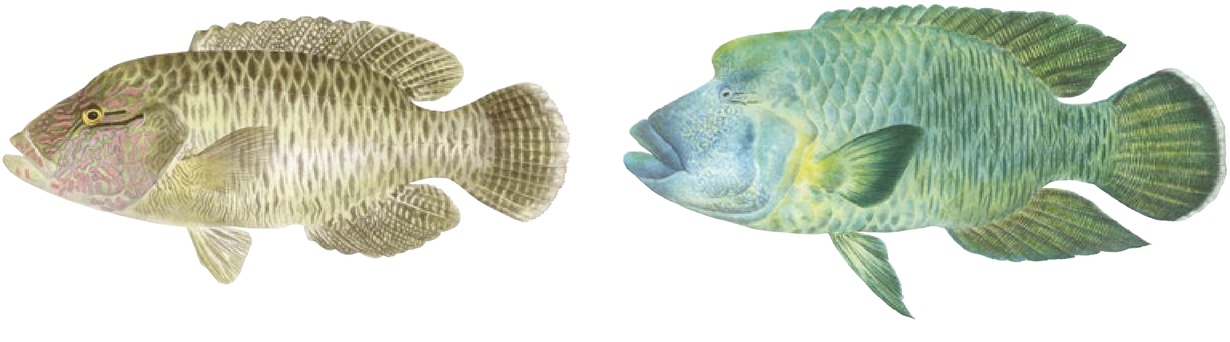


Figure 1. Sub-adult (left) and adult (right) humphead wrasse, *Cheilinus undulatus* (illustrations by Les Hata, ©SPC)

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[1] This article is a summary of a 2010 report of the Food and Agriculture Organization of the United Nations: Gillett R. 2010. Monitoring and management of the humphead wrasse, *Cheilinus undulatus*. FAO Fisheries and Aquaculture Circular No. 1048. Rome: Food and Agriculture Organization of the United Nations. 62 p.

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Figure 2. Humphead wrasse on display in Shanghai (photo by Mike McCoy).

The trade in live reef food fish

Some 60% of the international trade in live reef food fish flows into Hong Kong and mainland China. Live reef food fish enter the trade either as wild-caught fish that are held briefly before export, about 50–70% of the total trade (15,000–21,000 tonnes); undersized fish that are grown in cages or ponds until they reach market size, 15–40% of the trade (about 5,000–12,000 tonnes); or (for a few of the groupers and snappers) reared from egg to market size in controlled conditions in full-cycle aquaculture, 10–15% (3,000–5,000 tonnes). The humphead wrasse does not undergo full-cycle aquaculture.

The international trade in humphead wrasse

Humphead wrasse is a small, but important, part of the overall trade in live reef food fish. Although the fish is not even close to being the most important species in terms of volume in the markets of China and Hong Kong, it is one of the highest in unit value. In 1997 the leading suppliers of humphead wrasse to markets in China and Hong Kong were Indonesia, Philippines, China, Australia and Malaysia. The total recorded international live trade in this species ranged from about 58 to 138 tonnes for the years 2000–2006. The global domestic trade is likely to be at least 50 tonnes, exclusive of the Philippines, Malaysia and Indonesia. Although the humphead wrasse occurs in the waters of 48 countries, the important suppliers of this fish to the live trade are limited to a few countries in Southeast Asia and Papua New Guinea. In addition to its role in the live reef food fish trade, the humphead wrasse is valued for several reasons, especially for local food and its role in dive tourism. The illegal trade in this species appears to be intense in relation to Indonesia, Malaysia and the Philippines. Illegal exports from Singapore to China and Hong Kong also occur.

Threats to sustainability

The main threats of the live reef food fish trade to the sustainability of fisheries resources are the overfishing of the target species, and the effects of destructive fishing methods on the target species, non-target species and on the reef environment. The main threats to the sustainability of these fisheries are whether a fishing enterprise can be profitable when kept on a scale consistent with the limited productivity of the resource and whether the public management costs needed to keep the fishery within sustainable bounds is prohibitive. The threats posed by the live reef food fish trade to the humphead wrasse are similar, but more severe. This is because the prices obtained from humphead wrasse are very high, the fish is relatively non-resilient to fishing pressure, and it is likely that more destructive fishing is associated with this species than with others in the live fish trade due to the difficulty of capture using conventional techniques.

The question is whether this species can be adequately managed and monitored for sustainability.

CITES and the humphead wrasse

In October 2004, the humphead wrasse was listed on Appendix II of CITES. International trade of species on this list is permitted only if the export will not be detrimental to the survival of the species in the wild. For fish, this has generally been interpreted to mean that in the exporting country there must be a functional management plan and associated monitoring. It is recognized that many states will be challenged to develop such monitoring and/or management measures for humphead wrasse. Considerable efforts have, therefore, been taken to assist countries.

Fisheries management and the humphead wrasse

Some of the important desirable attributes of fisheries management are the precautionary approach, the ecosystem approach, adaptive management, and participatory decision-making. The major difficulty is that few of the major humphead wrasse exporting countries have much in the way of functional management for small-scale commercial fisheries, let alone use more sophisticated management concepts. Some reconciling of ideals and realities is required to develop a workable management strategy.

Major objectives in the management of humphead wrasse

Common objectives in the management of humphead wrasse include efforts to:

- achieve a sustainable level of fishing;
- reduce destructive fishing;
- increase humphead wrasse abundance for viewing on reefs by dive tourists;
- increase abundance for cultural and/or subsistence purposes; and
- generate government revenue.

Management measures

Various measures could be used to obtain the objectives commonly associated with the management of humphead wrasse. Some considerations on these measures include the following:

- All of the identified measures have significant deficiencies, especially in the extremely challenging management environment that exists in most of the humphead wrasse range countries, especially those that are major exporters.
- To attain any of the humphead wrasse management objectives that are commonly put forward, it is likely that more than one management measure will be required.
- This leads to the contention that humphead wrasse management requires considerable effort to be effective. Some countries may, therefore. conclude that attaining certain objectives is not cost effective.
- Many of the measures are applicable to attaining more than one objective. This may suggest that certain measures are especially important in humphead wrasse management. Accordingly, special attention should be given to the various restrictions on exports, the ban on scuba spearfishing, and marine protected areas.

Enforcement considerations

Some of the recent suggestions for improving humphead wrasse management consist of otherwise sensible measures that are predicated on remarkable progress in enforcement. The reality is that national fishery enforcement arrangements are unlikely to undergo major transformation due to the requirements of the relatively small humphead wrasse fishery. However, some generic suggestions for humphead wrasse management can be made:

- giving priority to management measures that are carried out at the point of export;
- focusing enforcement at the collector vessel level rather than on fisher vessels;
- using marine protected areas in appropriate situations;
- engineering enforcement cooperation at the one major overseas destination;
- creating incentives and constituencies for enforcement cooperation;
- using communities in enforcement;
- identifying opportunities for using awareness raising to facilitate enforcement; and
- promoting appropriate legislation.

Monitoring

Some important considerations on the collection of information for humphead wrasse monitoring purposes are:

- Rarely will all of the desirable monitoring measures be possible, hence there is a need for prioritizing a hierarchy of objectives. In many range countries, such a ranking is likely to result in the conclusion that collecting total catch and catch per unit of effort data is the most important objective.

- Should humphead wrasse data from a national fisheries statistical system be available, this could be valuable for monitoring purposes. This information, however, is often unverified and erroneous and should be used with caution.
- Effective monitoring of the small-scale component of the humphead wrasse fishery in many countries is likely to be costly and/or time consuming and out of proportion with the size and benefits of the fishery. This suggests that, wherever possible, monitoring activities related to humphead wrasse take place at the level of the collector vessel or higher.

Assessments

The assessment of a stock of humphead wrasse can range in sophistication from trends in simple biological indicators to very complex stock assessment models. Trends have the advantage that they are simple, easy for developing country managers to use, and are readily understood by policy-makers, fishers and the general public. The more sophisticated models are able to integrate many different types of information on the resource and can give important information, such as potential yields.

The new stock assessment approach for the humphead wrasse

A new stock assessment approach has been developed for determining the sustainable catch of humphead wrasse. It comprises a method for estimating stock density based on underwater visual surveys and a population model. The approach involves the following steps:

- Specifying an objective, such as maximum sustainable yield, or maintenance of a population size above some threshold level.
- Using the population model to determine the rate of fishing mortality that will, on average, achieve the above objective, and the associated uncertainty.
- Calculating the current size of the population.
- Multiplying the population size by the fishing mortality rate to give a raw catch limit.

The model represents a tremendous advancement in our ability to assess the status of humphead wrasse stocks. Where only analysis of trends in simple indicators was possible in the recent past, there is now a scientific basis for the establishment of catch limits and/or export quotas. Added advantages are that the model is relatively easy to use and does not require large amounts of data. Drawbacks include the uncertainty in calculating suitable reef area.

Rules of thumb

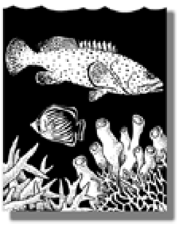
In countries where expertise in fisheries science is not available for humphead wrasse assessment, there could be considerable value in extending the model to developing simple "rules of thumb" yield estimates based on the model. This could consist of crude ranges in annual yields of humphead wrasse per linear or square kilometer of reef, under various conditions.

The single species focus of current approaches

Some simple management measures are needed to produce tangible benefits in an environment that has seen little management success, and these efforts could conceivably be broadened in the future to include other species, fisheries or ecosystem considerations.

Is the humphead wrasse exportable?

Nothing in this report should be taken as supporting the contention that exporting humphead wrasse is sustainable. Given that the fish is naturally rare, cannot sustain much fishing pressure, and is mostly caught in fisheries that are notoriously difficult to regulate, the logical solution in many range countries would be to simply ban the export of humphead wrasse.



The trade in humphead wrasse into and through Hong Kong[1]

Joyce Wu[2] and Yvonne Sadovy de Mitcheson[3]

The humphead wrasse, *Cheilinus undulatus*, is a naturally rare coral reef fish. Its biological characteristics – being hermaphroditic, long-lived and slow to mature – combined with its high market value make it vulnerable to overfishing and mean that population recovery is difficult to achieve without effective management. Because the species is mainly threatened by the international live reef food fish (LRFF) trade (CITES 2006), control of this trade is essential for its sustainable use.

The humphead wrasse is predominantly traded live as food for the LRFF trade, along with other groupers and wrasses, particularly from Indonesia, Malaysia and the Philippines but also from other range countries of the species, with the main destination being Hong Kong Special Administrative Region (SAR, hereafter simply "Hong Kong") and the People's Republic of China (hereafter "mainland China").

The humphead wrasse was classified as "Endangered" in 2004 according to the criteria and categories of the International Union for Conservation of Nature Red List, and has been listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) since January 2005. Indonesia has only permitted the export of live humphead wrasse, although the export quota has decreased from 8,000 tails (=animals) in 2006 to 2,000 tails from 2012 onwards.

At the completion of the Fifteenth Meeting of the Conference of the Parties (CoP15) to CITES in early 2010, CITES Decisions 15.86–15.88 urged all Parties to consider stricter domestic measures for regulating the humphead wrasse trade, including limiting international trade to shipments by air only; improving monitoring through inspection of boxes of mixed live reef fish; increasing the exchange of law enforcement information; and increasing the awareness and identification capacity of law enforcers.

Hong Kong requires CITES export permits for legal humphead wrasse imports; import permits and/or licences are also required for live specimens. Mainland China requires CITES export and import permits for humphead wrasse for any type of specimen. Possession or sales licences are required for commercial sale, regardless of whether the specimen is a live fish, a chilled (i.e. non-live) fish, or parts thereof. Both import and domestic sale regulations in mainland China and Hong Kong are compliant with CITES requirements for Appendix II species trade regulation, and due to the requirement for import permits (except for non-live fish for personal use) the domestic measures are stricter than those required by CITES.

According to trade data from the World Conservation Monitoring Centre of the United Nations Environment Programme (UNEP-WCMC) and CITES, humphead wrasse were traded in the following specimen type categories: live and as bodies, meat, and derivatives. In terms of quantity and frequency, live humphead wrasse were the most frequently traded specimen, at least 64,826 tails were traded between 2006 and 2013. The global reported trade volume peaked between 2007 and 2009, but has significantly decreased since 2010. The trade volume dropped to around 550 tails of live (the major form of import) in 2013. According to these data, the actual export quantities never reached the export quotas set by Indonesia. Indonesia, Malaysia and Papua New Guinea were the main exporters of humphead wrasse between 2005 and 2013, and Hong Kong was the largest importer. Hong Kong did not implement the CITES measures for humphead wrasse until 2006, yet Hong Kong Customs data for 2005 reports imports of live humphead wrasse from the Philippines and

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[1] This article is a summary of a recent report from TRAFFIC and IUCN: Wu J. and Sadovy de Mitcheson Y. 2016. Humphead (Napoleon) wrasse: *Cheilinus undulatus* trade into and through Hong Kong. Hong Kong, SAR: TRAFFIC. 32 p

[2] TRAFFIC East and South Asia.

[3] University of Hong Kong and IUCN Groupers and Wrasse Specialist Group. Email: yjsadovy@hku.hk. For more information, please see: https://www.iucn.org/about/work/programmes/species/who_we_are/ssc_specialist_groups_and_red_list_authorities_directory/fishes/groupers_wrasses_sg/

Singapore, which do not appear in those countries' export records. The conclusion is that any live humphead wrasse exported from Singapore and the Philippines to Hong Kong in 2005 must have taken place in violation of CITES regulations that were in force at the time.

Mainland China has not reported any import of humphead wrasse following the CITES listing since 2005, however Malaysia reported the export of 700 live humphead wrasse to mainland China in 2007. It is possible that the discrepancy may be a result of reporting based on the number of permits issued rather than the actual trade taking place. Both mainland China and Hong Kong did not report to UNEP-WCMC any humphead wrasse trade after 2005. Hong Kong Customs data also do not show any humphead wrasse re-exported to mainland China after 2005.

During this study, the authors found live humphead wrasse for sale in physical and e-commerce seafood markets in mainland China. Although only one live humphead wrasse was observed in a seafood restaurant during two surveys in Shenzhen, mainland China, 12 advertisements offering live or frozen humphead wrasse for sale were found on two Chinese language e-commerce websites. Three more advertisements offering live and frozen humphead wrasse from Indonesia and the Philippines were also found on a China-based English language website. In early 2013, around 300 live humphead wrasse were found in Beijing, Shanghai, Fujian, Guangdong and Hainan, according to a snapshot market survey (Liu 2013). Traders from many of the observed markets claimed that live humphead wrasse arrived regularly. It seems that live humphead wrasse were available on the physical and/or e-commerce markets in mainland China, even though legal CITES imports were never approved. Taking the low levels of humphead wrasse availability in the South China Sea into account, this raises questions about the legality of these humphead wrasse.

Seventy-three live humphead wrasse were observed by the authors in holding aquariums in 17 restaurants and stores in three retail markets in Hong Kong in April 2015. Although possession licences are required for anyone who holds humphead wrasse for commercial purposes, licence holders are only required to record their sales within three days of business transactions but do not have to report these records to the Agriculture, Fisheries and Conservation Department (AFCD), the CITES Management Authority in Hong Kong. Monthly market surveys by Hong Kong University found 1,197 live humphead wrasse available from three main retail seafood markets in Hong Kong from November 2014 to December 2015. In total, 157 live

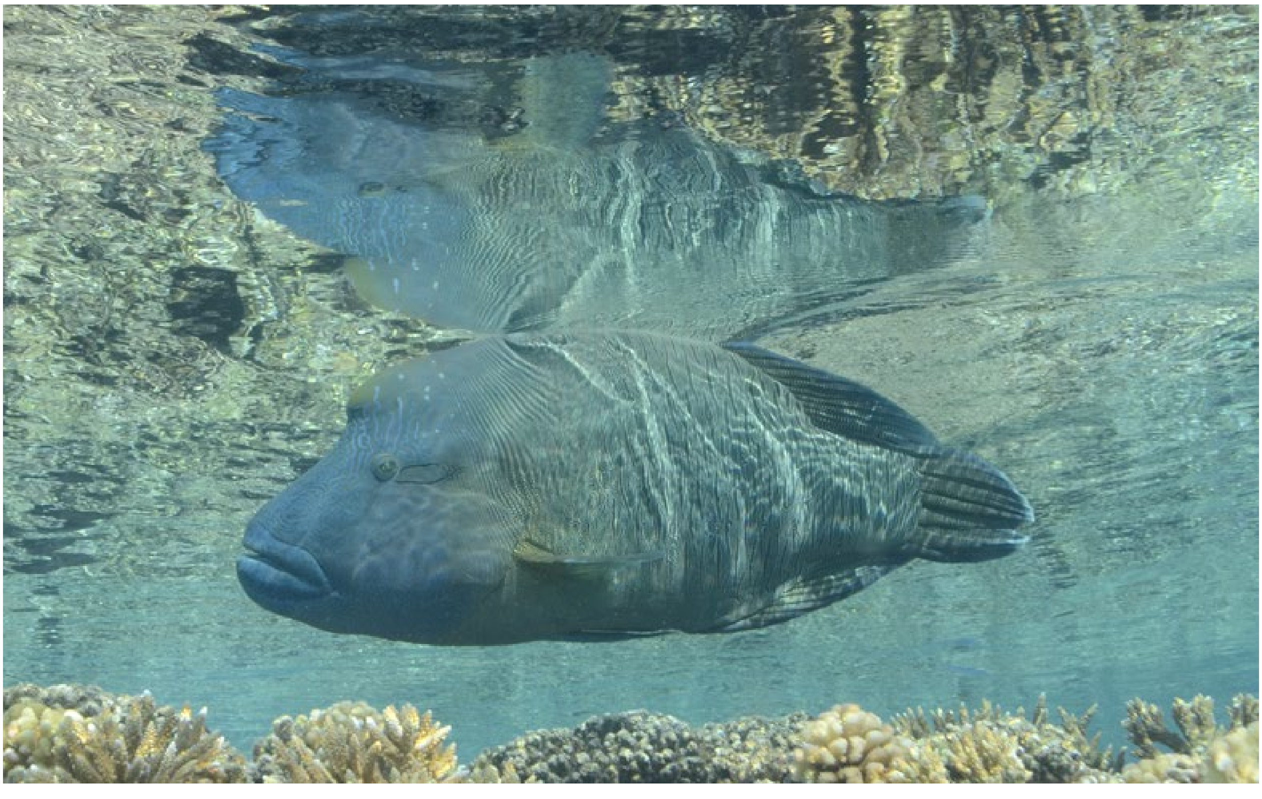

Figure 1. A humphead wrasse (*Cheilinus undulatus*) in an unfished pass in French Polynesia (photo: Yvonne Sadovy de Mitcheson).

humphead wrasse were observed in November and December 2014. According to the AFCD, only 150 tails of live humphead wrasse were imported into Hong Kong in 2014, which indicates at least 7 live humphead wrasse were illegally imported in 2014. Such illegal trade is presumably fuelled by demand, and perhaps persists because of insufficient patrolling and enforcement of existing trade regulations.

The authors observed no transport of humphead wrasse from Hong Kong to the nearest market, Shenzhen, in mainland China. However, other live fish and LRFF were observed in speedboats heading to Shenzhen, probably originating from Crooked Island in Hong Kong. Traders in Hong Kong and mainland China also claimed that LRFF tend to be re-exported to mainland China illegally to avoid high import tariffs, value added tax, and stricter import requirements. By avoiding the waiting time to obtain official documents, the risk of humphead wrasse mortality is also reduced.

In the past five years, only one instance of illegal trade in live humphead wrasse has been detected and enforced in Hong Kong. In 2010, a shipment of 53 live humphead wrasse from Indonesia was found with a valid export permit for only 50 fish (AFCD email communication to Joyce Wu, May 2015). Three fish were seized and the remainder was allowed to be imported. In December 2007, the Quarantine Bureau in Guangzhou Baiyun airport seized ten boxes of unauthorized humphead wrasse, which were smuggled in among 40 boxes of legitimate LRFF from Malaysia (Huang 2007). The 10 boxes of humphead wrasse were confiscated and destroyed, and the company fined CNY 1,000[4]. This case indicated that humphead wrasse were traded alongside other LRFF and also revealed that at least some humphead wrasse and other LRFF had been imported to mainland China without transit through Hong Kong.

The above findings indicate that more work needs to be done to improve the legality of humphead wrasse trade, both into and through Hong Kong, and compliance with CITES requirements, such as increasing the number of import inspections of mixed boxes of species containing LRFFs, domestic market monitoring, information exchange with source countries, raising the awareness and capacity of law enforcers and, importantly, recording imports into mainland China and enforcing the law regarding re-exports from Hong Kong.

The following recommendations are made to humphead wrasse stakeholders in Hong Kong and mainland China.

Figure 2. Frozen humphead wrasse on sale in a Malaysia supermarket in 2014 (photo: Allen To).

For humphead wrasse from source countries:

- The responsible authorities in Hong Kong and mainland China should increase awareness of all regulations and species identification issues for all relevant authorities (including customs, quarantine, marine police, aquatic management officials, industry and commerce officials) about the humphead wrasse trade in relation to CITES compliance.
- The intensity and frequency of import monitoring of mixed LRFF boxes or shipments needs to be increased.
- Information on export regulations and annual export quotas of the main humphead wrasse exporters, such as Indonesia and Malaysia, should be made public and accessible to the industry, relevant authorities, and others in the main markets, such as mainland China and Hong Kong.
- The relevant authorities in Hong Kong and mainland China should liaise with their counterparts in source countries (such as Indonesia and Malaysia) over every seizure case, and ensure that all relevant trade is reported to the CITES Secretariat.

For humphead wrasse available in domestic markets in Hong Kong and mainland China:

- Information on legal import quantities and the need for possession licences for legal sales should be communicated to the industry and general public in order to increase regulation compliance and reporting of any non-compliance.

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[4] CNY 1,000 = USD 135 in December 2007

- Domestic sales information on possession licence holders' recording sheets should be collected and analysed by AFCD in order to understand the scale of the trade and to determine whether illegal trade is occurring.

- Licences of humphead wrasse legal possession should be posted in a visible location. AFCD should consider whether to change the quota stated on the possession licence for those seafood shops because the current quota on the licence only records the number of fish that can be held at any one time, not the number of humphead wrasse retail outlets can have during the five-year validity of the licence.

- Patrolling domestic markets, high-end restaurants and hotels should be increased to verify whether any illegally traded humphead wrasse are on the premises. Patrolling is especially recommended during seasons of high demand, such as the Chinese New Year holiday, weddings and tourism seasons. Authorities should ensure that every humphead wrasse available in the market is clearly of legal origin.

For humphead wrasse shipments between Hong Kong and mainland China:

- Hong Kong should monitor and report re-exports of humphead wrasse to mainland China as part of the official CITES database for trade. Hong Kong should also check with the CITES Secretariat on the data discrepancy of its humphead wrasse re-export data. Authorities should co-operate to ensure the legality of live fish shipments.

For humphead wrasse arriving by vessels in Hong Kong and mainland China:

- Authorities should inspect the fishing vessels for the legality of the humphead wrasse harvest, and to record all humphead wrasse carried by the vessels in import or harvest statistics.

Figure 3. Humphead (Napoleon) wrasse, *Cheilinus undulatus*, and groupers (Serranidae) in Hong Kong (photo: Yvonne Sadovy de Mitcheson).

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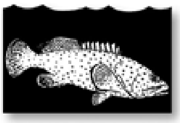

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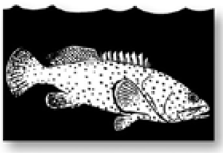

News and events

International coral reef symposium

The 13th International Coral Reef Symposium is being held in Honolulu, 19–24 June 2016. The symposium's theme, "bridging science to policy," promises opportunities to share information and ideas about live reef fish fisheries. Information is available at: https://sgmeet.com/icrs2016/

Nemo and Dory in the movies and in the news

Two scientists look at the impact of the Nemo and Dory films on the demand for ornamentals, the appropriateness of harvesting those two species to meet demand, and the role of ornamental reef fish in conservation. The Conversation, 14 Jun 2016: http://theconversation.com/finding-nemo-and-dory-is-easy-deciding-whether-they-should-be-pets-is-harder-60355

Petition calls for United States to test imported ornamentals for cyanide

The Center for Biological Diversity, the Humane Society, and For the Fishes have petitioned the US government to take more action to deter imports of illegally caught ornamental fish, including testing imported fish for cyanide traces. *National Geographic*, 10 March 2016: http://news.nationalgeographic.com/2016/03/160310-aquarium-saltwater-tropical-fish-cyanide-coral-reefs/

An app to distinguish "good fish" from "bad fish"

The non-profit organization, For the Fishes, has launched an app, called Tank Watch, for consumers to distinguish bred-in-captivity ornamental fish from those captured in the wild. *National Geographic*, 10 March 2016: http://news.nationalgeographic.com/2016/01/160126-Wildlife-Crime-Tech-Challenge-technology/

Sabah allows exports of cultured live tiger grouper and giant grouper

The government of Sabah has exempted certain species of cultured groupers from its ban on the export of live fish: *Daily Express*, 13 February 2016: http://www.dailyexpress.com.my/news.cfm?NewsID=106744

Hong Kong live reef food fish pictorial

This story is not much of a story, but it has a lot of pictures of live reef food fish in Hong Kong restaurants. *Jakarta Globe*: http://thejakartaglobe.beritasatu.com/multimedia/photos/eyewitness/reef-fish-trade-seafood/

Using fish sounds to identify spawning aggregations

Researchers in the Caribbean are using underwater microphones to identify reef fish spawning aggregations. *U.S. National Ocean and Atmospheric Administration*, 26 February 2013: http://www.noaanews.noaa.gov/stories2013/20130226_fishspawning.html

Live reef fish fisheries in the South China Sea

The live reef fish trade is mentioned in this article in reference to maritime disputes in the South China Sea. *The Diplomat*, 22 February 2015: http://thediplomat.com/2015/02/china-and-the-south-china-sea-resource-grab/

Australia working on culturing giant grouper

Researchers in Australia are working on breeding the Queensland groper, or giant grouper, one of the largest reef fish in the world. *The Cairns Post*, 17 February 2015: http://www.cairnspost.com.au/news/cairns/super-grouper-fish-grown-in-cairns-attract-international-demand/news-story/fc721b1fac64bde16bba11ae86bb10d7

Struggling to culture ornamental fish in Hawaii

Efforts continue in Hawaii to culture ornamental reef species, but it is not easy. *PBS Newshour*, 15 February 2015: http://www.pbs.org/newshour/updates/cant-captive-breeding-saltwater-aquarium-fish-catch-2/

Endangered species protection for Nemo?

In 2012, the Center for Biological Diversity petitioned the US government to list the orange clownfish (*Amphiprion percula*) and seven damselfish species under the US Endangered Species Act. Center for Biological Diversity, 20 September 2012: http://www.biologicaldiversity.org/news/press_releases/2012/reef-fish-09-13-2012.html

In 2014, the US National Marine Fisheries Service announced that the orange clownfish – but none of the damselfishes – may warrant protection under the Endangered Species Act because of threats from global warming and ocean acidification (but apparently not specifically because of overharvesting or the marine aquarium trade): https://www.federalregister.gov/articles/2014/09/03/2014-20955/endangered-and-threatened-wildlife-90-day-finding-on-a-petition-to-list-seven-indo-pacific-species

In 2015, the US National Marine Fisheries Service made its determination that the orange clownfish does not warrant listing under the Endangered Species Act: https://www.federalregister.gov/articles/2015/08/24/2015-20754/endangered-and-threatened-wildlife-and-plants-notice-of-12-month-finding-on-a-petition-to-list-the

Fishing near marine protected areas

A study of the effects of marine protected areas on the social and economic well-being of fishers found positive effects, including in Hawaii, where ornamental fish collectors benefitted from rising prices of the yellow tang. *FIS United States*, 6 March 2013: http://www.fis.com/fis/worldnews/worldnews.asp?l=e&country=0&special=&monthyear=&day=&id=59316&ndb=1&df=0

Traceable farmed grouper from Taiwan sold in mainland China

Quick-frozen groupers farmed in Taiwan are sold in mainland China with traceability tags. *The Fish Site*, 15 January 2013: http://www.thefishsite.com/fishnews/19239/traceable-taiwan-grouper-fish-now-being-sold-in-china

Coral Triangle partners set aside areas to protect species in live reef fish trade

At a meeting in early 2013, six countries (Indonesia, Malaysia, Philippines, Solomon Islands, Timor-Leste, and Vietnam) signed a resolution to establish marine protected areas specifically for species involved in the live reef fish trade, and to take other actions to put the trade on a sustainable footing.

See these news items put out by the Coral Triangle Initiative: http://www.coraltriangleinitiative.org/news/coral-triangle-countries-agree-joint-actions-sustainably-manage-live-reef-fish-trade; and USAID: http://www.usaid.gov/results-data/success-stories/coral-triangle-reef-fish-agreement-casts-protective-net.

A report of the meeting is available here: http://www.coraltriangleinitiative.org/sites/default/files/resources/LRFFTInter-GovernmentalForum31Jan-1Feb2013FullProceedingsReport_21Feb13_Final_V3.pdf

WWF calls for regional moratoria on trade and consumption of humphead wrasse

In releasing its report on legal and policy gaps in the live reef fish trade in the Coral Triangle (see Tsamenyi and Palma 2012 in the Noteworthy publications section of this bulletin), the World Wide Fund for Nature called for a regional moratorium on the trade and consumption of humphead wrasse. *WWF*, 5 September 2012: http://wwf.panda.org/wwf_news/press_releases/?206125/Legal-and-Policy-Gaps-in-the-Management-of-the-Live-Reef-Food-Fish-Trade-in-the-Coral-Triangle.

Philippines role in the live reef fish trade

The Philippines is the center of this story on the trade in live reef food fish and ornamentals: *Philippine Daily Inquirer*, 12 July 2012: http://globalnation.inquirer.net/43917/ph-center-of-%E2%80%98illegal%E2%80%99-live-reef-aquarium-fish-trade

Farming seahorses

Public aquaria in the United States are working on breeding seahorses and other marine species traded as ornamentals. *The Washington Post*, 15 April 2012: https://www.washingtonpost.com/national/health-science/farming-aquarium-species-to-save-them/2012/04/15/gIQAvYxfJT_story.html

"Snorkel Bob" protests Petco's sale of Hawaiian ornamentals

Parties are seeking to end the trade in ornamental reef fish harvested in Hawaii, the source of most yellow tang (*Zebrasoma flavescens*) in the global market for marine ornamentals. *SFGATE*, 4 January 2012: http://blog.sfgate.com/hawaii/2012/01/04/snorkel-bob-steps-up-protests-over-petcos-sale-of-reef-fish/

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