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The live reef fish export and aquarium trade

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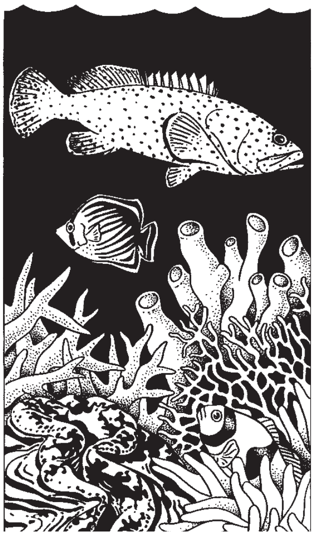

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Editors' mutterings

The *SPC Traditional Marine Resource Management and Knowledge Bulletin*, a companion publication to this one, demonstrates that fishers possess extensive knowledge about the waters in which they fish and the species they catch — knowledge that can be invaluable to researchers and government resource managers. Most of the effort to record and use such knowledge has focused on the Pacific Islands, Africa, and South America. Very little such research has been done in Asia; yet there are certain important types of indigenous expertise on fish to be found there that probably dwarf that which can be found anywhere else in the world.

One source of knowledge are the fishers who collect grouper fry from the wild for mariculture. In the past 20 years there has been an outpouring of scientific publications on settlement of post-larval coral reef fishes. Yet there remains a great deal that researchers in this field could learn from Asian fry collectors. This is made clear by the work of Sadovy (2001) (this publication, #8: 2) and Johannes and Lam (1999) (this publication, #5: 9), although these authors have only scratched the surface.

Even more could be learned from marine aquarium fish collectors; the bulk of the world's wild-caught tropical marine aquarium fish, in terms of both numbers and species, come from Southeast Asia.

In addition, there are thousands of small-scale marine fish farmers in Asia from whom much practical knowledge about fish husbandry could be learned. These people are professionals too, and in many ways they understand their particular situations much better than we do. Since many of them cannot afford the kinds of commercial medicines used by big operators, some will undoubtedly have developed, through trial and

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error, cheap local medicines and other methods for the health care of their fish. If these medicines were scientifically evaluated, some of them would undoubtedly prove to be effective. (The best place to look for them will be among old timers who raise types of fish that have been farmed for at least a generation.)

Other local medicines and other therapeutic aquaculture treatments will undoubtedly not withstand scientific scrutiny, but this is beside the point. Much of what first passed for scientific knowledge has not withstood scientific scrutiny either. And although some human medicines used by indigenous people have been shown to be ineffective, many medicinal compounds in use today, worth billions of dollars to the pharmaceutical industry, are derived from materials first used by indigenous peoples. We, likewise, ought to find out which indigenous mariculture medicines work.

I know of no research in this area[1], so it may seem presumptuous of me to be making these claims; but a 1989 annotated bibliography of ethnoveterinary medicine[2] — the terrestrial counterpart of what might be called ethnoaquaculture medicine — runs to 261 entries. The papers and reports it cites demonstrate repeatedly that one does not have to be formally well-educated, or even literate, to be clever, and to come up with clever solutions to problems with pests, ectoparasites, diseases, wounds and other problems with one's animals. As the authors of this bibliography say, 'many ethnoveterinary techniques are as effective as, and much cheaper than, their Western-world equivalents.' And, as Chan says (this issue, p. 26): 'Something must be done to assist the sustainable development of the mariculture industry in the region through better disease control measures.'

Since 1989 the study of ethnoveterinary medicine has taken off, especially in India, and such a bibliography today would undoubtedly be much larger. Given this example, and the growing interest in marine aquaculture research in Asia (as demonstrated, for example, in the pages of Aquaculture Asia and the Grouper Electronic Newsletter), is it not time to begin the study of ethnoaquaculture medicine in Asia's coastal waters?

Migrant fishers

The brevity of Ms Rivera-Guieb's note (p. 24) in this issue on the impacts of migrant fishers in one area of the Philippines, belies the importance of her subject. Of little apparent significance in the Pacific Islands, migrant fishers appear, however, to have very serious consequences for fisheries, including live reef fisheries, in parts of Southeast Asia, including the Philippines and Indonesia. Conventional community-based training programs to reduce cyanide fishing and other destructive fishing practices are not appropriate to combat this problem and local communities are often too weak to keep migrant fishers out of their waters. What are the best approaches to this problem? I welcome articles, letters or good references on the subject for publication here.

Bob Johannes

1. I have come across two references to aquaculture remedies for freshwater fish, both from Mexico (in reference 2, below) and, by now there are presumably more such references available from China, the world center of freshwater aquaculture.
2. Mathias-Munday, E. and C.M. McCorkle. 1989. Ethnoveterinary medicine: an annotated bibliography. Bibliographies in Technology and Social Change #8. Technology and Social Change Program. Iowa State University, Ames, Iowa. 199 p.

Live reef food fishery trial generates problems in Vanuatu

William Naviti[1] and Francis R. Hickey[2]

Vanuatu had its first live reef food fishery (LRFF) trials, during which a number of problems arose. In April 2001, the Vanuatu Department of Fisheries agreed to allow a Singapore-owned company to conduct some small-scale trials while it developed a management plan. The areas involved in the trials were the Port Vila area out to Devils Point, Havannah Harbour on north Efate, and Lamen Bay on Epi Island.

The company negotiated access to these areas with local communities. Holding-pen facilities were established for storing the catch. The target species included Napoleon wrasse and groupers. Fishing methods were limited to traps and droplining, and hookah gear was sometimes used to place the traps. The unbaited traps were anchored and camouflaged using rocks. One of the main grouper species caught in the traps using this method was the flowery cod *Epinephelus fuscoguttatus*. Some coral trout (*Plectropomus* spp.) were also caught, along with assorted bycatch.

One problem was that when traps were retrieved, the fish would attempt to escape by ramming the wire mesh walls and would damage their mouths. The resulting tissue damage often led to infection. Antibiotics were employed to counter the problem but mortality in the pens remained quite high.

Another area of concern was ciguatera (the development of toxicity of reef fish to humans as a result of consumption of a toxic dinoflagellate directly or — in the case of carnivores — via the food chain). Some groupers become ciguatoxic at certain times and in certain areas in Vanuatu. Shipments of ciguatoxic fish from some Pacific islands have caused major outbreaks of ciguatera poisoning among human consumers in Hong Kong (Sadovy 1999). Vanuatu fishermen are generally well aware of ciguatera in their waters, but they were sometimes hesitant to volunteer this information when cash was offered for these fish.

The company's long-term plan was to purchase a transport vessel equipped with live tanks to pick up the fish and transport them to the capital of Port Vila where they would be stored in net pens until 10–15 tonnes of fish accumulated. The fish would then be transshipped to the LRFF market in Hong Kong.

However, the Department of Fisheries became concerned that the trials were developing too fast before a management plan had been approved. They had also received complaints concerning the fishery from some of the communities involved. Communities were often divided on the issue of whether to allow access to outsiders to their reefs for this fishery. Customary marine tenure prevails in Vanuatu, so communities and clans own their nearshore fishing grounds and have the last say on reef access.

Some community members welcomed the opportunity to earn money through fishing. Others were concerned about the impact this fishery would have on their subsistence and artisanal fisheries as well as the overall ecology of their reefs. Complaints from the communities included:

- fish were damaged in the traps and their subsequent mortality in the net pens was too high;
- the company sometimes used their own crew rather than employing local fishers;
- bycatch was used to feed the fish held in the net pens rather than being released;
- reefs were damaged when the traps were weighted and camouflaged with rock (some said the divers were breaking up the reef to get this rock);
- the fishery was interfering with local sport fishing / tourist developments; and

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2. Country Coordinator, International Marinelife Alliance, PO BOX 1432, Port Vila, Vanuatu

- some of the promises made by the company, including financial compensation to the communities, were not always kept.

In response to reported problems with the company, members of one community removed company fish traps until their concerns were heeded. In another community the net pen was cut open to release the fish.

In a community that was divided over whether to allow LRFF operations, one chief declared a tabu on all fishing from his clan's fishing grounds specifically to block these operations.[3] The perceived threat in this case was that trap deployment and retrieval resulted in damage to the reefs by breaking coral. Other clans in the same community allowed LRFF operations to proceed in their reefs.

These problems underscore the need for communities to have more information on the pros and cons of this distinctive fishery. Many of the problems arising were due to community members and their leaders not having prompt access to practical information regarding this fishery. Such knowledge could have been provided by the company, the Vanuatu Fisheries Department and related NGOs.

To determine the viability of this fishery, the Vanuatu Department of Fisheries requested the Secretariat of the Pacific Community (SPC), to assist in performing some baseline LRFF stock assessments in areas being trialed by the company. Stock assessment surveys were performed in mid-August of this year by members of the Vanuatu Fisheries Department including the Director of Fisheries Moses Amos, Being Yeeting of SPC, and Dr Terry Donaldson and Steve Why of the International Marinelife Alliance. The surveys were concentrated in the Devils Point and Havannah Harbour area of Efate Island in central Vanuatu.

The final report from these surveys has not been released yet, but the preliminary findings suggest that the diversity and abundance of groupers in this area are not sufficient to support the LRFFT in addition to the subsistence and artisanal fishery of this area. The abundance of Napoleon wrasse was also found to be insufficient in these areas for export purposes.

The issuing of any licenses by the Department of Fisheries for the LRFFT in Vanuatu has been put on hold pending the recommendations arising from the stock assessment. All trials have been stopped since early June, at which time all of the fish caught during the trials were released. Stock assessment surveys for other areas potentially suitable for the LRFFT in Vanuatu will also be undertaken.

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Sadovy, Y. 1999. Ciguatera – a continuing problem for Hong Kong's consumers, live reef fish traders and high-value target species. SPC Live Reef Fish Information Bulletin 6:3-4.

3. The use by clans and communities of reef closures or tabus is a common means of community-based marine resource management in Vanuatu (Johannes l998.).

Advantages of pulse fishing in live product fisheries

Thomas R. Graham[1]

Time is an important factor in terms of seafood production costs. In general, the faster a product can be brought to market, the lower the production costs. Products that lose quality with time, such as chilled products, obviously have important constraints, especially the time between the points of capture and consumption. The importance of time with regard to live products is somewhat different. On the one hand, live product can be held for relatively long periods without any deterioration in product quality. On the other hand, organisms tend to die over time, so the size of a given live harvest will tend to decay over time.

Examined here are some of the relationships between live product holding times and production costs, and the implications of those relationships for fishery management. The discussion focuses on two production factors that are related not just to private production costs but also to public fish stocks: post-harvest mortality and the feed requirements of the live inventory. These two factors are especially important because their associated costs can grow disproportionately with holding time.

Holding time and mortality

Shipping costs generally decrease with increasing shipment size, so shippers have an incentive to build up their inventory before shipping. But that takes time and the longer the time, the greater the losses of live product. The by-sea trade in live reef food fish in the Asia-Pacific region presents an extreme situation — shipments by carrier vessel are cost-effective only with minimum shipment sizes of 5, 10 or even 20 metric tonnes (t).[2] Operations that ship by air, such as most ornamental fish operations, are not so severely constrained, but exceptions include locations where flights are infrequent, where there is strong competition for cargo space, and where the cargo rate decreases substantially with increasing shipment size.

There is a positive relationship between the time it takes for the harvest to reach the consumer and the percentage of the harvest that is lost along the way. But in many situations the loss is likely to be disproportional to the time elapsed. Take the case where a fishing operation is exerting constant fishing effort and harvesting at a constant daily rate. Assuming a constant daily mortality rate of the inventory, the daily addition to the inventory will remain constant over time, but the daily losses from the inventory will increase over time as the inventory grows. So while the cumulative catch increases steadily, the growth in inventory slows; at some point, the inventory will cease to grow in spite of a constant harvest rate.[3]

As an example, at a constant daily catch rate of 250 kg and a daily mortality rate of the inventory of one per cent,[4] the maximum possible inventory size is 25 t. A shipment size of 5 t would be reached in 23 days. The cumulative catch at that point would be about 6 t and the losses 0.6 t, or 10 per cent of the cumulative catch.[5]

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1. PO Box 235; Honolulu, HI 96809; USA
2. Johannes and Riepen (1995) cited Hong Kong sources that said 10 t was the minimum shipment size from the Pacific Islands and that 15 t would be ideal. Donnelly et al. (2000) reported 15 t to be ideal, with a maximum of 30 t. Chan (2000a) said that the large fish carriers working the more distant Pacific Islands required 20 t to be cost-effective.
3. The assumption of a constant daily catch may seem to be a generous one, since in theory an operation could increase fishing effort and catch over time in proportion to the size of the inventory. But most real-world operations do not have the luxury of controlling fishing effort to such an extent, particularly in cases where a fishing team of a given size is mobilised at a remote location, a common scenario in live reef food fishing operations.
4. Mortality is best modeled as two components: first, the percentage of a given harvest that dies regardless of the time elapsed since capture, and second, the percentage of the inventory that dies with each passing day. Only the time-dependent component is of interest and accounted for here. Time-dependent losses are not necessarily chronic — acute losses may occur from disease outbreaks, sharks, and theft. One factor not accounted for in these examples is that a certain amount of holding time is often needed to condition the fish in order to minimise mortality during transport. That would be relevant only for the fish caught during the last week or two before shipment.
5. This discussion has to do only with losses during pre-shipment holding periods. Not addressed is mortality during shipment, which, whether by sea or by air, often comprises the bulk of losses between capture and consumption.

The daily catch rate is obviously critical in these relationships, because the faster the fish are caught the faster the required shipment size can be reached. There is a critical catch rate below which a given shipment size will never be reached. With a minimum shipment size of 5 t and a daily mortality rate of one per cent, the critical catch rate would be 50 kg per day. If the catch rate is well above that critical level, as in the example above, the disproportionate component of the adverse effect is small.

Holding time and feed requirements

Another production cost that is dependent on holding time is the feed requirements of the live inventory. In the case where feed is obtained from an independent source, the effect is simply that feed requirements and costs increase in proportion to the holding time (per unit of inventory).[6] But in the case where fishing effort has to be diverted from fishing for target species in order to catch feed fish, the adverse effect is, like that of mortality, disproportional to holding time.[7] Figure 1 illustrates the relationships between holding time and inventory size, cumulative catch of target species, and cumulative catch of non-target species caught for feed. The assumptions are noted under the figure.

As the inventory grows, not only do daily losses increase, but the daily catch of target species decreases through time as fishing effort is diverted to provide feed fish. Again, there is a maximum inventory size that can be reached (6.25 t in the example). And conversely, there is a critical minimum daily catch rate below which a given shipment size will never be reached. It is equal to the shipment size times the greater of the mortality rate and the feed rate — in this case, 200 kg per day. At the catch rate in this example, 250 kg per day, a shipment size of 5 t would be reached in 40 days and post-harvest losses would be 1.2 t, or 20 per cent. As shown in Figure 1, a substantial harvest of non-target species (3.7 t) is required to sustain the inventory until shipment time.

The effect of bycatch

Not incorporated in the previous examples are the effects of bycatch. In most live reef food fish operations, the bycatch rate is likely to be substantial.[8] If the highest value of the bycatch is outside the live fish operation (e.g. it can be sold on the local market), then the bycatch has no remarkable influence in terms of the time-dependent effects described here. But if the highest value of some or all of the bycatch is as feed for the live inventory, then it is an important factor. Because less fishing effort would have to be diverted to fishing for feed, bycatch would tend to make the feeding rate less important and the mortality rate consequently more important.

Implications for fish stocks

Using the previous examples, and incorporating a bycatch rate of 50 per cent, Figure 2 shows the relationships between holding time and two crude indicators of impacts to fish stocks. Shown are two ratios of fish-caught to fish-shipped, one for target species only and one that includes all captured species. At the point that the inventory reaches 5 t (53 days), these ratios are 1.3 and 2.6, respectively. If the bycatch rate were zero, the first ratio would be 1.2 and the second 2.0.

Implications for efficiency

The implications of the time-related effects described above are obvious in terms of the efficiency of businesses involved in the distribution of live fish: shipping fast is the key, and shipping by air has a clear advantage over shipping by sea. In either case, where there are constraints on the minimum shipment size and thus the holding time, it clearly pays to fish fast.

In order to illustrate these time-related effects in terms of production costs, some indicative costs and prices are incorporated into the previous examples. In Figure 3 production costs (up to the point of shipment) are plotted against holding time. Only the direct costs of the fish harvested — including target species, feed fish, and bycatch — are accounted for in the cost curve. The fixed and other running costs of an export operation, many of which are also dependent on holding time, are not included.

In this example, at a catch rate of 250 kg per day, a 5-t-shipment size is attained in 53 days and production costs are $ 7.72 per kg of fish shipped. Doubling the catch rate to 500 kg/day would decrease the holding time by more than half — to 23 days — and production costs would decrease by 13 per cent to $ 6.69 per kg.

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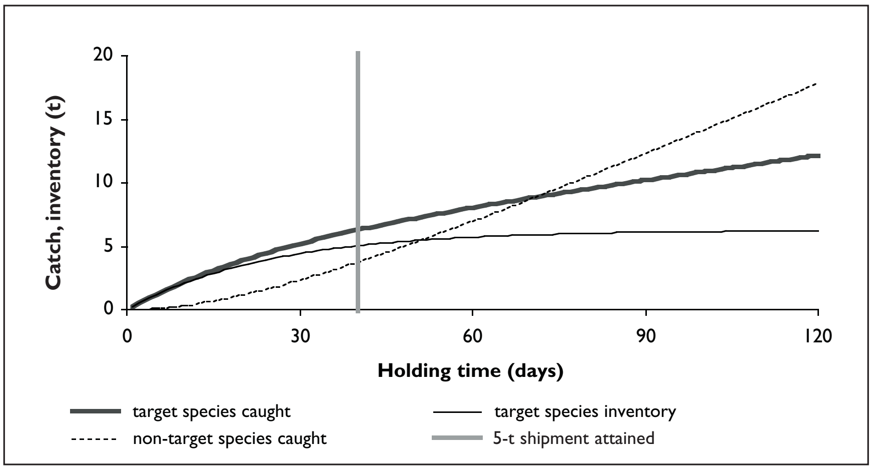
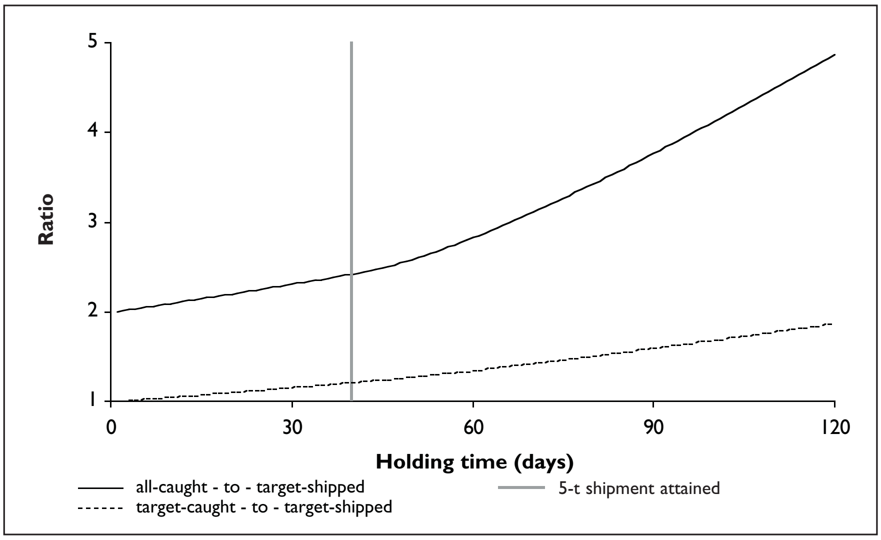
6. In a live reef food fish operation in the Solomon Islands, for example, tuna rejected from a nearby cannery were fed to the inventory (Johannes and Lam 1999).
7. This circumstance is, again, common to situations in which a fishing team is mobilised at a remote location.
8. For example, Donnelly et al. (2000) estimated the bycatch rate in a couple areas of Solomon Islands to be 50 to 80 per cent. It is worth noting that such high rates probably indicate that much of the fishing was not done on spawning aggregations — for example, the catch from hand-lining directly on a mixed aggregation of *Epinephelus polyphekadion* and *Plectropomus areolatus* in Palau was 97 per cent comprised, by number, of just those two species (n=3046 fish; Johannes et al., unpublished data).



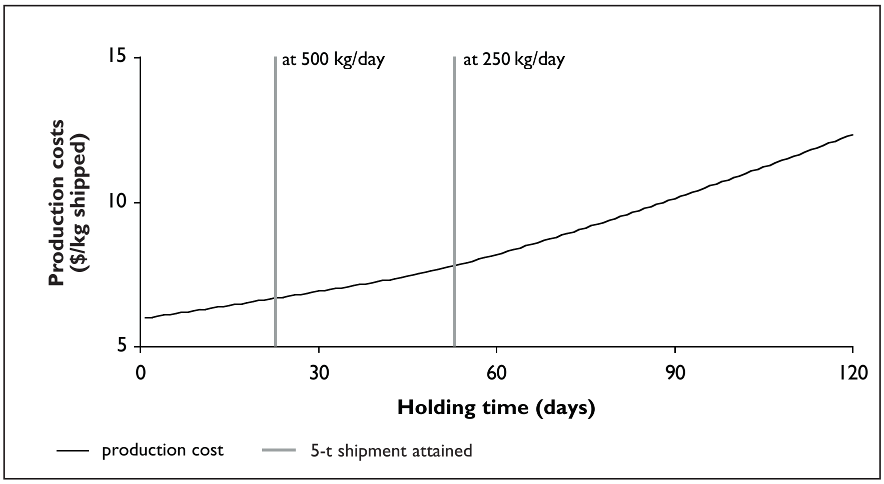
- The catch rate of target and feed species combined is 250 kg per day.
- The mortality rate is 1 percent of the live inventory per day.
- The feeding rate is 4 percent of the live inventory per day.
- Feed requirements are met first by losses of target species, and second by fishing directed at feed species.

Figure 1. Post-harvest losses on holding time



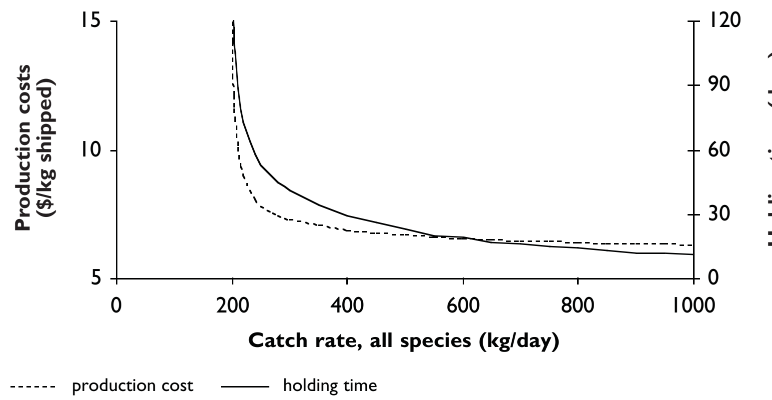
- The catch rate of target, bycatch, and feed species combined is 250 kg per day.
- The mortality rate is 1 per cent of the live inventory per day.
- The feeding rate is 4 per cent of the live inventory per day.
- The bycatch rate is 50 per cent.
- Feed requirements are met first by losses of target species, second by bycatch from target fishing, and third by fishing directed at feed species.

Figure 2. Ratios of fish-caught to fish-shipped on holding time



- The mortality rate is 1 percent of the live inventory per day.
- The feeding rate is 4 percent of the live inventory per day.
- The bycatch rate is 50 percent.
- Feed requirements are met first by losses of target species, second by bycatch from target fishing, and third by fishing directed at feed species.
- The cost (e.g., fishing cost) of target species is $5/kg.
- The cost (e.g., fishing cost) of non-target species is $1/kg.

Figure 3. Production cost on holding time



- The mortality rate is 1 percent of the live inventory per day.
- The feeding rate is 4 percent of the live inventory per day.
- The bycatch rate is 50 percent.
- Feed requirements are met first by losses of target species, second by bycatch from target fishing, and third by fishing directed at feed species.
- The cost (e.g., fishing cost) of target species is $5 / kg.
- The cost (e.g., fishing cost) of non-target species is $1 / kg.
- The shipment size is 5 t.

Figure 4. Production cost and holding time on catch rate

The importance of catch rate is further illustrated in Figure 4, in which holding time and production costs are plotted against catch rate for a given shipment size.

It can be seen that at catch rates below the critical level (200 kg / day), the 5-t-shipment size will never be reached and production costs will be infinite. Above that critical level, production costs approach the minimum possible ($ 6 / kg) with increasing catch rates.

There would seem to be ample incentive for fishermen and exporters to avoid the penalties apparent on the left side of Figure 4 — first, of course, through attainment of acceptable mortality and feed rates, and given those rates, through fishing fast enough. But there are two examples from Palau of live reef food fish by-sea export operations apparently failing, at least in part, from fishing too slowly.[9] In one operation, fishing took place for two to three months, producing a single shipment of only about 2 t. Being so small, the shipment itself was almost certainly not cost-effective. In fact, it may have been made prematurely in order to avoid what would have been substantial time-related penalties had fishing continued at such a slow pace (less than 100 kg / day). A second operation, based at Helen Reef, a remote atoll, was operating under conditions similar to those illustrated in Figure 2. The average daily catch rate was estimated to be between 250 and 300 kg, barely above the estimated critical minimum rate of 250 kg / day.[10] The operation ended after two years. In that case, poor profitability appeared not to necessarily be a contributing factor in the operation's closure. However, what was clearly an important factor was the local community's concern over adverse impacts to the atoll's fisheries resources, including non-target species used to feed the inventory. Those impacts were, of course, partially a function of holding time, which again, was a function of the catch rate (the ratio of all fish harvested to target species shipped was estimated to be between 2.1 and 3.6).

Implications for fishery management

Government intervention into a fishery is warranted to the extent that the costs of the fishery are borne by the public. For example, to the extent that a high catch-to-shipment ratio is indicative of overharvesting of a public resource, Figure 2 illustrates the public penalties that stem from large shipment sizes (or poor survival rates, or fishing slowly — however you look at it). And as illustrated by the Palau examples, in young enterprises, such as the ephemeral joint ventures that typify the live reef food fish export fisheries of the Asia-Pacific region, operational costs (including those associated with mortality and feed requirements) are often underestimated by industry participants. This leads to failed enterprises — sometimes several in succession — and in the process, adverse impacts to fish stocks with few benefits in return to the public.

9. This is not to imply that the operations would have been viable had they fished more quickly—the limited productivity of the resource appeared to be the more critical constraint in at least one of these examples (see Graham 2001, for details).
10. The daily catch rate was not measured directly but was estimated from the amounts shipped, the intervals between shipments, and rough estimates of daily mortality and feed rates.

Clearly, policies and laws for the live reef fish fisheries of the Asia-Pacific region should encourage shipping by air to the extent possible given the available routes and costs.[11] In fact, there has been a trend of live food fish imports to Hong Kong increasingly being made by air rather than by sea.[12] In cases where shipping by sea is the most efficient option, there are a number of strategies that could be used to encourage efficiency. In terms of the effects described above, the most compelling one is to encourage fast fishing.

This article does not address what is typically fishery managers' primary preoccupation — controlling the catch rate from a stock of limited productivity. The prescription made here to 'fish fast' does not refer to the overall rate of harvest from a population. It only means that a given optimal overall harvest should be taken quickly. If the 'fast' rate is less than the overall optimal rate, then it implies having to fish in pulses.

The advantage of pulse fishing, in terms of the effects described above, is that the concentration of fishing effort and catch in brief periods would reduce the percentage of post-harvest losses and feed requirements, allowing for greater operational efficiency and fewer impacts on the resource for a given level of production. Depending on local circumstances, pulse fishing might also offer other advantages, including:

- The pulse-fishing pattern might fit well with the desires of many fishermen, particularly in the Pacific Islands, where fishing is rarely a full-time or sole occupation.[13]
- It might facilitate cost-effective enforcement, as the time spent in local waters by fishing and carrier boats would be reduced and most enforcement activities could be limited to brief periods.

In the context of the live reef food fish fisheries of the Asia-Pacific region, it is difficult to discuss pulse fishing without addressing the targeting of spawning aggregations. For some of the species favoured in live reef food fish markets, catch rates from aggregations can be extremely high and bycatch rates extremely low, affording highly efficient fisheries. In fact, live reef fish operations often target aggregations and consequently tend to fish in pulses coincident with aggregating periods (e.g. see Johannes and Lam 1999, regarding Solomon Islands). The efficiency afforded by aggregations brings with it a high risk of overfishing. The typically prescribed response to that risk is to prohibit fishing at aggregation sites or during aggregation periods. Such a strategy makes sense where there is no other cost-effective way of controlling the total take (although in many cases simply closing the fishery would probably yield greater net benefits). But it is important to actually do that assessment — to determine whether there are alternative approaches that would not squander the efficiency afforded by aggregations, such as limits on catches, exports, or fishing effort. Without attempting here to account for all the benefits and costs of management regimes that would allow aggregation fishing, it is simply noted that in terms of the time-related effects described above, aggregation fishing — to the extent that it facilitates fast fishing — obviously offers an advantage.[14]

Although this discussion has largely avoided the issue of how to conserve fish stocks, it is important to emphasise that any management or development intervention that improves efficiency in a fishery is likely to increase the motivation to fish. If the intervention is not accompanied by effective controls on catch or effort it is likely to result in increased fishing effort and increased risk of resource depletion. The strategies of encouraging pulse fishing and/or aggregation fishing fall in that category of intervention. Other strategies in the same category include those that would improve prices, reduce bycatch rates, or reduce mortality rates (e.g. through improved handling methods or technological innovations). Obviously, reductions in the 'waste' associated with bycatch or mortality could allow the same level of benefits to be derived from a fishery at a lower overall catch rate. But without controls on the overall catch rate, any reduction in that waste would make the overall catch rate tend to increase, not decrease.

Clearly, interventions aimed at improving efficiency, such as rules that encourage pulse fishing, should be applied in concert with mechanisms to

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11. For example, Johannes and Riepen (1995:78) made a recommendation to ban the use of live fish transport vessels where airfreight is a viable alternative, and noted that Australia had already done so.
12. Chan (2000b) reported that the proportion of live food fish imported to Hong Kong by air had increased from 35 to 55 per cent.
13. Trochus shell, which is harvested in the Pacific Islands primarily for commercial export, offers a good example. Trochus harvesting is often limited by law or economics to just a few weeks each year, during which time there is intensive harvesting by a large number of people. Rather than providing steady income to a small group of people, the fishery provides occasional income to a large group.
14. Disadvantages of fishing spawning aggregations include the potential loss in reproductive output that results from harvesting fish just prior to spawning rather than, say, just after spawning, and for live product fisheries, the possibly enhanced post-harvest mortality that results from taking gravid females (from their increased susceptibility to stress and/or the tendency for captive gravid females to release their eggs, fouling the water and killing some of the inventory).

limit the overall catch rate — that is, to conserve fish stocks. But it would make little sense to ignore issues of efficiency when considering issues of conservation. Applied without regard to efficiency, conservative strategies tend to create fisheries that — even if sustainable — generate few benefits. The need to be cautious with regard to fish stocks is not at odds with the aim of providing fisheries that actually generate benefits.

Acknowledgements

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The live fish trade on Queensland's Great Barrier Reef: changes to historical fishing practices

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Introduction

Up until 1993, all catch from the Great Barrier Reef (GBR) commercial reef line fishery was sold as frozen fillet or whole fish, or as fresh chilled whole fish; and fish caught in Australia was sold on the domestic market, with limited amounts being exported. In 1993, the first live reef food fish were exported from Australia (McDonald and Jones 1998; Mapstone et al. 1996; Squire 1994). The practice developed slowly through 1994 and 1995 — with relatively small quantities of fish being supplied by only a few vessels — then grew rapidly in 1996 and in more recent years. For the most part, this growth has involved traditional participants in the fishery changing their holding and marketing practices, rather than the growth of a 'new' fishery.

'Live fishing' in Australia predominantly targets coral trout, particularly *Plectropomus leopardus*, with 90–95% of all live food fish exports from Australia being coral trout. Small quantities of barramundi cod (*Cromileptes altivelis*), humphead Maori wrasse (*Cheilinus undulatus*) and a number of small groupers are also exported from Australia. Selling live fish represents considerable value adding for the reef line fishery compared with selling the same product frozen. Prices for live fish have been between 40–300% greater than for the same fish dead, although prices for live fish have been unpredictable and can fluctuate on a daily basis.

The prospect of high returns for reef fish is seen as a strong incentive for Queensland fishers to enter into the live fish industry. Anecdotal information

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suggests that the high value of live reef fish already has resulted in increased numbers of people entering the industry and has raised concerns that increased fishing pressure may have detrimental effects on the GBR. These concerns were flagged with CRC Reef ELF (effects of line fishing) researchers as early as 1995, mainly from recreational fishers and conservationists, but also from some commercial fishers. Specific concerns were about the potential for increases in commercial fishing effort and resultant over fishing, with detrimental effects to the fishery and the ecosystem in the GBR World Heritage Area. Concern was also raised that live fishing effort was concentrated on reefs close to large ports with international airports, which are required for freight of the live product, resulting in potential localised depletion of fish stocks. The issue of localised concentration of effort may be complicated further because the reefs close to major population centres are the preferred fishing locations for recreational fishers, thus providing the environment for greater visibility of commercial operations and conflict between the two fishing sectors.

This controversy prompted researchers from the CRC Reef, based in Townsville, Australia to investigate this new industry. The aim of the research was to provide managers and stakeholders with information on how the change in fishing practice (from selling frozen to live fish) impacted catch rates, effort and fishing behaviour in the reef line fishery in Queensland. This research was carried out over two years (1996–1998) in the early development of the trade. The research was based on four sources of information: 1) Direct observations of fishing activities by on-board observers; 2) Analysis of research logbooks filled out voluntarily by skippers of commercial fishing operations; 3) Analysis of compulsory logbook data provided to the Queensland Fisheries Service (formerly the Queensland Fisheries Management Authority); and 4) interviews with skippers. This article highlights some of the main findings from this research project.

Background

Commercial fishing for demersal reef fish on Australia's Great Barrier Reef has been established since at least the early 1940s. The fishery harvests a wide variety of fish species, with three main target species groups: coral trout (mainly *Plectropomus leopardus*, *P. laevis* and *P. maculatus*), red throat emperor (*Lethrinus miniatus*) and spanish mackerel (*Scomberomorus commersons*) (Mapstone et al. 1996). Similar species are also the target of a large recreational fleet with access to the same reef areas. Commercial fishers fish from 3.5–6 m boats (dories) tendered to larger primary vessels, with each fishing operation having between 0 and 6 dories, depending on the fishing license held. Fishing is done by hook and line, using 50–130 lb breaking strain hand lines with a single 7/0–9/0 hook. Fishers generally only use one line per person when fishing commercially.

Management arrangements for the fishery are complex because the fishery operates within the GBR Marine Park and World Heritage Area. As a result, it is subject to direct and indirect regulation by both state and commonwealth acts. Minimum size limits apply to a number of important target species, including coral trout, and are set to protect spawning stocks. Other regulations restrict areas where fishing can occur, and currently around 16–23% of coral reef habitats within the GBR Marine Park are protected from fishing. Destructive fishing practices such as cyanide poisoning and explosives are strictly prohibited. Commercial fishers must hold an endorsement to sell coral reef fish in Queensland. The number of these endorsements has been capped at around 1800 licenses since 1993. Fisheries regulations are strictly enforced by surveillance agencies, and despite the considerable size of the area, surveillance is reasonably efficient, using planes, boat patrols and voluntary reporting facilities.

Effort in the Queensland commercial reef line fishery has increased in recent years from around 16,800 primary vessel days in 1989 to over 27,000 vessel days in 1998. Effort specifically targeting live fish has also increased from less than 100 vessel days in 1993 to nearly 7400 vessel days in 1999. The extent to which the live fish industry has contributed to the overall increase in fishing effort is unclear, partly because of inconsistent reporting of live fishing in the early days of the industry and partly because a number of other management adjustments in related fisheries may have led to increased participation in the reef line fishery. Nevertheless, it is expected that the high price paid for live fish has provided at least part of the incentive for real increases in total commercial effort in the fishery since 1994, whether through increased effort by already active fishers or through the activation of inactive licenses.

Consequences of growth in the trade in live reef fish

Historically, line fishing effort was uneven along the tropical Queensland coast with the majority of catch and effort recorded in the Central GBR region (Townsville, Mackay and Swains regions; Mapstone et al. 1996). Live fish were first landed in the Mackay and Swains regions in 1993. Since 1996–1997, the distribution of live fishing has spread substantially to the north and south, with a concentration of effort in the vicinity of Cairns, the location of the main international airport suitable for export of live fish. This concentration of effort may be responsible for much of the controversy about the live fish trade as Cairns also has a large recreational fishing fleet. The prospect of encounters between recreational and commercial fishers with resultant conflicts would have been high. In recent years, however, this concentration of effort has diminished with live fish now being taken from most areas of the GBR and live operations tending to fish in more remote locations.

Research on trip lengths and the distance traveled by live fishing operations on normal fishing trips provided some information on the notion that live fishers were targeting inshore reefs close to major ports. Anecdotal information provided to the research team indicated that especially in the early days of the live fish industry, poorly refined handling and holding techniques resulted in primary vessels being unable to hold live fish on board for more than five to six days. This, in addition to the fact that holding capacity for live operations is considerably lower than a similar operation keeping frozen product, meant that live operations made shorter trips than 'dead operations' and stayed closer to port. The research corroborated this commentary from fishers, showing that live operations tended to make shorter trips, remain closer to ports during trips, and spend shorter periods at fishing sites than those targeting fish for the frozen / fresh market. However, this trend may now be diminishing with better husbandry and holding techniques on fishing vessels.

Catch rates of most species of reef fish in this study tended to be less when fish were being kept alive for market than when they were being killed. This was most conspicuous for by-product species but also was true for live target species at times of maximum catch rates, indicating that keeping fish alive tended to impose lower maximum catch rates than if fishers were killing their catch. This may be due to increased handling times in the dory and other factors. Fishers targeting live fish tended to fish for shorter periods per fishing session, make more returns to the primary boat, move more often between 'hangs' (fishing sites), and spend more time searching for each fishing site than did fishers who were killing their catch. Further, fishers selling live fish were more selective about where they fished in order to maximise their catches of prime market fish, especially coral trout, rather than less valuable species that could not be sold live. Indeed, on some live fishing vessels, most species that could not be sold alive were simply not kept. Overall, operations selling their catch alive generally landed up to half as much demersal by-product as operations killing their catch.

The size of coral trout taken also varied between live and dead fishing practices. The results, however, did not support the notion that live operations harvest significantly more small coral trout than did dead operations, despite small trout (38–45 cm total length) being preferred for the live market and fetching higher prices than larger individuals. Relatively higher rates of capture and subsequent release of coral trout under the 38-cm minimum size restriction that applies in Queensland, were observed on live trips than on trips where the fish were killed, which may be a concern if post-release mortality is significant.

Spawning aggregations

The research also found little evidence of the consistent targeting of spawning aggregations of coral trout by commercial fishers. The targeting of fish spawning aggregations has been suggested to have major detrimental impacts on fish stocks overseas due to large increases in catch rates, and disruption of spawning behaviour. Earlier studies have shown that *P. leopardus* form relatively small spawning aggregations (Samoilys 1997; Samoilys and Squire 1994; Zeller 1998) on the GBR and only about 6–10% of coral trout individuals attend such aggregations sites at any one time (Fulton et al. 2000). This would make spawning aggregations difficult to find, and the benefits from searching for them minimal. This research indicated that either deliberate targeting of spawning aggregations of *P. leopardus* is a relatively minor factor in the success of fishers on the GBR or that spawning aggregations cannot be found consistently. Hence, it appears unlikely that *P. leopardus* is at great risk from the targeted harvesting of spawning aggregations by Queensland commercial fishers, although other species that are believed to form larger, more predictable aggregations may be more vulnerable to harvest when spawning.

Conclusion

The potential exists on the GBR for the trade in live reef fish for food to be a success story, largely because of a strong regulatory environment, the absence of destructive fishing practices, and a range of management strategies that protect spawning stocks while also allowing regulation of their harvest. The trade in live fish on the GBR has not resulted in increased per capita catch rates or fishing practices that are intrinsically worse than those that have been in place in the fishery for decades. Indeed, given the significantly reduced catches of by-product species, no increase in catch rates of live target species, and added value to the industry, the transition from frozen to live markets for GBR reef fish might be seen as positive development in both economic and ecological terms. On the other hand, the increased prices paid for live fish are likely to have provided at least part of the incentive for real increases in effort seen in the fishery since 1994. Any potential benefits of the live fish industry, such as reduced catch rates, especially of by-product species, that can be sustained by individual fishers due to value adding on the live product, may be offset by overall increases in effort. Prudent management action is advisable, therefore, to control effort adequately and avoid real or perceived stock depletions, either locally in areas close to ports and population centres or more widely, and economic hardship in the fishery.

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An economic analysis of the spawning aggregation function in Komodo National Park, Indonesia

Herman Jack Ruitenbeek

Abstract

This study provides an economic valuation of the demersal fishery spawning aggregation function in Komodo National Park. A parametric generalised single-period model is developed to assist in modeling and estimating the value of the fishery linkages. For a linear function, the maximum value of the spawning aggregation function is calculated to be USD 629,000 annually at 100% protection of the spawning sites. This is of a similar order of magnitude to the direct recreational values associated with the park.

Introduction

Komodo National Park (KNP) is widely recognised as an exceptional storehouse of both terrestrial and marine biodiversity with global significance. Established in 1980, it is listed as a World Heritage Site and a Man and the Biosphere Reserve. Located between Sumbawa and Flores Islands in eastern Indonesia, the park consists of three main islands, Komodo, Rinca, and Padar and several smaller

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islands. The park contains most of the habitat of the world's largest reptile, the Komodo monitor. While originally established to protect the Komodo dragons, it is now highly valued as a marine reserve as well. About 76 per cent of the area of the park is water; it is considered one of the richest areas for coral species in Indonesia and contains one of the most diverse collections of fishes in the world.

The goal of park authorities is to conserve and sustainably use the biodiversity assets of KNP through establishing a set of mechanisms and systems to help ensure effective long-term park management. International funding support is directed towards implementing a 25-year master plan completed by the government of Indonesia with the assistance of The Nature Conservancy (TNC et al. 2000).

In support of the planning efforts at KNP, a series of economic analyses was conducted. Their scope included economic policy reviews, economic feasibility studies for alternative livelihood development in the park area, and a cost–benefit analysis (CBA) of the conservation initiative. The CBA was intended to look at the overall efficiency of the conservation expenditures, given the likely income from enhanced tourist revenues from diving and dragon watching. In addition, the CBA looked at a number of hitherto neglected benefits of conservation through estimating their potential economic contribution in monetised terms. Valuation of a spawning aggregation function was one of these additional benefits. Its inclusion within the analysis performs an important awareness-building role to the extent that the monetised value can be directly compared to the direct benefit measures associated with tourism.

As readers of this Bulletin are well aware, the potential value of spawning aggregation sites is becoming well acknowledged in the scientific literature (Pet et al. 2001; Pet-Soede et al. 2000; Russell 2001; Sadovy and Eklund 1999; Johannes 1997; Turnbull and Samoilys 1997; Vincent and Sadovy 1997). Within the context of marine protected areas, such sites can also serve an important basis for delineating the protected area system, implementing seasonal closures or instituting similar regulatory measure (Nowlis and Roberts 1999; Roberts 1997, 1998a, 2000). But many policy-makers are unconvinced or unaware of the benefits of protective measures, and the traditional economic analyses of marine protected areas (MPAs) management typically focus on tradeoffs between conservation benefits and fishery catch (see Cartier and Ruitenbeek 1999 for review). More recently, economic analyses have started addressing so-called 'spill-over benefits' from MPAs, whereby MPAs are seen to provide an important function through allowing fishery stocks to recover within no-take zones (Roberts 1998b; Rodwell et al. 2000). In such areas, economic efficiency may be improved through (i) higher yields; (ii) lower fishing effort and cost to realise these yields; or (iii) lower regulatory costs because of easier monitoring of the fishing fleet. But the role and value of spawning aggregations in such spill-over analyses is not addressed.

In the case of KNP, ongoing monitoring studies have revealed the importance and the complexity of spawning aggregation sites within the park boundaries (Pet 1999; Pet et al. 1999; Pet and Muljadi 2001). Upon the advice and request of TNC, economic analyses were conducted to draw attention to the potential economic significance of this function. The purpose of this article is to present the simplified model and estimates for KNP.

Model

At this time, little is known about the complex dynamics of spawning aggregations in Komodo. Moreover, no economic analyses of the value of this function have been conducted elsewhere; hence no formal methodology has been developed for treating this potentially important value. To address the issue, a generalised model was developed that could be used in any setting. The model requires some considerable simplification of the relationships, yet it provides enough scope and flexibility to permit value estimates to be generated that are of similar reliability to those associated with other costs and benefits (e.g. recreation benefits) typically incorporated into a CBA at the feasibility analysis stage.

A simple single-period model is used that reflects a parametric density function for the demersal fishery in the park area. The model has a general form as follows:

x = Presumed area of spawning aggregation sites
X = Presumed influence area
P = Total protected area (no-take zone) ($P \leq X$)
a = Degree of protection given to spawning area ($0\% \leq a \leq 100\%$)
D_o = Fishery density in absence of disturbances
$D = D(ax,b)$ = Generalised fishery density, such that $D = a^b D_o$
$H(a,b,X,P) = D * (X - P)$ = Harvest value

The annual value of the spawning function is taken as the difference between $H(a{=}0,b)$ and $H(a{=}1,b)$ for any particular site. This general model is very flexible as it can accommodate all extremes of the usual management assumptions. At one extreme we have the typical assumption that spawning aggregation is not important (b=0) and that the density function is thus not a function of protection efforts. In such a scenario, protecting some area simply reduces fishery harvest because of the no-take zone. We can also specify a linear dependence (b=1) between spawning aggregation site protection and density; at b=1, a 50% protection would place the density throughout the region at 50% of D; even so, harvest value would be less than 50% of the total fishery because of the influence of the no take zone. One can also model non-linear effects (b>1) to demonstrate strong linkages between spawning aggregation site and regional density. In general, the value of the spawning aggregation function will depend on the ratio of the no-take area to the influence area (P/X), the ratio of the spawning area to the no-take area (x/P), the protection level of the spawning area (a), and the linkage parameter (b).

Data and assumptions for KNP

Information for KNP was derived from the management plan (TNC et al. 2000) and from official government fishery statistics for the demersal fisheries in the region (BPS 2000; Dinas Perikanan Kabupaten Bima 2000). We caution that one of the most important values of this function is the Benchmark Density (D_o), which is based on secondary sources through local Fishery Department landing data — these data in Indonesia are known for their unreliability and the final result must therefore be regarded as an order-of-magnitude estimate.

In the case of Komodo Park, we place a maximum value on the spawning aggregation function based on the following assumptions:

- Total area of influence X = 3,142,000 ha (~100 km radius; excludes land)
- Total area of spawning aggregation sites x = 1700 ha (reef area in KNP)
- Total protected area (no-take zone) = 132,000 ha (area of KNP Marine component)
- Benchmark density (D_o)= USD 0.209 · ha^{-1} (based on local demersal fishery statistics)

Results and discussion

For a linear function (b=1) the maximum benefit value of the spawning aggregation function is calculated to be USD 629,000 annually at 100% protection of the spawning sites. In a traditional economic analysis that excluded this function (i.e. b=0), the impact of the MPA would be to impose a *cost* to the fishery sector of USD 27,600 (corresponding to the lost value of the fishery density within the no-take zone of 132,000 ha).

The benefit value is considerable in relation to other benefits associated with the park. In present value terms (using a 10% discount rate) the benefit corresponds to USD 6.3 million. To place these figures in perspective, TNC estimates annual operating costs for KNP to be of the order of USD 1.5 million to USD 2.0 million. The park currently generates about USD 60,000 annually in direct gate revenues from diving and dragon-watching tourists, although this 'recreation benefit' will likely increase substantially as the number of visitors increase and as gate fees are increased to match those in marine parks elsewhere in the region.

The implications of these results for management authorities are significant. First, they provide an economic rationale for aggressively protecting known and potential spawning aggregation sites. Second, at KNP, the value of such aggregation sites is equal in economic significance to the recreational value of the park as a whole. Finally, overall protection efforts are consistent with protecting a regional demersal fishery on which many households living outside of the park depend.

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Clove oil used as an anaesthetic with juvenile tropical marine fish

Patrick Durville[1] *and Adeline Collet*[2]

Introduction

Clove oil has been used for a number of years to anaesthetise fish in seawater. In fish farming, this is essential for performing basic procedures such as weighing, tagging, experimental work and for transport. It considerably reduces pathology risks from stress, injury and accident during handling (Keene et al. 1998). It has also been recently proposed as a better alternative to cyanide for the capture of live reef food fish (Erdmann 1999). Clove oil is distilled from *Eugenia caryophyllata* stems, buds and leaves. In Indonesia, it has been used on humans for centuries as a local anaesthetic (Soto and Burhanuddin 1995). The active ingredients are phenol derivatives, essentially the $C_{10}H_{12}O_2$ eugenol compound (Taylor and Roberts 1999).

In a study conducted on coral fish farming on Reunion Island using wild-caught juveniles, a clove oil experiment protocol was required so as to find a means of handling fish regularly and efficiently. A series of experiments on two fish species was carried out so as initially to determine the optimum clove oil quantity for use on fish weighing less than 10 g and, subsequently, the effect of fish weight and the species under consideration.

Material and methods

The method used consisted of introducing the active ingredient of clove oil into the fish's gills through the water, ie 'anaesthesia by immersion' (Brousse 1974). The substance is absorbed through the gills and travels through the bloodstream to the central nervous system. The fish then goes through several anaesthesia stages ranging from balance loss to total motionlessness and ventilatory arrest (McFarland 1960).

In the first part of the study, clove oil from an agricultural cooperative was mixed with seawater at rates of 0.025, 0.050, 0.1 and 0.2 ml · l^{-1}. Ethanol, which is normally used as a solvent, was not used in these experiments. The anaesthetic was simply prepared by vigorously shaking a small flask of clove oil and seawater to obtain a whitish emulsion.

The experiments were carried out on wild-caught juvenile *Valamugil cunnesius* and *Monodactylus argenteus* introduced into the farm. After a week in a tank, they were individually anaesthetised. During the experiments, each fish was placed in a two-litre treatment tank and the emulsion poured in. The 'induction time' was recorded when the fish sank motionless to the bottom with total balance loss. It was then placed in a recovery tank. During these procedures, a number of guidelines recommended by Hicks (1989) were followed:

- 24-hour diet beforehand,
- properly aerated anaesthetic bath,
- same temperature in bath as in breeding tanks, and
- thoroughly aerated recovery bath flowing through open circuit.

In the second part of the study, once the optimal dose had been determined for each fish type, the induction time was recorded for each specimen at the same time as its weight and species. A series of statistical correlation and mean difference tests were conducted on the data obtained.

Results

Induction times in terms of clove oil dose

A total of 100 fish were anaesthetised in four batches of 25 corresponding to the four clove oil doses: 0.025, 0.050, 0.1 and 0.2 ml · l^{-1}. The average and standard deviation were calculated for each set (Fig. 1). A Krusskal-Wallis non-parametric test conducted on all four batches demonstrated that induction times differed significantly ($H = 55.5$; $P < 0.01$). Mann-Whitney mean difference tests were then carried out on pairs of batches, revealing significantly different induction times for 0.025 ml · l^{-1} doses as compared with the others. They fell by more than half from 0.025 ml · l^{-1} to 0.050 ml · l^{-1} but did not differ significantly thereafter as the dose increased. It should be pointed out that two specimens died at 0.2 ml · l^{-1}, which may indicate the upper limit in this experiment.

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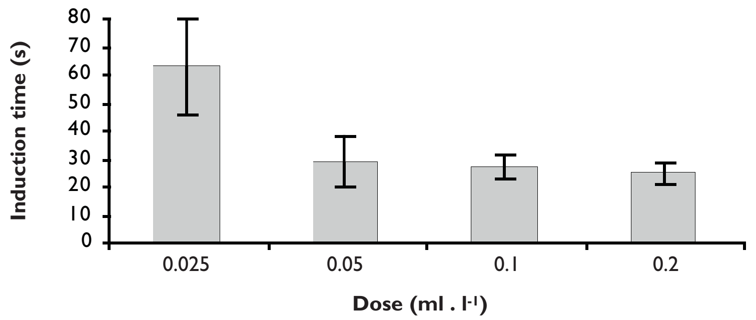

	0.05 ml · l-1	0.1 ml · l-1	0.2 ml · l-1
0.025 ml · l-1	**U = 606; P < 0.01**	**U = 625; P < 0.01**	**U = 625; P < 0.01**
0.05 ml · l-1		U = 329; P < 0.37	U = 388; P < 0.07
0.1 ml · l-1			U = 389; P < 0.06

Figure 1. Induction time averages and standard deviations observed in terms of clove oil dose, followed by Mann-Whitney mean difference test results (significant differences are in bold type).

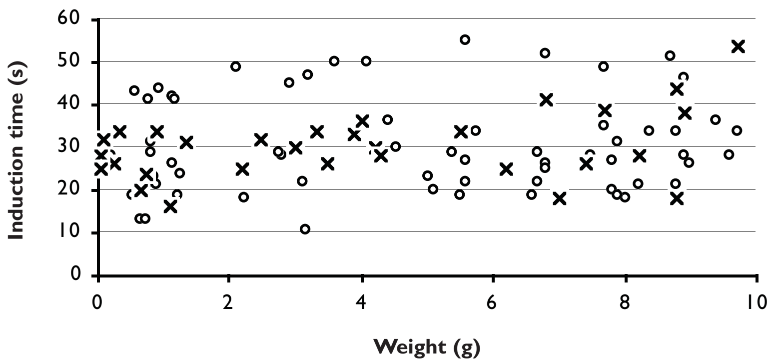

Figure 2. Induction times observed in terms of weight in *Valamugil cunnesius* (circles) and *Monodactylus argenteus* (crosses) with 0.05 ml · l-1 of clove oil.

A 0.050 ml · l-1 dose was subsequently selected for the remaining experiments. It had the advantage of anaesthetising the fish quickly with a small dose.

Induction times in terms of fish weight and species

The study on induction times in terms of fish weight was conducted using a 0.050 ml · l-1 dose of clove oil on 100 specimens weighing from 0.05 g to 9.7 g (Fig. 2). The induction times observed ranged from 13 to 56 seconds with an average of 30.4 ± 9.9 s. A Pearson correlation test indicated that there was no significant link between induction times and anaesthetised fish weights (Cp = 0.13; P = 0.09). The weight factor, therefore, had no effect on induction times when a 0.050 ml · l-1 dose was administered to fish weighing less than 10 g.

Induction times were then compared for two species, *Valamugil cunnesius* and *Monodactylus argenteus* (Fig. 2). An average of 30.1 ± 10.8 s was obtained for 67 *Valamugil cunnesius* and 30.7 ± 7.9 s for 33 *Monodactylus argenteus.* A Mann and Whitney mean difference test revealed that the difference between samples was not significant and clove oil should, therefore, have the same effect on both species (U = 1052; P = 0.23).

Conclusion

Clove oil proved to be highly effective and easy to use on juvenile tropical marine fish. The 0.05 ml · l-1 dose selected in this experiment anaesthetised the fish in less than a minute and made it possible to handle them without any losses. Weight did not appear to have any effect on induction times in juvenile fish (< 10 g) and clove oil could even be used on small specimens weighing less than 1 g. No induction time difference was observed between the two species considered.

These observations may also apply to other juvenile fish. Methods that suit local conditions are becoming increasingly necessary for developing tropical marine fish breeding from spawners' eggs or wild-caught post-larval and juvenile fish.

Clove oil, which is not well known or widely used, could become an alternative to the standard MS-222, Phenoxyethanol, Quinaldine or Benzocaine, which are hazardous, expensive, hard to come by in developing countries and sometimes less effective (Munday and Wilson 1997; Erdmann 1999). The results obtained may vary according to clove oil quality and active ingredient content, but this product has some potential in tropical aquaculture.

Acknowledgements

This study could not have been undertaken without the assistance of Aquarium de la Réunion or the University of Reunion Marine Ecology Laboratory (ECOMAR).

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SPC Pacific Regional Live Reef Fish Trade Initiative

Being Yeeting[1]

Extracted from the *SPC Fisheries Newsletter* #97, April–June 2001

Introduction

During the second quarter of 2001, several field activities were undertaken as part of SPC's Pacific Regional Live Reef Fish Trade Initiative. It was the first time that actual fieldwork was conducted since funding was approved for this initiative from the Asian Development Bank (ADB) in December 2000.

Ujae and Lae (Marshall Islands) ciguatera fish poisoning surveys

Ciguatera fish poisoning is a serious problem for many Pacific Island countries. It is a major threat to local fishing communities that depend heavily on coastal fish resources, as well as to those countries that wish to develop reef fish export trades to generate income. A better understanding of the situation and extent of the problem in the region is imperative, both for local communities and entrepeneurs.

In the Marshall Islands, ciguatera fish poisoning is a common threat to fisherfolk. Some atolls, such as Ujae and Lae Atolls, however, are uninfected or have at least insignificant incidences of poisoning.

In June 2000, due to the sudden increase of ciguatera cases on Ujae and Lae, the mayor and senators of the two atolls requested SPC to look at the problem. Between 08 and 22 March 2001, we visited the atolls and conducted a survey.

With logistical support from the Marshall Islands Marine Resources Authority (MIMRA), algae samples were collected from various sites within the atolls (20 samples from Ujae and 16 samples from Lae). These samples were processed on site and taken back for counting and analysis. Historical information on ciguatera poisoning came from interviews with local communities, and medical reports of past fish poisoning incidences came from the Health Department in Majuro.

1. Live Reef Fish Specialist, Secretariat of the Pacific Community. E-mail: beingy@spc.int

After spending time with the island communities, it became apparent that there was generally a poor understanding about ciguatera fish poisoning, especially its causes and effects. Community meetings were, therefore, organised to give a simple explanation of the technical aspects of ciguatera and its implications to fish and people. To facilitate dialogue, a ciguatera poster, produced by the SPC Fisheries Information Section in collaboration with the French Institute of Reseach for Development (IRD), was used. The poster helped tremendously, but fact sheets or information leaflets about ciguatera fish poisoning, which people could take home to use as a reference or a reminder, would also have been useful. This would also give local fishers the opportunity to read and study the contents of the fact sheets on their own time.

A report describing the results of the survey is being prepared, and will include recommendations and strategies for minimising the incidences of ciguatera fish poisoning. The report will also detail a ciguatera monitoring program for MIMRA.

Papua New Guinea LRFFT Awareness Workshop

The workshop was held at the Mohonia Na Dari Research Station, Kimbe Bay, West New Britain, PNG, and was organised by The Nature Conservancy (TNC). It was the first step in the live reef food fish trade (LRFFT) awareness activities in the region. The main purpose of the workshop was to bring together fisheries officers, information specialists and others to discuss the issue of awareness regarding the LRFFT. The primary aims were to determine the main message and the most effective way to deliver that message, and to identify the target audience.

Participants of the workshop included staff from the Secretariet of the Pacific Community (SPC), the International Marinelife Alliance (IMA), The Nature Conservancy (TNC), the Papua New Guinea National Fisheries Authority (NFA) the World Wildlife Fund (Solomon Islands), the PNG Divers Association, and Mahonia Na Dari – PNG.

At the end of the workshop a list of awareness materials to be developed was agreed on. The list includes:

1. Two information sheets, giving a simplified overview of the LRFFT and describing some simple concepts of resource management and the biology of fish targeted by the trade.

2. Several fact sheets: Simplified overview of trade; Management options and monitoring; Resource biology / ecology – simplified; Chain of custody and pricing issues; Talking points to quiz industry; and Monitoring and enforcement.

3. A 5–10 minute video targeting government decision-makers. This video will use interviews with heads of regional fisheries departments and regional NGOs representatives who have been confronted with the trade. Video footage will include fishermen using destructive techniques as well as some of the bad practices of the trade.

4. A video showing a theatrical play by Wan Smolbag, a Vanuatu group. This video will target communities. Wan Smol Bag team was met by Steve Why prior to our workshop. They were looking for fisheries-related subjects, and told Steve that they had money to produce videos and theatrical plays.

5. A feltboard kit that would include all materials, instructions on how to assemble, how to use, and a number of prepared stories for awareness. This would be used mostly for school kids.

6. A 10-minute Powerpoint presentation that can be used for government officials, boards, etc.

7. Fish ID Cards for field workers, fishermen and industry staff:
   - A-4 size page with 10-15 main target LRFFT species with scientific name, common name and a blank space for local names to be added by locals. (waterproof); and
   - Flip cards – all above and also biological and ecological facts, one species per card (waterproof).

8. Manuals in form of a series. Three to start with but list to be added:
   - Best practices targeting industry and community leaders;
   - Monitoring targeting government; and
   - Management options and guidelines.

9. Fish poster summarising the information given on the flip cards.

All these materials are in preparation and will eventually be available through the SPC Fisheries Information Section (see address on cover page of this bulletin).

Targeting the demand side of the live reef fish trade

By Joel Simonetti[1]

A few years ago I was teaching fifth grade at an international school in Indonesia. In my class were children from Singapore, South Korea, Hong Kong, Taiwan, Japan, the Philippines, Indonesia and half a dozen other nations from around the globe. Like many teachers, I often share with my class interesting excerpts from books that I read. This creates a 'book club' atmosphere in the classroom where kids learn, like adults at a social gathering, to raise questions among their peers related to their reading. Teaching children how to have these discussions lets them see how reading generates curiosity, and leads to inquiry, greater understanding and sometimes even passionate interest.

One book I shared with my class in Indonesia was Carl Safina's *Song for the Blue Ocean*. My students already knew about my personal interest in reefs and fish. They had already sat through probably too many of my slide shows — looking at underwater pictures I'd taken on frequent dive trips — so coral reefs and the idea that the oceans could be overfished wasn't new to them. What was new, however, to all of us, was the recipe for shark-fin soup Safina included in his book.

'You mean,' said one of my South Korean students, 'the soup gets its flavor from chicken and pork? It's so good. I thought it got its taste from the fins.' Other students also voiced their surprise at this discovery. We talked about it; about the ethics of finning; about humans eating fish populations unsustainably and about our personal responsibilities in these long chains of events. We wondered about the difference between tradition and fad. We wondered if traditions are always sacrosanct.

Of course I've simplified what happened. My students didn't use words like 'sacrosanct,' but many of the privileged 10 year olds in my classes were sophisticated, deeply concerned about the environment, and already in possession of a strong sense of personal morality. What they lacked, however, was the information necessary to make the incredibly broad connections that exist between cause and effect in today's world.

To my surprise, a week after we discussed the recipe, a couple of Korean boys related how they'd refused to eat shark-fin soup when their parents had taken them out to dinner over the weekend. I'll never forget that moment and the looks in the other students' faces as these two boys proudly retold how they'd acted upon their convictions and tried to 'educate' their parents. Knowledge had empowered these kids to make personal, meaningful choices, and they not only developed convictions, but they developed the strength to act upon them.

In subsequent weeks, more students followed suit. During this time I showed the recipe in Safina's book to a science teacher colleague of mine, my wife Lisa Cook. In a unit on marine ecology, she shared Safina's recipe with her sixth graders, with similar results. She was also able to build upon the connections between people's consumption patterns and the trade in reef curios, which is widespread in Indonesia. As a way of educating the wider school community and communicating what they had learned about the impacts of their consumption patterns, Lisa's class built a large glass cabinet, which is on display in the school's foyer. Her students filled the cabinet with donated stuffed sea turtles, turtle shell jewellery, and endangered animals and shells.

Subsequently, many parents came to Lisa and echoed the surprise of their children. They hadn't realised that the triton trumpets, giant clam shells and the turtle shell jewellery they had bought in Bali were the tragic end products in a chain of events driven by their own consumption patterns.

It was in part from this experience that 'The Shark Finning and Live Reef Fish Education Project' was born. This two-year project, funded by The David

1. Joel Simonetti is an educator based in Seattle, Washington, USA. He welcomes any inquiries and input from others interested in marine conservation research and education. Phone: 425-226-9912; e-mail: lisa.joel@mcbi.org.

and Lucille Packard Foundation, is a targeted education program that will hopefully contribute to the building of a marine conservation ethic among Southeast Asia's affluent youth. In pursuit of this goal, Lisa and I, with the help of others, will produce, and distribute educational materials specifically designed to raise the awareness of two unsustainable fisheries centered in the region — the trade in live reef fish for consumption (LRFT) and the trade in shark fins for use in making shark fin soup.

The materials that the project will create — two resource books and a curriculum — will be designed for upper elementary and middle school-aged children. They will be distributed through East Asia's network of international schools at regional teacher conferences. These schools serve more than 50,000 kindergarten to grade 12 students many of whom are wealthy ethnic Chinese and affluent Asians of other nationalities — the leading consumers of shark fin soup and live reef fish. With the proper tools and understanding, it is our hope that Southeast Asia's international school teachers will be able to help their privileged students make the ocean to dinner table connection.

By nurturing children's critical thinking and innate sense of morality, we will strive to create tools other teachers can use to sensitise kids so knowledge and reason lead them to make choices about their eating habits — choices that support a future where marine resources are used equitably and sustainably.

In less than a decade these international school students will graduate and become the dynamic young adults who energise Southeast Asia's communities. Fostering in this new class of future business and government leaders an awareness of the oceans' limits and an appreciation for marine conservation is a challenge for us all.

Back to the sea for the future

Dr Charles Birkeland[1]

Source: *CALYPSO LOG*, June 2001

Oriental restaurants have always displayed live reef fishes and invertebrates for customers to select for their meals. But the live reef fish trade has expanded into a billion-dollar industry which has devastated stocks in the western Pacific. Oriental dietary tastes run counter to the notion of sustainability. Crabs with eggs are favoured over those without eggs and sell at higher prices. The more rare and endangered the species, the more valuable and sought-after it is as status symbol.

The Buddhist philosophy, however, is consistent with science in that all life is passed on from generation to generation and so it is important to perpetuate the species. Therefore, Buddhists sometimes take up collections to purchase live fishes and invertebrates to return them to the sea. If they cannot buy all fishes in the market, the priorities are for those carrying eggs and those representing endangered or rare species.

In the past eight months, a particular group of Buddhists in northern Taiwan has accomplished eight release events, freeing about 15 metric tons of coral reef life back to the ocean. In order to maximise survival, the leader, Wu Yi-Dah, dives along the coast and selects areas for release that are healthy coral reef habitat for the animals, and are also relatively inaccessible to fishermen. Lobsters with eggs are taken by scuba to be individually placed into holes and crevices.

On the trip I attended, the Buddhists purchased nearly a quarter million Taiwan dollars (USD 7300) worth of live fishes, sharks, crabs and molluscs. Two trucks with seawater tanks and airstones arrived at market and were loaded with about 3,500 pounds (1.6 metric tons) of living coral reef creatures. The trucks and two busloads of volunteers then headed to an isolated spot along the coast that Mr Wu had previously surveyed; there

1. Dr Charles Birkeland has been studying the ecology and management of coral reef resources for 31 years. He was a research associate at the Smithsonian Tropical Research Institute in Panama 1970-1975, a professor at the University of Guam Marine Laboratory 1975-2000, and is currently with the Hawaii Cooperative Fishery Research Unit (USGS) at the University of Hawai'i at Manoa.

People pass buckets down to the sea to release the animals, then back up to the truck for more

A small jump to freedom for an octopus

was healthy coral reef habitat for the animals but it was inaccessible to fishermen during much of the year. The trucks and buses stopped briefly at a temple along the way to bless the live animals and wish them success. When they arrived at the site, the hundred or so volunteers formed a human chain from the truck to the shore, passing the animals in buckets of seawater to the sea and returning the empty buckets for refills. As they handed the fishes down to the ocean, they chanted or sang 'Amitabha Buddha' to wish the sea life eventual passage to a pure place.

It is a long uphill effort to change the tastes of people away from creatures with eggs and the status symbol of eating endangered or rare species. There is also the worry that the twice-monthly purchases of thousands of dollars worth of live fishes may stimulate the coral-reef live fish trade. In order not to encourage the fishing industry by becoming a reliable market, Buddhists in northern Taiwan make their visits as unpredictable as possible.

The ultimate mechanism of this endeavour is education. This coming July, when the wave action is least, it is planned for life-guards to be present as a hundred or more children return the creatures to the sea, learning the priorities of those with eggs, those endangered by small remaining populations for breeding stock, and those such as parrotfish that keep the competition between algae and coral recruits in check.

Miscellaneous
live reef fish

The impact of migrant fishers on sustainable development in Ulugan Bay, Palawan, Philippines

By Rebecca Rivera-Guieb
Environmental Science Program, College of Science, University of the Philippines, Diliman, Philippines

Source: Wise Coastal Practices Forum <http://www.csiwisepractices.org>

I want to share with you, an interesting insight into the socioeconomic research done on Ulugan Bay for the UNESCO-CSI/UNDP (United Nations Educational, Scientific and Cultural Organization - platform for Environment and Development in Coastal Regions and Small Islands/United Nations Development Programme) project on community-based sustainable tourism. The residents of Ulugan Bay on Palawan Island, Philippines, have observed the effects of temporary migrant-fishers' activities on their livelihoods.

Although an accurate number of these migrants has yet to be established, residents have reported that in Buenavista, three to five boats of migrants from the Visayas (an island group to the east) regularly fish in the bay every year. Each boat carries 30 fishers. These migrants fish for about five days and then leave, and return again after three months. This pattern of operation means that these groups fish for approximately 20 days in a year. They are reportedly using compressors and cyanide. In the adjoining community of Cabayugan, about 100 fishers from the Visayas also regularly fish in the bay using cyanide. They fish for a full straight month, at least six times a year.

It is the residents' opinion that these temporary migrants do not care about Ulugan Bay because they can always go to another area if they can no longer catch anything in the bay. These migrant fishers are also organised into groups managed by medium- to large-scale fishing businesses, thus, their concern is possibly only to earn as much as they can and then move from one area to another. Their pattern of exploitation is observable but little is known of their organization, their skills and conditions. What has been observed is their apparent lack of responsibility and sense of ownership of the waters they exploit.

There are very few studies that have looked at the conditions of temporary migrant fishers. Their numbers are increasing as fish catches become more scarce, thus an investigation of their impacts on local fishing, their relationships with the communities they temporarily stay with, and their values and perspectives on the environment is urgently needed.

Marine Aquarium Council 'Core Standards' and 'Best Practice Guidance' now available

The Marine Aquarium Council's (MAC) 'Core Standards' and 'Best Practice Guidance' have been completed and are available on the MAC website <http://www.aquariumcouncil.org/> in the section on 'MAC Standards'.

These documents establish the basic criteria and supporting advice on environmental certification for the marine ornamentals trade in the areas of:

- Ecosystem and fisheries management
- Collection, fishing and holding
- Handling, husbandry and transport

The 'Core Standards' and 'Best Practice Guidance' incorporate public feedback and the results of numerous rounds of review by the international, multi-stakeholder MAC Standards Advisory Group.

Clarifying cyanide testing in relation to MAC certification

Source: Marine Aquarium Council News 1st Quarter 2001

Most MAC Network members will be familiar with the cyanide detection tests conducted in the Philippines by the Bureau of Fisheries and Aquatic Resources (BFAR) and the International Marinelife Alliance (IMA). Fish awaiting export are randomly tested and if no cyanide is detected, there is a 'certificate' to that fact.

Unfortunately, these certificates have been inappropriately used by some to claim that 'certified' net caught fish are now available. Cyanide detection testing can only evaluate cyanide presence or absence. It cannot verify whether fish are net-caught or verify any other aspect of sustainability, e.g. good practices in handling and husbandry. The misuse of the term 'certified' can create confusion as to what is certified for what and by whom.

MAC and IMA have reaffirmed an agreement that it is inappropriate to use the term 'certified', except in the context of MAC Certification. We have agreed that an appropriate shorthand way to characterise fish that have been tested for cyanide in the Philippines is 'Tested Cyanide-Free'. A more complete description is that: 'These fish are from a shipment that was randomly sampled and tested in the Cyanide Detection Test center of the Philippines BFAR and found to contain no detectable cyanide'.

MAC is establishing a Chemical Detection Methods Committee that will identify and approve credible, accurate and reliable methods for detecting chemicals suspected of being used in the collection of marine aquarium organisms.

Grouper industry news – Hong Kong

By Patrick Chan
Chairman of the Hong Kong Chamber of Seafood Merchants Limited

Modified from: Grouper Electronic Newsletter #13, October 2001

Hatchery produced grouper fingerlings

Several hatcheries from Chinese Taipei will produce fingerlings for *Epinephelus lanceolatus*, *E. coioides* and *E. fuscoguttatus* from next month. It appears that more hatcheries that produce grouper fries are starting up in the Asia-Pacific region . Recently, several hatcheries in Bali and Lampung (Indonesia), Philippines, and Queensland (Australia) have produced hatchery bred grouper fingerlings of *E. fuscoguttatus* and *Cromileptes altivelis* and are keen to sell the fingerlings to China and Hong Kong. However, these two grouper species are not really suitable for growing in Hong Kong and nearby areas as the water is too cold in the winter.

Life reef fish trading

The source of supply of live reef fish (LRF) continues to shrink since Fiji has imposed a ban on exporting LRF by ship, in early 2001. An Australian / Hong Kong fishing company has withdrawn its Fiji operation, but another company is planning to send LRF to Hong Kong by air via South Korea. The only LRF operation in Kiribati suspended operations a few months ago as the captured quantity was not desirable and puffer fish attacked holding cages, resulting in many fish escaping. It is unlikely that this operation will resume in the near future.

Currently, the supply of wild captured LRF relies heavily on Australia, Philippines and Indonesia. Australia is sending about 16–20 tonnes of coral trout per week to Hong Kong; Philippines about 10–12 tonnes / week and Indonesia 8–10 tonnes / week, all these are delivered to Hong Kong by air. This represents 65–70% of the total imported LRF and the remaining is delivered by ship.

Grouper aquaculture

Epinephelus bleekeri (duskytail grouper)

E. bleekeri was widely cultured in Hong Kong in the early 1990s when green groupers experienced disease problems that could not be overcome. *E. bleekeri* was not affected by the same disease, so fish farmers gave up farming green grouper and changed to this species. *E. bleekeri* adapted very well to the new environment but grew much slower than green groupers. Disease problems with *E. bleekeri* began about three years ago. The diseased fish would consume excessive food one day, then stopped feeding the following day. By then an infection was noticeable on the fish's body. Its condition would worsen very quickly and within three days most of the fish would die.

Treatments with antibiotics, freshwater bath, malachite green, methylene blue and formalin have had no success with this problem. The situation is uncontrollable this year (2001) with an almost 95% mortality rate for imported *E. bleekeri*.

Last year the Hong Kong Chamber of Seafood Merchants Limited requested the Chinese University of Hong Kong to conduct a test. Researchers found that the disease was caused by a new vibrio. So far Hong Kong does not know how to deal with this problem.

Epinephelus lanceolatus (giant grouper) and _Epinephelus fuscoguttatus_ (tiger grouper)

Farming experience in the Hong Kong grouper industry has shown that the survival rate of giant groupers will be better if the fish can be reared up to eight inches before transferring to floating cages. Tiger grouper on the other hand will provide a better survival rate if the stocking size is between three and four inches.

*Author's note: None of the grouper fry used were vaccine-treated. If the fry are properly treated before putting them into cages the situation will change totally. Something must be done to assist the sustainable development of the mariculture industry in the region through better disease control measures.

Most recent grouper aquaculture advances and setbacks

By Patrick Chan
Chairman of the Hong Kong Chamber of Seafood Merchants Limited

A commercial hatchery in Chinese Taipei has successfully hatched potato cod (*Epinephelus tukula*). At present the hatchery has about 25,000 juveniles of potato cod, 10-cm long. This hatchery has more than 30 parent fish and more fry may be produced next season. This is a breakthrough in grouper culture industry. This hatchery was also among the first to hatch giant grouper (*Epinephelus lanceolatus*).

Nearly all *Epinephelus bleekeri* (dusktail grouper) fry from Thailand, Myanmar and Sumatra, Indonesia are having difficulties surviving in Hong Kong and Chinese waters this year. About 300,000 to 500,000 fry were imported to Hong Kong and re-exported to China but the mortality was 95%. The purchase of *E. bleekeri* fry from these countries has come to an almost total stop. *E. bleekeri* fry from the Phillipines do better with survival rates from 50–60%. The supply of table size *E. bleekeri* in Hong Kong and China markets will be limited and prices may escalate

Collaborative APEC Grouper Research and Development Network activities

Under the Asia-Pacific Economic Cooperation (APEC) Fisheries Working Group support for 2001, the network will explore issues concerning the dissemination and extension of grouper aquaculture technologies and experiences in aquaculture as an alternative livelihood for fishermen involved in unsustainable fishing practices.

It is hoped during 2001 to gather information from all APEC economies that have reef areas or involved in aquaculture of reef fishes. This may include Singapore, Indonesia, Philippines, China, Hong Kong SAR, Mexico, USA, Vietnam, Malaysia, Thailand, Brunei, Australia, and Chinese Taipei.

The following are the expected outputs:

- Identification of areas in the Asia-Pacific region where unsustainable reef fish fisheries occur. This includes the use of fry, fingerling, juveniles and adult fish for both ornamental and food fish and documentation of unsustainable fishing practices. The emphasis will be on understanding of the socioeconomic aspects of such practices.
- Understanding the role of grouper aquaculture (and, where relevant, other forms of coastal aquaculture) as a livelihood alternative for coastal communities to unsustainable reef fish fisheries activities, as well as understanding the issues to be considered in promoting aquaculture as an alternative.
- A set of guidelines for APEC members on the

findings from the study, taking into consideration livelihood improvement, extension methodologies and environmentally sound aquaculture management, and prioritised recommendations on future pilot projects where aquaculture has a role to address highly unsustainable fishing practices.

To achieve these outputs, four or five case studies on aquaculture and destructive fishing practices will be carried out. The case studies will focus on the current practices of unsustainable fisheries and the socioeconomic aspects of such practices, as well as the role of aquaculture as an alternative livelihood.

For institutes interested in obtaining more information, submiting information or participating in the case studies, please contact:

Asia-Pacific Grouper Network
c/o NACA
P.O. Box 1040
Kasetsart Post Office
Bangkok 10903
Thailand
Fax: (66-2) 561-1727.

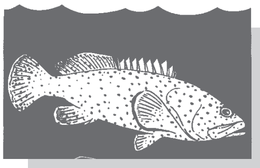
Fiji bans live reef fish operation

Source: *Fiji Times*, Saturday 21 April 2000 — 'Ratu Mara stops fish plan' (by Matelita Ragogo)

Former President and Lau Provincial Council Chairman, Ratu Sir Kamisese Mara, has stopped an Asian company from exporting live fish from Fiji waters. He disclosed this on the Council's last day of deliberations at the Civic Centre in Suva. A member had expressed reservations over the firm's operations involving the export of live fish.

The council member had said his concerns stemmed from information that the exporters were catching schools of small fish that they kept until export. He wanted to know who had given the company permission to fish, to which Ratu Sir Kamisese said '*O au*' - 'I did'. The member challenged Ratu Sir Kamisese stating, that the latter had expressed reservations over such fishing ventures just the day before. Ratu Sir Kamisese said that he did not know so many different species or many fish were being caught for live export. He said that, after finding out how much the Lau waters were being exploited, he advised the company to stop its operations.

Fisheries Director Maciu Lagibalavu said yesterday that his department was unaware of any Asian company exporting live fish from Lau waters. Mr Lagibalavu said the department made monthly and other regular checks to ensure such companies did not abuse their fishing licence in Fiji waters. He said that if other provinces felt the same way as Ratu Sir Kamisese, it would not pose any problems.



Noteworthy publications
live reef fish

- APEC/SEAFDEC. 2001. Husbandry and health management of groupers. APEC, Singapore and SEAFDEC, Iloilo, Philippines. 94 p.

  For copies of the English version of this manual please contact Dr Cruz-Lacierda at the address below. The manual will also be translated into Filipino, Thai, Mandarin and Bahasa Indonesia and the translated versions will be available at the end of 2001.

  Dr Erlinda R. Cruz-Lacierda, Aquaculture Department, Southeast Asian Fisheries Development Center, Tigbauan, 5021 Iloil Philippines. Tel: 63-33-335-1009; Fax: 63-33-335-1008

- Manual for Reef Fish Disease Diagnosis

  The Central Research Institute for Sea Exploration and Fisheries of Indonesia, supported by the Japan International Cooperation Agency (JICA) has had some success in identifying pathogens and diagnosing and establishing treatment and preventive measures for various marine finfish (mainly grouper and other coral reef species) and shrimps. A 49-page manual has recently been published to disseminate their findings. The manual contains information on clinical signs, causative agents and possible treatment methods for various viral, parasitic, bacterial and non-infectious diseases. It also contains colour photos illustrating clinical signs and causative agents for many of these diseases.

  For a copy of this manual, write to:
  I. Koesharyani, Disease Section, Gondol Research Institute for Mariculture, PO Box 140, Singaraja 81101, Indonesia.

- FAO/NACA. 2000. Asian regional technical guidelines on health management for the responsible movement of live aquatic animals and the Beijing Consensus and Implementation Strategy. FAO Fisheries Technical Paper No. 4202. Rome, FAO 53p.

- McGilvray, F. and T.T.C. Chan. 2001. The trade in live food fish: a Hong Kong perspective. International Marinelife Alliance. 16 p.

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 the availability of information on marine resources to users in the region, so as to support their rational development and management. PIMRIS activities include: the active collection, cataloguing and archiving of technical documents, especially ephemera ('grey literature'); evaluation, repackaging and dissemination of information; provision of literature searches, question-and-answer services and bibliographic support; and assistance with the development of in-country reference collections and databases on marine resources.

PIMRIS
Pacific Islands Marine Resources Information System