

Fisheries Authority wants to use the LRFF fishery management plans and the experience as a model for other coastal fisheries in PNG.

Community Fishery Management Plans

The draft community fishery management plans (area specific) are designed to enable communities to manage the fishery. Control of licensing is still with the National Fisheries Authority but the latter is only a co-manager of the fishery. Among the management measures being proposed under the Community Fishery Management Plans are the closure of spawning aggregations areas, gear restrictions, size limits, total allowable catches and restrictions on fishing by foreigners and outsiders.

Information needs

Key gaps in information required for basic management of the fishery have been identified, and include the standing stock of target species, the level of stock that can be fished sustainably, spawning areas, spawning seasons and size at sexual maturity. Information required for the national and area specific management plans will be extrapolated from similar tropical areas (in-country or regionally), gathered during the one-year trial fishing and from other relevant sources. The National Fisheries Authority is working collaboratively and exploring ways to address the information gaps with NGOs and other scientific organisations.



Protecting grouper spawning aggregations, a potential target of the live reef food fish trade in Ysabel and Wagina Islands, Solomon Islands

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Introduction

The Solomon Islands government has lifted the moratorium on the live reef food fish (LRFF) trade in its waters. The single worst biological threat posed by the trade in this country is its ability to eliminate spawning aggregations³ of certain target species, especially groupers (serranids), through heavy fishing pressure. The destruction of grouper spawning aggregations in more than ten different tropical countries has been documented; and apparently none of these aggregations has become reestablished (Johannes et al. 1999). Once these aggregations disappear, the fisheries associated with the stock also collapse.

It is important, therefore, that Solomon Islands fisheries authorities obtain details concerning the existence of grouper spawning aggregations in their waters so that they can ensure their protection from the LRFF trade. To this end, between 7 and 15 December 2000, we interviewed fishermen along the east and north coasts of Ysabel Island and on Wagina Island in order to find out what they knew about the location and timing of spawning aggre-

gations of groupers in their waters. We interviewed in the villages of Bualo, Baolo, Kolopakisa, Kia, Babahayo, Cookesin and at a few isolated locations west of Sabahayo. The purpose was to find out as much as possible about these spawning aggregations in order to prepare contingency management plans for use in the event that the LRFF trade targets these waters.

If it does not, such plans could nevertheless prove useful to future generations. Although the fishing pressure on these marine resources is relatively low (see below) this may not be the case indefinitely; Solomon Islands has one of the highest birth rates in the world.

We used the excellent photographs in Lau and Li's Identification Guide to Fishes in the Live Seafood Trade of the Asia-Pacific Region (Lau and Li 2000) to identify those species fishermen were familiar with. Fishermen leafing through this guide demonstrated a sophisticated appreciation for grouper taxonomy, having specific local names for the majority of the 36 *Epinephelus* and *Plectropomus* species⁴ pictured in the book.

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3. The use of cyanide in this trade has been a serious problem in some Southeast Asian countries (e.g. Johannes and Riepen 1995), but appears to have posed little or no threat in Solomon Islands.

4. Members of the grouper genera *Cephalopholis* and *Variola* were not included in our discussions because members of this genus do not tolerate holding and long-distance transport well and are thus not targeted by the LRFF trade in Solomon Islands.

Results

Ysabel fishermen confidently pinpointed eight spawning aggregation sites of *Plectropomus areolatus* on our hydrographic map of their waters. *Epinephelus fuscoguttatus* was also reported to form spawning aggregations at several of these sites in the same months. Similarly, *Epinephelus polyphekadion* was also said to spawn at least one of these sites⁵. These are the same three grouper species that were targeted in their joint spawning aggregations by the LRFF trade in Roviana and Marovo Lagoons, Solomon Islands (Johannes and Lam 1999) as well as in Palau (Johannes et al. 1999).

Fishermen were consistent in their assertions that *P. areolatus*, which is caught in the waters east and northeast of the northwestern end of Ysabel, was the most important species of potential interest to the live reef fish trade, whereas *P. leopardus* was the most important species caught in reefs of waters northwest of the northwestern end of Ysabel and the reefs off Baolo, southeastern Ysabel.

Fishermen described only two spawning aggregation sites for *P. leopardus*. This may be because this species typically forms relatively small spawning aggregations (e.g. Samoilys 1997), and these would probably be harder to find than the larger aggregations of *P. areolatus*.

It is nevertheless likely that Ysabel fishermen have not located all (nor perhaps even most) spawning sites of *P. areolatus* in their waters. This is because they have no need to search out carefully the best fishing spots as they would in more heavily fished waters. Two to three men can often fill two 100 kg eskies (ice chests) in a single day's fishing. As one of them said to us, "there are probably more of these spawning aggregations, but I need only to target the one I first discovered in order to get plenty of fish." It is noteworthy that he first located this spawning aggregation only three years ago, providing more evidence that the process of local discovery is incomplete.

Not all of the 17 fishermen, or groups of fishermen, we interviewed were able — or perhaps willing in the case of Wagina — to tell us where and when spawning aggregations of groupers occurred. The most knowledgeable fishermen turned out, in general, to be the older ones, and not necessarily those reputed to make the biggest catches.

The reefs around Ysabel appear to be more lightly fished, on average, than those of many Pacific Island areas, including some other areas in Solomon Islands. This is because the ratio of population to reef fishing grounds is low. Collectively, commercial fishermen operating out of Kia, the main population centre on northern Ysabel, land an average of about 3000 kg of fish per month according to Kia Fisheries Centre figures. The area of the shallow fishing grounds available to these fishermen (i.e. running northwest from Ghizunabeana Passage as far as Suramingini reef, and southwest around Ysabel as far as Allardye Harbour) was roughly calculated by laying a transparent grid over the hydrographic chart of the area, counting the number of squares occupied by shallow reef and lagoon areas and multiplying this number by the area represented by a single square. This area is roughly 900 km². The commercial catch of finfish in the area is, therefore, about 0.04 t · km⁻² · yr⁻¹. If we add an estimated subsistence consumption of 100 g of finfish per day per person⁶ for the roughly 1500 people in the Kia area, we arrive at a total (i.e. commercial plus subsistence) annual catch of 90,000 kg, which is equivalent to about 0.1 t · km⁻² · yr⁻¹.

These figures are only rough approximations, but they are adequate for demonstrating that fishing pressure on the reefs in this area is light. The average yield per unit area reported for ten Pacific Island countries by Dalzell et al. (1996) was 6.0 t · km⁻² · yr⁻¹ (4.4 t · km⁻² · yr⁻¹ if we omit the extremely high figures from Western Samoa, which includes a large invertebrate catch). These authors estimate that the average reef and lagoon area can yield 5–20 t · km⁻² · yr⁻¹ of finfish sustainably. Clearly the fisheries in the shallow waters off the northeastern end of Ysabel Island are taking only a small fraction of the potential sustainable yield.

To look at the data another way, the catch per unit of effort (cpue) in these fisheries averages around 170 kg per day in boats with two or three man crews (unpublished Department of Fisheries data). If we assume that each of three crew fishes for 8 hours, then the cpue is about 7 kg · man⁻¹ · hr⁻¹. In contrast, the average cpue for shallow reef fish in nine Pacific Island line fisheries listed by Dalzell et al (1996) is only 1.7 kg · man⁻¹ · hr⁻¹ with the highest cited cpue being 3.5 kg · man⁻¹ · hr⁻¹.

Kia and other Ysabel fishermen we interviewed were, moreover, in agreement that catch rates of

5. Other foodfish reported to form spawning aggregations at some of the same sites, but which are not sought by the LRFF trade in Solomon Islands, are two snappers, *Lutjanus bohar* and *L. gibbus*. These two species (along with many others) were similarly found to aggregate to spawn at *P. areolatus* spawning sites in Palau (Johannes et al. 1999).

6. Local clams and tinned meats and fish were very much in evidence in the diets of villagers during our trip.

reef fish have not declined noticeably in their lifetimes⁷ (although fishermen now range further from their villages than they used to).

Discussion

Nothing we say below should be construed as implying that we recommend managing rather than banning the live reef fish trade. But if the trade is to be allowed, then it must be managed rigorously in order to minimise negative environmental, social and economic impacts. Johannes and Lam (1999) discuss the general requirements for this in Solomon Islands.

Banning the targeting of spawning aggregations does not fully guarantee protection of grouper stocks from overfishing. Too many fish might still be caught outside the spawning season. But it is generally agreed by biologists, that protecting spawning aggregations is both the simplest and most effective way to reduce overfishing (e.g. Johannes et al. 1999; Sadovy 1994). Another reason for prohibiting the live reef food fish trade from targeting spawning aggregations is that female fish are reported by the trade to be more susceptible to stress when they are ready to spawn and, therefore, they do not survive handling and caging as well as at other times. (And it is the fishermen, not the companies, that lose when the fish die in their cages.) This is one reason why commercial live reef fishermen in Queensland, Australia have asked the government to ban LRFF fishing during the grouper spawning season (L. Squire, pers. comm.).

In Marovo and Roviana Lagoons it is possible to imagine protecting most spawning aggregations on site, location-by-location. This is because grouper spawning aggregations are located in waters that are relatively close to fishing villages and regularly frequented by fishermen⁸ who could police them.

It is not practical, however, to do the same in Ysabel–Wagina waters. Many of the aggregation sites are too far from fishing villages and too far out of the main flow of boat traffic. In addition, at Wagina there seems to be little concern with marine conservation issues and, thus, little evidence that local enforcement of management regulations would work in the near future.

However, there is a more practical alternative means of protecting grouper spawning aggrega-

tions in these waters; that is, by closing the live reef fishery entirely during June and July, the main spawning season for the most vulnerable four species of aggregating spawners. (We include *P. leopardus* here because, although fishermen know few of its spawning aggregation sites, it spawns during the same months as the other three grouper species according to fishermen. Moreover, because of its coloration it is the most highly valued of the four species in the Hong Kong LRFF market.)

Judging by temporal spawning trends elsewhere, it is possible that smaller aggregations of some of these groupers form in the months preceding and following June and July. Depending on the size of these aggregations, it might be desirable to extend closure of the fishing for live reef fish beyond June and July. Determining the months, if any, in question could be determined by gonad sampling at the fisheries centres, or dive-monitoring of the spawning aggregation sites. Because of the remoteness of these sites, dive monitoring would be a very expensive option.

The imposition of any fishing regulations on people who for centuries have owned their fishing grounds just as surely as they own their lands, is bound to arouse suspicion and resistance. “You are suddenly telling us, who have been exploiting our fin-fisheries without depleting them for centuries that we have to limit our fishing activities?”

Clearly, under the circumstances, sensitive consultation with the villagers (in their villages, not just among leaders in Honiara) is needed to pave the way for local acceptance of any regulation of fishing for the LRFF trade. If any such regulation is to gain their support and cooperation, villagers must understand the reasons for it and, moreover, have an opportunity to suggest and discuss modifications or alternatives. Without their support such regulation will be much harder to enforce. It cannot be overstressed that, according to both traditional and modern law, it is *their fishery* we are proposing to regulate.

Our results demonstrate the value of interviewing fishermen in order to quickly and inexpensively pinpoint spawning aggregations of reef fish. Another option for finding spawning aggregations is to use hydrographic charts and dive at likely locations. This would undoubtedly be too expensive by orders of magnitude to be used as a routine

7. Fishermen say that yields of commercial marine invertebrates have, in contrast, declined significantly. These include trochus, beche-de-mer, green snail, pearl shell and rock lobsters. This is a Pacific Island-wide trend.

8. Most are in, or at the mouths, of channels that are the focus of travel in and out of these lagoons and are also the focus of significant general fishing activity.

approach. There will be dozens of such locations in some areas. In addition, some species aggregate at depths beyond the safe limits of SCUBA. The approach could only be used economically in areas where reefs, and thus potential spawning sites, are few and within safe diving depths.

Where site-based management is impractical, but seasonal closures are an option, determining the seasonality of spawning would be all that is needed in order to protect spawning aggregations. This could be done by monitoring the catch throughout the year when it is gutted.

This approach also has the virtue of not risking the dissemination of information on spawning aggregations that could lead to their eventual overexploitation. This inexpensive form of applied research on spawning aggregations might be considered for other areas in Solomon Islands as well as for other countries.

Summary and conclusions

Interviews with reef fishermen along the eastern and northern coastal portions of Ysabel Island revealed considerable knowledge of the timing and location of spawning aggregations of the coral trout, *Plectropomus areolatus*, and two other grouper species that aggregated to spawn at the same times and locations.

Our key findings are:

1. *P. areolatus* aggregates to spawn at at least eight locations. Ysabel fishermen from different villages were virtually unanimous in asserting, moreover, that the peak months for these aggregations are June and July.
2. *Epinephelus fuscoguttatus* and *E. polyphemus* were sometimes reported to form spawning aggregations at the same times and locations. These and *P. areolatus* are the three main species that have been collectively targeted in their spawning aggregations by the live reef food fish trade in Solomon Islands in Marovo and Roviana Lagoons and Ontong Java, although their reproductive seasonality differs in each area.
3. *P. areolatus* is reportedly the most important grouper of potential interest to the LRFF trade in catches made in the north-eastern quadrant of Ysabel's reefs, but *P. leopardus* is more important in catches on Ysabel's north-western reefs and the reefs off Baolo along the south-east coast.
4. Fishermen said that *P. leopardus* is most likely to be found with well-developed gonads, like the

three other grouper species mentioned above, during June and July.

5. Fishermen of Wagina did not provide much useful knowledge about spawning aggregations. But given the proximity (and even some possible overlap) of their fishing grounds with those of northern Ysabel fishermen, it is likely that spawning aggregations in their waters are similarly timed.
6. Finfishing pressure on the reefs off the north-western end of Ysabel is significantly less than the area could withstand sustainably.

Recommendations arising from these findings:

1. If the LRFF trade is allowed to operate in these waters (although we are not recommending it), then the spawning aggregations of *P. areolatus* and the two associated grouper species must be protected to sustain the fishery.
2. It would be impractical to protect individual spawning sites in this area by on-site enforcement; they are far too distant from population centres and too widely dispersed.
3. It would, however, be practical to ban the catching (and holding in cages) of these groupers during the main spawning months of June and July.
4. Consensus-building should precede implementation. In order to gain local support and cooperation, sensitively conducted discussions in fishing villages should precede any attempt to introduce such a management measure.

In addition:

Our results demonstrate that not all reef fishermen can be expected to know where and when key grouper spawning aggregations occur — or divulge that information if they do. Nevertheless, more than enough fishermen were able to provide consistent information on the subject to enable us to determine the best strategy for protecting these aggregations from overexploitation by the live reef food fish trade.

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An integrated attitude survey on live reef food fish consumption in Hong Kong

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The following is the executive summary of the report: An integrated attitude survey on live reef food fish consumption in Hong Kong by N.W.W. Chan. World Wide Fund For Nature Hong Kong, Hong Kong. 2000. For information on how to obtain the full report contact Noel Chan at <NCHAN@wwf.org.hk>

This report presents the results of the first integrated survey to document and elucidate the attitudes and eating habits of Hong Kong people in relation to the consumption of live reef food fish (LRFF), their attitude towards possible alternatives, and their supportiveness of conservation and regulatory measures. The results should assist in the development of strategies for a consumer awareness campaign and the implementation of conservation measures for LRFF. The integrated survey includes three parts: a telephone survey of 1,604 people representing the Hong Kong general public, a face-to-face survey of 321 Chinese seafood restaurant customers, and a qualitative survey of 36 LRFF stakeholders (seafood traders and restaurant managers).

Hong Kong is the largest consumer of LRFF worldwide. Annual imports of LRFF into Hong Kong in 1997 totalled 32,000 tonnes from over 10 different countries, mostly in the Southeast Asia region. The sheer volume documented immediately raises doubt about the sustainability of the trade and coral reef resources.

Further, the high demand for LRFF in Hong Kong has led to the LRFF trade becoming a lucrative business, driving many fishermen in Southeast Asia to use sodium cyanide to catch the fish alive. Cyanide may leave the structure of coral reef intact, but can kill corals and the surrounding marine organisms. Moreover, the preference for giant grouper *Epinephelus lanceolatus* and hump-