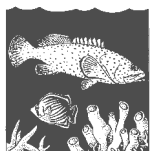


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Live reef fish developments in Fiji

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Condensed from an article originally printed in the SPC Fisheries Newsletter 88: 25–36 (1999).

Background

Fiji is one of the very recent countries in the Pacific to get into the Live Reef Food Fish (LRFF) trade. With interest being shown by some overseas LRFF companies, it was identified as a potential income-generating project to pursue by the Fiji Fisheries Department under their Commodity Development Framework (CDF) programme in 1998. With the preliminary arrangements being negotiated for one overseas LRFF operator to start, Fiji has wisely decided to look seriously at the management and regulatory issues relating to this fishery based on experiences and lessons learned from other coun-

tries. The primary aim is to set up a LRFF industry that is sustainable in the long term. Fiji Fisheries therefore decided that the first step was to know about the extent of their LRFF resource and to set up a management structure in the form of policies, regulations and legislation for the trade.

Request for assistance

In August of 1998, a letter of request for assistance was received by the Secretariat of the Pacific Community (SPC) from the Ministry of Foreign Affairs and External Trade in Fiji on behalf of the Fiji Fisheries Department.

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The request was for SPC to assess the potential for LRFF in an allocated fishing area in the Bua Province of Vanua Levu, and draw up some management guidelines that would be useful in the formulation of a management policy and regulations for the trade. The agreed terms of reference (TOR) are briefly outlined below:

1. To find out where the spawning aggregation sites are for coral trout and cod species and the times of the year when they occur.
2. To give an approximate existing stock estimate for the potential target species.
3. To design catch data forms and establish a monitoring programme for catch, effort and export.
4. To set up a database for the live reef fishery in Fiji that can link and exchange information on a regional level.
5. To formulate guidelines and make recommendations towards a management policy and regulations for the live reef fish trade in Fiji.

The SPC Integrated Coastal Fisheries Management Project (ICFMAP) was given the task of providing the necessary advice and assistance to Fiji Fisheries under the given terms of reference.

The target area

The Province of Bua is one of the three provinces of Vanua Levu, the second biggest island in the Fiji Group. The province forms most of the southern part of the island. It contains 54 villages with a predominantly Fijian population of just over 9,000. The Bua Provincial Council, the administrative body for the province is in Nabouwalu, the administrative centre, which is located near the southernmost tip of the island.

The main target fishing area is in the Lekutu and Navakasiga District and is owned by the vanua (tribes) of these two districts. The total area of the Lekutu and Navakasiga District fishing rights area is about 1,600 km². The actual total reef area in the fishing area that was surveyed is made up of about 432 km² of inside reef areas and about 84 km² of reef on the barrier reef area. Thus the total reef area in the fishing rights area is about 516 km² or about 30% of the total fishing rights area. This area is regarded as prime fishing ground.

The LRFF company and their plan

The partners in this new Live Reef Fish venture are *Satellite Seafoods (Fiji) Ltd.* an Australian owned and based company, and *Altracor (Fiji) Ltd.* which is a fully locally-owned local Fijian company.

Shares are 70% and 30% respectively. The company will utilise local fishermen and their existing boats for catching fish. Assistance would be provided by the company to modify boats and in training of fishermen in catching and maintaining the fish alive. About 20 – 25 fish cages will be set up, of 4 m x 4 m x 6 m (depth), each with a capacity of holding up to 500 kg of live fish.

A live fish transport vessel (F/V *Crested Tern*) capable of holding up to 4 tonnes of live fish, would be brought in from Australia, to collect the fish from the fish cages and transport them to a main holding facility in Vanua Levu.

The live fish will then be shipped overseas using a 'live fish' carrier vessel. The *Yong Sheng Lai 18* owned by *Yong Shing Fishery Co.* based in Hong Kong has indicated their interest in transporting the fish.

The fishing company is hoping to export a minimum of 10 tonnes of live fish each shipment, which will include coral trout species, groupers, rock cods and the humphead wrasse.

A memorandum of understanding between the people of Galoa in the District of Lekutu and *Satellite Seafood Pty (Fiji) Ltd.* has been drawn up. This outlines the payment procedures, training and other assistance that the company will provide and what the people of Galoa are required to do.

Target species

Generally, the target species are all those fish species that have potential to sell to the live reef fish markets. The main species of interests for Fiji were the coral trouts, *Plectropomus* species and the humphead wrasse (*Cheilinus undulatus*). The highly-valued *Cromileptes altivelis* is not common in Fiji.

Survey Methods

Visits were made to the Bua fishing area from 12 September to 2 October and from 17 to 26 November 1998 to do the required fieldwork.

The fieldwork conducted in the target area included informal interviews with fishermen to collect basic local information that could be useful in the preliminary assessment of the live reef fish potential. Fishermen were asked questions relating to fishing activities, fishing seasons, spawning seasons and spawning grounds for different species, but with emphasis on the live reef fish target species. Questions were chosen carefully in order not to 'lead' fishermen. In addition

fish outlets in Suva were also visited and the managers or owners were interviewed in order to get an idea of the importance and value of the LRF target species on the local market. Particular attention was paid to those fish dealers that purchase fish from Bua Province.

A broad-brush survey of fish using underwater visual census (UVC) 50 m x 5 m transects was conducted. Sampling stations were selected haphazardly in both the inner reef areas and the barrier reef. Sampling was also designed to look at the effects of depth (less than or equal to 10 m (shallow), greater than 10 m (deep)) in both reef areas.

Densities and mean length of fish were estimated from the UVC surveys. From these biomasses were then calculated using length-weight relationships for the same species in New Caledonia (Letourneur *et al.*, 1998). Where data on this relationship were available, the one for the closest species was used. Stock sizes were then estimated for the reef areas.

Results

Fishing activities

Seven fishermen were interviewed; three from Galoa Island and 4 from Tavea. Their ages ranged from 39 to 65. From the interviews it became apparent that the community of Tavea did more fishing than Galoa. Part of the reason was that the fishermen of Galoa have recently become very involved in diving for bêche-de-mer, which has taken a lot of their fishing time.

The dominant fishing activity for both islands was handlining on the nearby reefs from small skiffs. The bigger boats on the islands were all used for going out further from the shore to dive for bêche-de-mer especially in Galoa.

On Galoa there were about 20 individuals taking part in bêche-de-mer diving. All bêche-de-mer diving was done using hookah. The divers were fully aware of the dangers in using this apparatus (accidents had happened) but most of them felt it was the best way of getting good income for the family.

Other fishing activities included gillnetting on the shallow reef areas and spearfishing, which were more commonly practised by the fishermen from Tavea. In Galoa many women fish, mainly gleaning on the nearby reefs for clams and crabs. Most fishermen fish mainly for subsistence.

However, when they have more than enough for themselves, they sell it locally to other people in

the community. On Tavea there are part-time commercial fishermen who catch fish to sell to the middlemen based in Lekutu, who then sell them to fish shops in Suva. Fishermen do not seem to target any particular species.

Spawning aggregations and sites

Although fishermen interviewed claim that they were not fully aware of spawning seasons of fish species, the information they provided in relation to the quantity of a particular fish at different times of the year suggested strongly that spawning seasons and aggregations do exist.

All but one fishermen interviewed claimed that they had come across big schools of *donu* (*Plectropomus areolatus*, *P. laevis* or *P. leopardus*) while out fishing.

Although information given by fishermen about spawning seasons was not very consistent, for *Plectropomus areolatus* especially, there seems to be some common agreement that summer is spawning season. Ovatoa passage and Nauqina Reef were the sites mentioned most often in this connection. Sampling is needed to confirm these assertions.

Underwater visual census (fish transects)

A total of 39 fish counting transects were carried in 13 sampling stations. Twenty-four transects (8 stations) were conducted on inner reefs and 15 transects (5 stations) were on the barrier reef area, yielding a sampling area of 9.75 km² (2% of the total reef area in the fishing area).

Fewer than 10 individuals of most species of interest to the LRFF trade were seen during the survey. Twenty-seven *Plectropomus areolatus* were seen, however.

Relation of *P. areolatus* sizes and biomass to habitat

For *P. areolatus* a simple t-test compared the mean length of fish from the deep reef areas against shallow areas. The results confirms that there is a high significant difference ($P < 0.05$) implying that larger *P. areolatus* are more likely to be found in deeper reef fishing areas.

The density of *P. areolatus* was higher in the inner reef areas than the barrier reef areas (Table 1). Biomass, however, was higher on the barrier reefs than the inner reefs. This is because the fish were larger on the barrier reefs than on the inner reefs.

The total stock estimate for *P. areolatus* comes to just over 1,600 tonnes of which 58% comes from

Table 1: Densities and biomass of *P. areolatus* on the inner reefs and the barrier reefs (\pm standard errors).

Reef area	Densities (nos/1000m ²)	Biomass (kg/1000m ²)	Estimated stock (tonnes)
Inner reefs	10.33 \pm 3.08	2.15 \pm 0.47	928.29 \pm 204.19
Barrier reefs	5.07 \pm 1.48	8.04 \pm 2.79	675.81 \pm 233.91
TOTAL	8.72 \pm 2.00	5.12 \pm 1.31	1604.10 \pm 438.10

the inner reefs and 42% from the barrier reefs (Table 1).

Findings and recommendations

The study was intended to give a snapshot view of the current status of the reef fish species with potential for the live reef fish trade. The actual stock estimates of the different fish species are expected to provide some basis for management decisions before more information becomes available. The information gathered from the interviews and the underwater surveys, although preliminary, provide some baseline data that can be used to help direct further research on the live reef fish species.

The interviews revealed that local fishing effort is concentrated on the nearby reefs. The shortage of big boats, the cost of fuel and the safety consciousness of fishermen were major factors that contributed to concentrated fishing efforts on the nearby reefs. Unfortunately it seems that one of the most commonly fished nearby reefs is a possible spawning aggregation site for the *Plectropomus* species, and some of the other serranids.

Based on the information collected from the local fishermen, there appear to be spawning aggregation sites in the area. The Fisheries Division should try to verify their locations and timing. Once this has been done then it is recommended that a ban be put on fishing at spawning aggregation sites.

The accounts of some fishing trips given by some fishermen indicate that there may have been considerable fishing over spawning aggregations done unintentionally. This may have taken its toll on the stocks (as it has in the Solomon Islands (Johannes & Lam, 1999)). The Fisheries Division

should therefore find out more about these spawning aggregation periods and sites. This could be simply done by monitoring fish catches from the area and by visiting the potential aggregation sites at least once a month² (for a year) as a start and possibly more frequently during those months that have been reported to be spawning aggregation times.

It was also evident that many fishermen from Galoa Island are involved with bêche-de-mer diving. All use hookah. It should be ensured that this hookah gear is not used in the live reef fish trade. To deal with this problem, Fiji Fisheries should undertake an education programme showing the dangers of using hookah, using examples from Asia, and ban its use in the live reef fish trade.

The results from the underwater surveys provided some first estimates of the status of the stock. The results of the surveys showed that among the serranids, *Plectropomus areolatus* is the most abundant species both in the inner reef and barrier reef areas.

For the live reef fish trade, *Plectropomus areolatus* is likely to be the main target species, being the only one that was abundant and also being a preferred species in the trade. The estimated total of the species for the total fishing area is just over 1600 t. This is equivalent to a wholesale value of US\$ 56 m in the Hong Kong market (based on 1994 prices in Johannes & Riepen, 1995). The maximum sustainable yield for the area was difficult to estimate with the current available information but is expected to be much less than the estimated biomass. A monitoring programme is clearly needed to refine these figures.

The size of this fish is an important factor to consider in the LRFF trade. The mean size of *P. areolatus* in the inner reef areas is about 23.6 cm compared to 45.4 cm on the barrier reefs. This equates to weights of 0.26 kg and 1.6 kg respectively. With the preferred weights of fish in the LRFF market being between 0.8–1.5 kg, then the best area to fish would thus be the barrier reef.

For the inner reefs, the smaller sizes of coral trouts should be investigated further. Considering the

2. Editor's note: At the appropriate moon phase—probably during the days just prior to the new moon judging by the lunar timing of spawning aggregations of several species, including *P. areolatus*, elsewhere in the western Pacific.

small sizes of fish and the possibility of spawning aggregation areas being located in the inner reefs, the suspension of fishing for coral trout species and the imposition of size limits for subsistence fishing is a possible management option. Once the spawning periods and sites have been worked out, they should be marked and set up as marine reserves where fishing is banned.

The valuable *Cheilinus undulatus* was seen in very low numbers. Although our survey results need to be verified by additional research, the low numbers should be noted and a total ban on fishing for this species should be considered as a precautionary approach. Research is needed on the ecology and biology of this species.

Considering the other serranids and other species, the numbers counted on the transects were too low to be able to give reliable estimates. The general low density could be a result of underestimation relating to the sampling method used where the width of the transect is fixed at 5 metres and therefore with limited time the total sampling area is very small relative to the total fishing area. This might be improved by doing many more UVC transects in future and possibly by adopting a transect method of unfixed widths which would enable surveying of more extensive areas.

The industry, being new, should be carefully monitored and controlled. Information and experience from South East Asia should be utilised to avoid making the same mistakes and to make the industry a sustainable one.

There is a strong need to set up some management regulations backed up by specific legislation for the trade. The legal framework already exists under the Fisheries Act for the imposition of specific legislation and regulations for better management of this trade.

The customary fishing rights law provides an effective local mechanism for keeping control of fishing activities in the fishing area and for enforcing regulations. A small council is made up of all the different parties involved legally for the protection of resource owners' interests. A coordinated plan for enforcement of regulations together with an outline of the different responsibilities should be established to ensure that enforcement efforts are well supported at both community and government level.

A set of management policy guidelines for the LRFF industry is proposed³. Along with management regulations and enforcement, a good monitoring programme is essential to ensure that the companies are continuously in compliance with the rules, and to collect basic information useful for the future management and development of the industry. A data collection programme is proposed below. The relevant forms can be obtained from the Reef Fishery Assessment and Management Section of the SPC Coastal Fisheries Programme.

The Data Collection Programme

A data collection system is therefore proposed that involves most of the stakeholders in the fishery. Data collection should be one of the requirements and responsibilities of any LRFF company. The Fisheries Division is however the main authority, taking charge of regular monthly record submissions by the company, collecting biological information on fish that died during the handling stages, processing and analyses of the data and the review of management decisions and options.

The proposed data collection programme consists of four data sheets, described below.

1. Fishing Data Sheet – To be filled in by the fishermen as they go out on a fishing trip. It basically details information on fishing effort, fishing conditions, fishing location(s) and fish catches (species, length and weight). This is to be handed in to the LRFF company site manager on arrival to the LRFF holding cage site after the trip.

2. Catch Summary Form – To be filled in by the LRFF company site manager when stocking the holding cages. It records the number and weight of fish put into the holding cages by species and also records the species, number and weight of fish that are dead at this stage of handling. The dead fish are to be kept aside for further data collection. Dead fish consequently found in the holding fish cages should also be recorded on this form.

3. Biological Data Sheet (Dead Fish) – This is to be filled by the Fisheries Division officer in charge of the LRFF industry. It contains biological information on the dead fish collected during handling. On it are recorded species, length, weight, sex, maturity stage, gonad weight and stomach contents. The Fisheries Officer is expected to be responsible for this. However we anticipate problems in keeping dead fish frozen before the fisheries officer vis-

3. Editor's note: In the article from which this is extracted, a long series of recommendations follows, based largely on those given by Johannes and Riepen (1995) and Smith (1977).

its the holding cage station rather than selling it fresh. The ideal solution is to train someone on site on how to handle the fish, sex measure, weigh and gut. We therefore propose that the fisheries officer arrange with the site manager for the dead fish to be processed. The guts can then be frozen in a sealed plastic bag properly labelled for later identification.

4. Export Data Sheet – This is the final sheet to be filled in before the live fish is exported overseas. It is to be filled by the LRFF Company Site Manager and is basically a record of what species of fish; numbers and weight are exported live overseas.

The data sheets have been designed for filling in with the minimum effort. The sheets to be filled in by the Site Manager are records that the company would need for itself anyway. Certain coding, which is a desk job for the Fisheries Officer, is required and a list of codes is provided.

The SPC Reef Fishery Assessment and Management Section would continue to provide assistance where required to establish the monitoring programme and in the analyses of the data. All information would be kept confidential.

Resource assessment

This forms the second part of the monitoring programme and is basically the Fisheries Division's responsibility. The purpose of the assessment is to track the long-term impact of the industry on the reef fish stocks, to check regularly for signs of destructive fishing methods such as cyanide-fishing, and to build up information on spawning seasons and spawning aggregation sites.

It is recommended that field assessment should be done twice a year for the first 2–3 years and then once a year after that.

The fieldwork involved would utilise the underwater visual census (UVC) method. Some training on the UVC method used was given to the local village divers and fisheries personnel involved in the study.

The SPC Reef Fishery Assessment and Management Section would, however, be able to provide further training on an improved version of this method that would be standardised as a package (field method and analyses methods) throughout the region for possible comparison with other areas.

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Note

Copies of the MOU and data collection forms are available upon request from:

The Reef Fishery Assessment
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