Reef Corals of the Northwestern Lagoon of Grande-Terre, New Caledonia

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Chapter 4

Asessment of targeted fish stocks of the northwestern lagoon of Grande-Terre, New Caledonia

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SUMMARY

- An initial stock assessment of select targeted coral reef fishes was undertaken on a wide range of coral reef habitats in the northwest lagoon area (Yandé to Koumac) of New Caledonia. Observations were made by underwater visual counts while SCUBA diving.
- From the target list of 164 species, a total of 127 target species from 51 genera and 18 families were recorded on 63 transects (each of 500 m²) at 52 sites.
- The most diverse families observed were Acanthuridae, Scaridae, Serranidae, Lutjanidae and Labridae, but the most abundant species were from the family Caesionidae.
- Caesionids contributed over 60% of fish counted and over 21% of total biomass with *Caesio caerulaurea* being the most abundant species of this family.
- Counts of individual target fishes ranged from zero to 2,839 (mean 257).
- There was a trend for decreases in the mean number of target families, species, number of fish and biomass observed from the outer barrier reef to the inshore reefs. The barrier reef had the highest observed values.
- Mean target species biomass as well as mean densities and lengths of Serranids observed were greater than that observed during several other Conservation International Marine Rapid Assessment Surveys in western central Pacific areas using similar methods, including Raja Ampat in Indonesia.

INTRODUCTION

There are three main types of fishing for finfish in New Caledonia that include lagoon, coastal and deep sea. Lagoon fishing is generally intended for the local market. Much of this is amateur and sustenance fishing which is more important in terms of tonnage caught than commercial fishing. Coastal fishing takes advantage of the resources on the ocean side of the reef. Deep sea fishing is for tuna, marlin and pelagic fish in the Exclusive Economic Zone (EEZ) to 200 miles offshore. This is nearly all for export, mostly to Japan for fresh bigeye and yellowfin tuna, and Europe for frozen fish (Chamber of Commerce and Industry of New Caledonia or CCINC, 2005). All tuna fishing within the EEZ is carried out by French flag-owned boats. Since 2001, no licenses have been issued to foreign vessels (West Pacific Regional Fisheries Marine Council or WPRFMC, 2006).

This chapter addresses the stocks of reef and lagoon fishes of commercial, recreational, or artisanal importance in the northwestern lagoon of New Caledonia, and assesses their distribution and abundance observed during the survey period. The survey area is in the northwestern part of Province North from Yandé Island and nearby reefs in the north to Koumac and nearby reef sites in the south (Map 1).

This area of New Caledonia generally has a low level of development and small population. A study by Labrosse et al. (2000) showed that fish stocks in the northern part of this area were virtually un-fished, while fish communities in the southern part of this zone show characteristics consistent with exploitation. Koumac is a town with a small commercial fishing port and marina for recreational boats. It is the main point of access to the lagoon and reef for fishing purposes, and has the only fish processing factory north of Nouméa (WPRFMC, 2006). The northwestern lagoon was the focus of an extensive fish survey that examined the relationship of land erosion to lagoon (Kulbicki et al. 2000) and commercial fish (Letourneur et al. 2000).

There is widespread, though low key, artisanal fishing from coastal villages in the north, and commercial and recreational fishing from Koumac. In many Pacific islands, in contrast with industrialized nations, subsistence fishing is estimated to be about 80% of the fishing pressure (Labrosse et. al. 2000). In the Northern Province of New Caledonia, Labrosse et al. (2000) found that fish consumption was 30.3 kg per capita per annum, with 94% represented by subsistence fishing. In New Caledonia commercial lagoon fisheries remain poorly developed and to a great extent an artisanal activity (Labrosse et.al. 2000).

Labrosse et.al. (2000) noted that in the Northern Province, the yield of commercially valuable reef and lagoon fish was about 10% of the Maximum Sustainable Yield (MSY), and 1% of the total estimated stocks. Thus they were far from being endangered on a collective basis. However catches were close to the sustainable maximum in some southern parts of the Northern Province, where fishing activity was beginning to affect the fish populations.

There is also potential for a substantial increase in fishing pressure as the population is expected to increase with the establishment of a large nickel mine to the north of Koumac. This may also increase access to the un-fished zone to the north. Thus there is some urgency to establish Marine Protected Areas (MPA's) and an adaptive management plan in this area in anticipation of increased fishing pressure. The Provinces (local government) have authority over fishing regulations as well as to create natural parks and reserves in order to protect the animals and plant life in the lagoon and as far as the coral reef (CCINC 2005).

METHODS

Fifty-two of the 62 sites visited during the survey were quantitatively surveyed for target species, in a wide range of reef classes (Table 4.1).Observations were made during an underwater visual census (UVC) while scuba diving and data were recorded in pencil on prepared plastic data sheets with target fish listed by Family.

The method for UVC was similar to that used in other RAP surveys (La Tanda 2001, Cornuet 2006). Counts were made while swimming along a 10-metre wide belt transect centered on a 50-metre line on a small "wreck reel" clipped to the diver's weight belt and run out while roughly following a depth contour. Fish were counted in front of the diver, as much as possible before any disturbance of the area by other divers or the counting diver. Area sampled for each transect was 500 m^2 .Total diving time spent on actual fish counts was about 17 hours. The time spent on each transect ranged from 8 minutes to 45 minutes (mean 16.25 minutes per transect) depending on the complexity of the topography, the visibility and the number of species and individuals on the transect.

Data were collected for one transect at most sites where the reef dropped to sand in less than 10 to 12 meters. Two transects were counted at 11 of the 52 sites surveyed, where the reef profile allowed a deep (about 15 to 24 meters) and a shallow count. Fifteen of the transects were classified as deep (15 to 24 meters) and 48 transects were classified as shallow (<10 to12 meters). The deep transects were mostly on outer barrier front reef sites and a few intermediate lagoon reefs, whereas shallow transects occurred across all reef classes recognized.

Target species were generally edible species selected by commercial, recreational, and artisanal fishers in the area, and likely to be seen by divers doing UVC surveys. The list of target species was agreed to in advance in consultation with Province Nord and was the same as that used in RAP 42 in the northeastern lagoon and Mt Panié area (Cornuet 2006). Although a few other species of potential target importance were seen occasionally on the transects, they have not been included in this analysis because either they were considered to be not reliably counted by this method (e.g. *Lethrinus nebulosus*,) or were left out for consistency with other RAP surveys (e.g. some grouper species). These sightings were very few and would most likely make little difference to the results.

Numbers of individuals and sizes were recorded usually to the nearest 50 mm, or less for some smaller species and juveniles. Actual counts were made for most fishes, except

Table 4.1. Sites assessed for targeted fish as categorized by reef class with habitat.

Reef Classes with habitat	# sites	Site numbers
barrier front reef	8	6, 7, 9, 17, 58, 59, 79, 80
barrier back reef	13	11, 13, 14, 16, 61, 62, 63, 65, 69, 72, 73, 74, 84
barrier passage reef	3	10, 60, 83
intermediate lagoon reefs	17	1, 2, 3, 33, 36, 37, 38, 40, 41, 43, 45, 48, 49, 51, 52, 85, 87
inner lagoon and inshore reefs	11	18, 19, 20, 22, 24, 26, 28, 29, 32, 35, 86

for those occurring in schools where an estimate of number to the nearest 50 or 100 fishes was made, as well as an estimate of average size. Most schooling fish are consistent in size among individuals that tends to validate the method. In addition to the actual fish counts, also recorded was the time taken for each count, the visibility, and the depth at the beginning and end of each transect. Habitat notes were recorded by other divers in the survey.

Quantitative counts were not made at all sites visited by the survey. At four sites (12, 42, 64 and 70) no data were collected due to illness of the observer. At a further five sites (30, 31, 34, 56 and 57), mostly inner lagoon fringing reefs, visibility was less than 2 meters, and as low as 0.6 meter, precluding the possibility of accurate counts in a 10-metre wide belt transect referred to here after as transect.

Data were used to calculate diversity (number of target species) and abundance (number of individuals). Biomass was calculated by two different formulas or methods. In the first method, length was converted to weight by the formula:

$$W = 0.05L^3$$

where W is weight in grams, and L is length in centimeters. This commonly used cubic weight formula tends to overestimate the weight of the majority of species. The second method used was a more complex but specific formula from Kulbicki et al (1993, 2004) that seems to give a more accurate weight result but requires two specific coefficients (a and b) for each species considered. Both methods for calculating biomass have been used in this study. For this chapter, the notation, B1 will be used in cases where the first formula is used and a B2 will be used for the specific formula from Kulbicki and colleagues. Most analysis in this report involves the cubic weight formula or B1. In the discussion, biomass is usually expressed as tons per square kilometer (t/km²), converted from the original expression of grams per 500 m².

RESULTS AND DISCUSSION

A total of 127 target species from 51 genera and 18 families were recorded on the transects (Table 4.2). The target species most commonly seen on the belt transects, with the percentages of transects on which they were observed in brackets, were *Acanthurus nigrofuscus* (84.1%), *Chlorurus sordidus* (76.2%), *Parupeneus multifasciatus* (61.9%), *Zebrasoma scopas* and *Scolopsis bilineatus* (60.3%), *Plectropomus laevis* (55.6%), and *Caesio caerulaurea* and *Acanthurus blochii* (47.6%).Schooling fusiliers in the family Caesionidae were by far the most abundant fishes observed on the transects, comprising over 60% of total fish numbers (Fig. 4.1). Other important families each contributing more than 5% to total fish numbers are Lutjanidae, Acanthuridae, and Scaridae.

The biomass contributed by the various families of the target species was calculated using both formulas (Table 4.3). The cubic formula (B1) is an oversimplification, assuming all fish are shaped like a cylinder and does not take into account the different shapes of fishes. The specific formula (B2) takes into account the different shapes using species specific coefficients in the formula, so expression of biomass is tailored to each individual species. As expected the use of the specific formula is preferable as it gives a more accurate

Table 4.2. Number of genera, species and individuals observed from each family ranked from highest to lowest number observed by each parameter.

Family	# Genera	# Species	# Individuals	% of total	Rank
Acanthuridae	5	20	1,390	8.58	3
Balistidae	3	4	52	0.32	13
Caesionidae	2	6	9,868	60.89	1
Carangidae	3	6	20	0.12	16
Carcharinidae	2	3	22	0.14	15
Dasyatidae	1	1	2	0.01	18
Haemulidae	1	4	37	0.23	14
Holocentridae	3	3	66	0.41	12
Labridae	6	10	173	1.07	9
Lethrinidae	2	5	815	5.03	5
Lutjanidae	4	12	1,407	8.68	2
Mullidae	3	9	476	2.94	6
Nemipteridae	1	3	277	1.71	7
Platacidae	1	1	67	0.41	11
Scaridae	4	16	1,243	7.67	4
Scombridae	2	2	8	0.05	17
Serranidae	7	14	177	1.09	8
Siganidae	1	8	107	0.65	10
Total	**51**	**127**	**16,207**	**100.00**	**18**

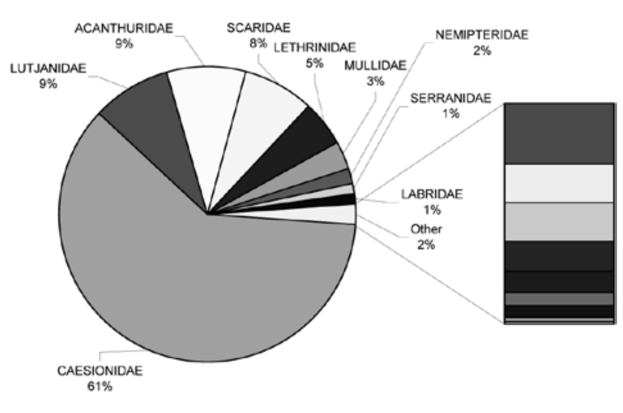

Figure 4.1. Percentage of targeted fish belonging to different families. Other refers to families with 1% or less recorded and include Signidae (0.7%), Holocentridae (0.4%), Platacidae (0.4%), Balistidae (0.3%), Haemulidae (0.2%), Carangidae (0.1%), Carcharinidae (0.1%), Scombridae (0.05%) and Dasyatidae (0.01%). The percentage for each family are rounded to the nearest whole number.

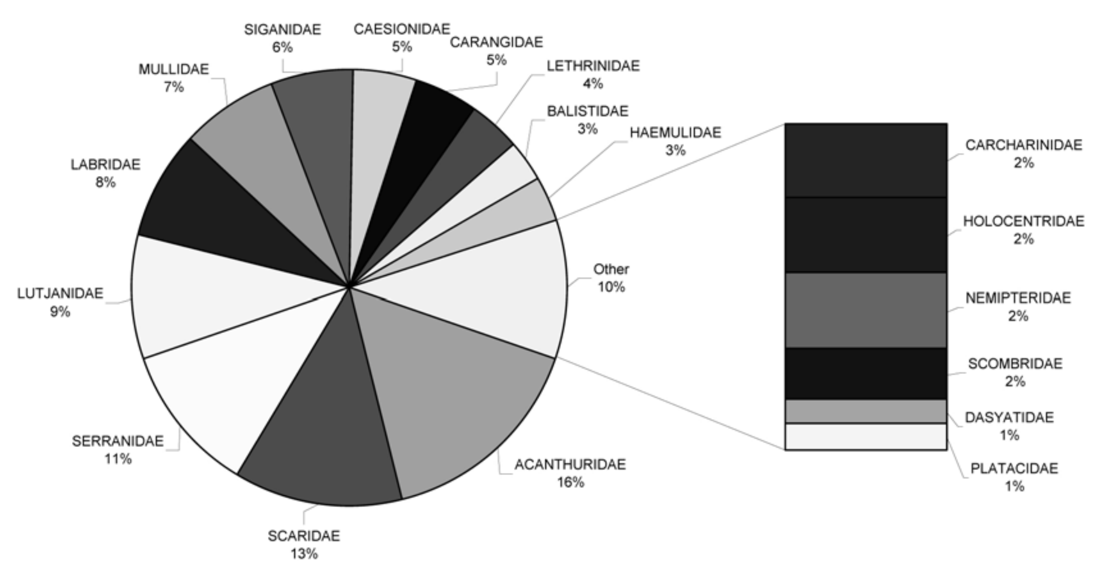

Figure 4.2. Percent biomas contributed by each family. Biomass was calculated using the cubic formula. Percent values are rounded to the nearest whole number.

Table 4.3. Biomass values and percentage of total contributed by families of target species as determined by the two biomass formulas. Biomass values (ton/km²) calculated by the cubic formula are labeled as Biomass 1 formula (B1) while those calculated by Kulbicki's specific formula are denoted as Biomass 2 formula (B2).

Family	Biomass 1 formula (ton/km²)	% of total	Rank by B1	Biomass 2 formula (ton/km²)	% of total	Rank by B2
Acanthuridae	32.96	9.57	5	15.67	12.71	4
Balistidae	0.43	0.12	17	0.23	0.19	18
Caesionidae	72.85	21.16	1	28.06	22.75	1
Carangidae	6.30	1.83	11	2.17	1.76	12
Carcharinidae	66.21	19.22	2	16.30	13.22	3
Dasyatidae	0.41	0.12	18	0.30	0.24	17
Haemulidae	7.11	2.06	9	2.65	2.15	9
Holocentridae	0.91	0.26	16	0.45	0.36	16
Labridae	6.40	1.86	10	2.49	2.02	10
Lethrinidae	13.21	3.84	7	4.99	4.05	7
Lutjanidae	55.12	16.01	3	21.13	17.14	2
Mullidae	6.02	1.75	12	2.29	1.86	11
Nemipteridae	2.21	0.64	14	0.81	0.66	15
Platacidae	4.52	1.31	13	3.37	2.73	8
Scaridae	40.02	11.62	4	14.28	11.58	5
Scombridae	9.00	2.61	8	1.34	1.09	13
Serranidae	18.71	5.43	6	5.82	4.72	6
Siganidae	2.03	0.59	15	0.95	0.77	14
Total	**344.41**	**100.00**	**18**	**123.30**	**100.00**	**18**

Table 4.4. Reef classes with mean visibility, number of target fish families, species, individuals observed with calculated biomass observed. For the fish study, the sites were categorized by reef classes as: (1) outer barrier reef front denoted as outer barrier, front; (2) outer barrier pass reefs denoted as outer barrier, pass; (3) outer barrier reef back denoted as outer barrier, back; (3) intermediate lagoon reefs; and (4) inner lagoon reefs. Biomass values (ton/km²) calculated by the cubic formula are denoted as Biomass 1 formula (B1) while biomass values (ton/km²) calculated by specific formula are denoted as Biomass 2 formula (B2).

Reef Classes	Number of sites (n)	Mean visibility (m)	Mean number of families per site	Mean number of species per site	Mean number of fish per site	Biomass per site (ton/km²) Biomass 1 formula	Biomass per site (ton/km²) Biomass 2 formula
outer barrier, front	8	23	10.9	29	491	432.15	160.22
outer barrier back	13	15	9.2	11	203	416.02	141.49
outer barrier passage reefs	3	15	11.3	33	555	617.47	220.39
intermediate lagoon reefs	17	10	9.6	20	366	322.96	116.38
Inner lagoon reefs	11	4	6.0	11	76	114.74	43.34

representation of biomass, but it does require that measurements are made of each species to derive the coefficients a and b used in the formula. Where these are not available for a species, there is little choice but to use the simpler cubic formula. The further from cylindrical the fish is, the less accurate will be the biomass B1 derived from the cubic formula. The difference between the two formulae is evident in the calculations and results, and is a similar finding to that of Cornuet (2006).

Despite their small size, the large numbers Caesionids contribute approximately 21% of total biomass (Fig 4.2 using B1). *Caesio caerulaurea* and *C. cuning* contributed most of the biomass within the Caesionidae. Despite the small numbers observed, the sharks (Carcharinidae) observed along the transects were comparatively larger than the other fish observed during the survey. Therefore it takes only a few (a total 22 in the targeted fish survey) to make a big difference to biomass.

Depth of the transect appeared to influence the number of species and individual fish observed along transects. There were slightly more species at shallow sites on average compared to the deeper transects (mean 18.3 species per shallow transect; mean 16.9 species per deep transect). There was a substantial difference in total numbers of fish observed between the shallow and deep transects. Shallow transects averaged 144 fish per transect, whereas deep transects averaged 621 individual fish. This may be due to habitat differences as well as depth itself. At the 11 sites where both deep and shallow transects were counted, shallow sites averaged 229 fish per transect, while deep transects averaged 567 fish per transect. Much of this difference was due to schools of Caesionids on the deeper drop-offs of the outer barrier reef front sites. Similarly, biomass was on average higher on deep transects (474 ton/km²) (B1) than on shallow transects (304 ton/km²) (B1), but again much of this difference may be influenced by habitat differences and encounters with schools of Caesionids.

There was a strong relationship between mean visibility by reef classes and the observed counts (species, individuals) and calculated biomass (B1, B2) values of the target fish fauna (Table 4.4). However other factors (e.g. such as habitat complexity, currents and accessibility by humans) also contribute to the observed values and cannot be discounted. The outer barrier reef front sites had the best visibility and generally more rugosity. At the other end of the scale are the inner lagoon and fringing reefs close to the mainland that are heavily influenced at some localities by silt runoff from the land, reflected in the poor water clarity at these sites. The mean number of families per site ranges from 11.3 in the barrier passage reef habitat to 6.0 in the inner lagoon and inshore reefs. Mean number of target fish species per site ranges from 33 (barrier passage reef) to 11 (inner lagoon and inshore reefs). Similarly the mean number of target fish per site ranges from 555 (barrier passage reef) to 76 (inner lagoon and inshore reefs).

Table 4.5. Best-ranked transects for number of target species, individual fish counts, and biomass. B1 indicates where the biomass value was calculated from the cubic formula while B2 indicates where the specific formula was used.

Rank	# of species		# individuals per transect		Biomass B1 ton/km^2		Biomass B2 ton/km^2	
	Site	Value	Site	Value	Site	Value	Site	Value
1	83s	41	87d	2839	63s	1869.04	63s	724.92
2	52s	35	83s	1425	79d	1488.68	83s	518.34
3	60s	32	36s	867	9s	1515.76	87d	517.84
4	63s	32	63s	691	83s	1443.83	79d	511.19
5	61s	31	79d	651	87d	1414.35	65d	272.06
6	73s	27	80s	643	65d	826.45	36s	239.36
7	80s	25	85s	539	85s	648.10	52s	225.67
8	85s	25	9s	466	52s	642.54	9d	222.97
9	79s	25	59d	382	3d	624.16	85s	220.69

For each transect, the value observed for each targeted fish attribute (i.e. number of species, number of individuals and biomass values) varies. Table 4.5 ranks the nine best transects for these attributes. Ranking of the transects slightly differs depending on which attribute of the target fish is considered. For number of target species observed, the best transect is 83s (shallow), which is a barrier passage reef off of Koumac. For number of individual fish observed, transect 87d, on an intermediate lagoon reef was the highest. This number was strongly biased by Caesionids, with around 1600 *Caesio caerulaurea*, 1000 *Pterocaesio digramma*, and 100 *C. cuning* swelling the numbers. If all Caesionids were taken out of the count there would only be 139 individuals of other species present.

The maximum number of Serranids observed of all target species on a transect occurred at site 83s, where 10 fish were counted on the 500m2 transect, which is equivalent to 20 per 1000m2. This compares favorably with the maximum of 17 individuals per 1000m2 at Raja Ampat (La Tanda 2006). Mean length of Serranids observed during this survey was higher (32.6cm) than that observed on northeast coast of New Caledonia (29.3cm), Raja Ampat (approximately 25cm), Philippines (<20cm), and Togian-Banggai, Indonesia (>20cm), but possibly similar to Milne Bay Papua New Guinea (>30cm) (La Tanda 2001).

Although underwater visual survey techniques employed for this survey are widely used for assessing reef fish, it is important to note their limitations. In areas with poor visibility, it is not possible to see far enough to do accurate counts out to the 5-metre vision limit of the belt transect. In deeper water, diver time is very limited and beyond about 30 meters other diving safety issues arise. Some species are "diver shy" and visual counts by divers will be biased against these species. Conversely a few species are attracted to divers and a positive bias for those species could occur. Thus for surveying commercial species the method is likely to misrepresent some aspects of the fish population of interest to the fishery.

In closing to summarize, the general state of the target fish populations as indicated by this assessment appears to follow a trend of an increase in diversity and abundance of fish as distance from land increases. Sedimentation on the inshore reefs has damaged corals and that appears to have affected the habitat for target fish species. Target fish diversity is greatly variable by site and habitat. The number of fish observed and biomass values and fish numbers are highly variable. Observed values for fish diversity, abundance and biomass suggest that the impact of fishing appears to be less on the reef sites assessed in the north than in the south that are closest to human population centers.

The nature of this rapid protocol of assessing targeted fish renders this study spatially and temporally limited as 52 sites were visited once with data collected on one or two transects. This precludes us from making specific targeted fish conservation recommendations. Further work by Province Nord is in progress to assess, adaptively manage and conserve targeted fish stocks in the region of the survey.

REFERENCES

Chamber of Commerce and Industry of New Caledonia. 2005. Fishing and Aquaculture No. 18.

Cornuet, N. 2006. The assessment of targeted fish stocks. *En:* McKenna, S.A., N. Baillon, H. Blaffart, et G. Abrusci (eds.) Une évaluation rapide de la biodiversité marine des récifs coralliens du Mont Panié, Province Nord, Nouvelle Calédonie. Bulletin PER d'évaluation biologique 42. Conservation International, Washington DC, USA Pp. 35–42.

Kulbicki, M., G.,Mou Tham, P. Thollot, and L. Wantiez. 1993. Length-weight relationships of fish from the Lagoon of New Caledonia. NAGA 16 (2-3): 26–30.

Kulbicki, M., P. Labrosse and Y. Letourneur. 2000. Fish Stock Assessment of the Northern New Caledonian Lagoons: 2 – Stocks of Lagoon Bottom and

Reef-associated Fishes. Aquatic Living Resources 13(2): 77–90.

Kulbicki, M., N. Guillemot and B.Amand. 2004. A general approach to relationships of length for Pacific lagoon fishes. Cybium.

Labrosse, P., Y. Letourneur, M. Kulbicki and J.R. Paddon, 2000. Fish stock assessment of the northern New Caledonia lagoons: 3 – Fishing pressure, potential yields and impact on management options. Aquatic Living Resources 13(2): 91–98.

La Tanda 1998. Species composition, distribution and abundance of coral fishes in Togean and Banggai Islands. *In*: Werner, T.B., G.R. Allen and S.A. McKenna, (eds.). A Rapid Marine Biodiversity Assessment of the Togean and Banggai Islands, Sulawesi, Indonesia. Bulletin of the Rapid Assessment Program 20, Conservation International, Washington DC, USA.

La Tanda 2002. A Basic Stock Assessment of Economically Important Coral Reef Fishes of the Raja Ampat Islands, Papua, Indonesia. *In*: McKenna, S.A., G.R. Allen and S. Suryadi (eds.) A Marine Rapid Assessment of the Raja Ampat Islands, Papua Province, Indonesia. RAP Bulletin of Biological Assessment 22, Conservation International, Washington DC.

Letourneur, Y., M. Kulbicki, and P. Labrosse. 2000. Fish Stock Assessment of the Northern New Caledonian Lagoons: 1 – Structure and Stocks of Coral Reef Fish Communities. Aquatic Living Resources 13(2): 65–76.

West Pacific Regional Fisheries Marine Council 2006. Summary report: Workshop on South Pacific Albacore Longline Fisheries. September 19–21. Honolulu Hawaii.