PACIFIC REGIONAL OCEANIC AND

COASTAL FISHERIES DEVELOPMENT PROGRAMME

(PROCFish/C/CoFish)

WALLIS AND FUTUNA
COUNTRY REPORT:

PROFILES AND RESULTS FROM SURVEY WORK AT VAILALA, HALALO, LEAVA AND VELE

(August – December 2005 and March 2006)

by

Mecki Kronen, Emmanuel Tardy, Pierre Boblin, Lindsay Chapman, Ferral Lasi, Kalo Pakoa, Laurent Vigliola, Kim Friedman, Franck Magron and Silvia Pinca

This document has been produced with the financial assistance of the European Community

Original text: English

Secretariat of the Pacific Community Cataloguing-in-publication data

Pacific Regional Oceanic and Coastal Fisheries Development Programme (PROCFish, coastal component) – Wallis and Futuna country report: profile and results from in-country survey work (August to December 2005 and March 2006) / by Mecki Kronen, Emmanuel Tardy, Pierre Boblin, Kim Friedman, Silvia Pinca, Lindsay Chapman, Franck Magron, Kalo Pakoa, Ferral Lasi and Laurent Vigliola.

(Pacific Regional Oceanic and Coastal Fisheries Development Programme (PROCFish/C/CoFish) / Secretariat of the Pacific Community)
ISSN

I. Kronen, Mecki. II. Tardy, Emmanuel. III. Boblin, Pierre. IV. Friedman, Kim. V. Pinca, Silvia. VI. Chapman, Lindsay. VII. Magron, Franck. VIII. Pakoa, Kalo. IX. Lasi, Ferral. X. Vigliola, Laurent.
XI. Title. XII. Secretariat of the Pacific Community, ReeFisheries Observatory. XIII. Series.
1. Marine resources – Wallis and Futuna – Statistics. 2. Fisheries – Wallis and Futuna – Statistics. 3. Fisheries – Economic aspects – Wallis and Futuna.

338.372 096 85 AACR2

ISBN 978-982-00-0261-6

Secretariat of the Pacific Community
Coastal Fisheries Programme
BP D5, 98848 Noumea Cedex, New Caledonia
Tel: +687 26 00 00
Fax: +687 26 38 18
Email: spc@spc.int; http://www.spc.int/

Prepared for publication and printed at
Secretariat of the Pacific Community headquarters
Noumea, New Caledonia, 2008

ACKNOWLEDGEMENTS

The Secretariat of the Pacific Community (SPC) acknowledges with gratitude the funding support provided by the European Commission for the implementation of the Pacific Regional Oceanic and Coastal Fisheries Development Programme (PROCFish), in this case the coastal component[1].

SPC also acknowledges the collaborative support of the staff of the Wallis and Futuna Department of Agriculture, Forests and Fisheries and the Department of Conservation for their in-country assistance, in particular Mr Jacques Fourmy, Director of Agriculture, Forests and Fisheries; Mr Emmanuel Tardy, Chief Fisheries Officer, Wallis; Ms Amalia Fotofili, Fisheries Officer and PROCFish/C attachment; Mr Paino Vanai, Director of Environment; Mr Enelio Liufau, Environment Officer, Wallis; Mr Didier Labrousse, Chief of Environment, Futuna; Mr Julien Barbier, Assistant Chief of Environment, Futuna; Ms Helena Takaniko and Ms Maleta Mugneret, interpreter, socioeconomic surveys; Mr Sosefo Malau, and Mr Lafaele Maniulua, survey-boat owners and operators; the Kings of Alo and Sigave on Futuna; and the village chiefs of Halalo 'Suiafu', Vailala 'Utumaka' and Tufone 'Makakele' on Wallis, and Poi 'Fainuava', Tamana 'Safeitoga', Vele 'Tuiasoa', and Leava 'Safeisau' on Futuna.

Others at SPC who assisted with the production of this report were Ms Céline Barré, report compiling, formatting and layout; Ms Sarah Langi, report editing; Ms Youngmi Choi, cover design; and the SPC Translation Section, translating the executive summary; their assistance is acknowledged with thanks.

In addition, thanks are provided to Dr Serge Andrefouet and his team for the provision and analysis of satellite images used in this report for the calculation of reef-habitat surfaces. More information on this project is provided in Appendix 5.

PROCFish/C and CoFish staff work (or used to work) for the Secretariat of the Pacific Community, BP D5, 98848 Noumea Cedex, New Caledonia under this EU-funded project. All PROCFish/C and CoFish staff work as a team, so even those not directly involved in fieldwork usually assist in data analysis, report writing, or reviewing drafts of site and country reports.

The team is made up of:

- Lindsay Chapman, Coastal Fisheries Programme Manager
- Kim Friedman, Senior Reef Fisheries Scientist (invertebrates)
- Mecki Kronen, Community Fisheries Scientist
- Franck Magron, Reef Fisheries Information Manager
- Silvia Pinca, Senior Reef Fisheries Scientist (finfish)
- Kalo Pakoa, Reef Fisheries Officer (invertebrates)
- Pierre Boblin, Reef Fisheries Officer (finfish)
- Emmanuel Tardy, Reef Fisheries Officer (invertebrates)
- Marie-Therese Bui, Project Administrator
- Ferral Lasi, previous Reef Fisheries Officer (invertebrates)
- Aliti Vunisea, previous Community Fisheries Scientist
- Ribanataake Awira, previous Reef Fisheries Officer (finfish)
- Samasoni Sauni, previous Senior Reef Fisheries Scientist (finfish)
- Laurent Vigliola, previous Senior Reef Fisheries Scientist (finfish).

[1] CoFish and PROCFish/C are part of the same programme, with CoFish covering the countries of Niue, Nauru, Federated States of Micronesia, Palau, Marshall Islands and Cook Islands (ACP countries covered under EDF 9 funding) and PROCFish/C countries covered under EDF 8 funding (the ACP countries: Fiji, Tonga, Papua New Guinea, Solomon Islands, Vanuatu, Samoa, Tuvalu and Kiribati, and French overseas countries and territories (OCTs): New Caledonia, French Polynesia, and Wallis and Futuna). Therefore, CoFish and PROCFish/C are used synonymously in all country reports.

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EXECUTIVE SUMMARY

The coastal component of the Pacific Regional Oceanic and Coastal Fisheries Development Programme (PROCFish/C) conducted fieldwork in Wallis and Futuna from Aug – Dec 2005 and in March 2006. Wallis and Futuna is one of 17 Pacific Island countries and territories being surveyed over a 5–6 year period by PROCFish or its associated programme CoFish (Pacific Regional Coastal Fisheries Development Programme).

The aim of the survey work was to provide baseline information on the status of reef fisheries, and to help fill the massive information gap that hinders the effective management of reef fisheries.

Other programme outputs include:

- implementation of the first comprehensive multi-country comparative assessment of reef fisheries (finfish, invertebrates and socioeconomics) ever undertaken in the Pacific Islands region using identical methodologies at each site;
- dissemination of country reports that comprise a set of 'reef fisheries profiles' for the sites in each country in order to provide information for coastal fisheries development and management planning;
- development of a set of indicators (or reference points to fishery status) to provide guidance when developing local and national reef fishery management plans and monitoring programmes; and
- development of data and information management systems, including regional and national databases.

Survey work in Wallis and Futuna covered three disciplines (finfish, invertebrate and socioeconomic) on each trip by a team of four programme scientists and four local counterparts: two from the Fisheries Department and two from the Environment Department. The fieldwork included capacity building for the four local counterparts through instruction on survey methodologies in all three disciplines, including the collection of data and inputting the data into the programme's database.

Results from fieldwork at Vailala and Halalo in Wallis

Wallis is a solitary island of volcanic origin (Uvea). The island is relatively low-lying (basaltic volcanism, maximum elevation 149 m at Mt Lulu), with a relatively large land mass (approximately 76.14 km^2, without lagoon islands) and high annual rainfall (over 3000 mm). It is surrounded by a large lagoon (154.3 km^2) and barrier reef with small sand islands (up to 20 in the northeast and south). Extensive shallow-water intermediate reefs and reef margins comprising mixed hard and soft benthos were noted in the lagoon, which is subjected to a full range of terrestrial and oceanic influences. The southeast trade winds subject this sector of the barrier reef to the greatest wave action, and the reef slopes generally fall off more quickly into deep water on this side of the system. The easterly lagoon presents a more protected environment and extensive areas of shallow-water soft benthos and seagrass are found along the coastline of Uvea, especially in the northwest.

Socioeconomics: Vailala and Halalo in Wallis

Although salaries provide the first income for most households of both villages, fisheries are nevertheless important sources of income. Over 70% of all households in Halalo depend financially upon fisheries, compared to 40% in Vailala. In Halalo ~38% (in Vailala ~19%) reported fisheries as their first income source and ~35% (Vailala ~22%) as their second income source. In Halalo, all households eat fresh fish and most (83%) consume invertebrates regularly. Fresh fish consumption is high (80.5 kg/person/year), above the regional average and highest across all sites surveyed in Wallis and Futuna. Invertebrate consumption is low (~5 kg/person/year). However, In Vailala, most households eat fresh fish but only 35% regularly consume invertebrates. In both villages, although both men and women fish for finfish, only men fish commercially, while women focus on subsistence fishing for finfish and invertebrates in the sheltered coastal reef and collect shells for handicrafts from the outer *motu* (small coral islands). Men are the only fishers who dive for invertebrate species, such as trochus and lobsters. Motorised boats are used for all fishing trips except trips to the sheltered coastal reef. In Halalo, the trochus fishery is the most important by wet weight, productivity and for commercial purposes.

In Vailala, catches range between 200 and 700 kg/fisher/year only; when the lagoon and outer-reef areas are jointly fished, catch rates reach ~1300 kg/fisher/year and CPUEs are also highest. In Halalo, catches are around 700 kg/fisher/year for lagoon and passage fishing; productivity is higher in the passages, where CPUE is 3 kg/hour fished as compared to 1.5 kg/hour fished in the lagoon. Invertebrate fisheries in Vailala mainly serve commercial rather than subsistence needs. However, total catch (wet weight) amounts to only ~3 t/year. Lobster catches alone determine over half of this reported annual impact, followed by catches from reeftop gleaning and intertidal harvesting. In contrast, invertebrate fisheries in Halalo mainly serve subsistence needs. Trochus is the most important commercial fishery (~37% of total catch); however, the total catch (expressed in wet weight) amounts to ~2.7 t/year only.

Finfish resources: Vailala and Halalo in Wallis

Overall, finfish resources at Vailala appeared to be in relatively good condition and slightly better than in Halalo (higher average density, biomass, size, size ratio and biodiversity). The reef habitat was relatively rich and the fish population diverse and abundant. However, populations of Lutjanidae, Kyphosidae and Siganidae showed size ratios below 50%, indicating impact from selective fishing, probably spearfishing. Detailed assessment at reef level also revealed a high biodiversity and an equal abundance and biomass of herbivorous and carnivorous fish families. Fishing in Vailala is carried out for subsistence purposes; most catches were from internal reefs but resources in the back-reefs appeared to be decreasing (lower density and biomass, size and size ratio as well as a dominance of herbivores over carnivores).

At Halalo, finfish resources appeared to be in average condition. Both the composition of the substrate and the density, biomass and biodiversity of fish were much poorer than in Vailala. However, strong differences were found between the rich outer reefs and the very poor lagoon and sheltered coastal reefs. The outer reefs displayed the highest density, size, biomass and diversity of fish of all the habitats analysed, suggesting healthy stocks and little exploitation in this environment. In contrast, at the lagoon reefs, fish sizes and size ratios were particularly low. The fishing methods (mostly gillnets and spearfishing), rather than the frequency of catches, are mainly responsible for the impact recorded on average fish size. Gillnetting and spearfishing are harmful practices for fish communities.

Invertebrate resources: Wallis

Although there was a wide range of shallow-water reef habitats suitable for giant clams in Wallis, clams were markedly impacted by fishing pressure, especially at easily accessed fishing locations. The density of elongate clams, *Tridacna maxima*, was low, and to a point where the sparse distribution could negatively affect spawning and fertilisation success, and therefore the sustainability of this resource. Despite the fluted clam, *Tridacna squamosa*, being recorded as present in Wallis, none were noted in this survey, and therefore we consider this species to be 'commercially extinct'[2] in Wallis.

Trochus habitat at Wallis was extensive, with all the major components to support a commercial fishery. However, the low density of trochus in the main fishing areas suggests that stocks are moderately impacted by fishing. The size profile of trochus shells suggests that large broodstock are present in the population and recruitment is ongoing. Trochus under 9 cm (new recruits) were noticeable in survey, especially in the southeast of Wallis (on the reeftop). These young trochus need to continue to be protected until they have had at least one season of spawning before they enter the capture size classes. The blacklip pearl oyster, *Pinctada margaritifera* was absent from survey records, although other mother-of-pearl stocks, such as the green topshell, *Tectus pyramis* (of low commercial value), were recorded at low density.

Wallis has a diverse range of environments and depths suitable for sea cucumbers, with large sheltered embayments of protected lagoon in the northwest, in contrast with the more oceanic-influenced reefs and passage in the southeast. The range of sea cucumber species recorded at Wallis was large considering its eastern position in the Pacific, distant from the more species-rich areas close to the centre of biodiversity. The presence and density data collected in the survey suggest that sea cucumbers are impacted by fishing pressure, but commercial fishing is only having a critical effect on some species.

Recommendations for Wallis

Based on the survey work undertaken and the assessments made, the following recommendations are made for Wallis:

- Given the importance of fisheries to people in Wallis both for food and income, the fact that most people fish in one way or another, and that the country enjoys an open-access system, MPAs be established, which represent the country's most important habitats, in order to secure biodiversity and reproduction for the future.

- The ongoing efforts of the Fisheries Service to establish a better link and cooperation with the fishermen's association be continued, with a focus on: increasing registration of commercially oriented, small-scale fishers and their motorised boats; adopting a minimum mesh size for gillnetting; and controlling leisure or lifestyle fishing.

- The national Fisheries Service continue with their control of export fishery produce, mainly bêche-de-mer and trochus, and possibly include other species, such as lobsters.

[2] 'Commercially extinct' refers to scarcity such that collection is not possible to service commercial or subsistence fishing, but species is or may still be present at very low densities.

Monitoring should accompany annual quotas provided by species and size, and compliance with existing regulations should be enforced.

- The use of gillnetting and spear diving, especially in the lagoon, be regulated and spear diving at night be banned.

- There are still reports of dynamite fishing continuing in Wallis. This, together with bleach fishing, which are very destructive practices for both fish resources and habitat, be immediately stopped and fines imposed on any fishers practising them.

- Major harvests of trochus be postponed until stocks build up to 500–600 per ha in the major aggregations. To do this, size controls that limit the sale of shells above 12 cm should continue to be enforced to ensure the protection of the most productive-sized specimens (over 11–12 cm basal width). Also, trochus under 9 cm (new recruits) continue to be protected until they have had at least one season of spawning before they enter the capture size classes. There is also potential to move some trochus from areas of high-density recruitment in the southwest to adult habitat around Wallis (including the northwest).

- Careful management of sea cucumber fishing is required if Wallis wants to ensure this fishery is sustainable. Fishing for sandfish (*Holothuria scabra*) should be halted as soon as possible to allow the limited stocks to recover from critical levels of overfishing.

Results from fieldwork at Vele and Leava in Futuna

Futuna is a volcanic island with a relatively large land mass (approximately 64 km^2) that rises steeply from a narrow coastal plain to an elevation of 875 m (401 m on Alofi Islet). Rainfall is reportedly high (over 2500 mm). In general, the environment on reefs was generally dynamic, with little protection from wind and ocean swells. Reef margins of mixed hard and soft benthos were not common, although immediately beyond the coastal reef flats there is a second terrace (shoal) at 5–10 m depth, where a network of sloping terraced pavements interspersed with spur-and-groove habitat and sandy areas predominates. This system extends a further 200–400 m from the coast, to a depth of 40 m before the depth gradient increases sharply. In some areas, coral cover was estimated to range from 30–50%. In some areas, the nearby island of Alofi acts as a protective barrier from windward surges. Unlike Wallis, Futuna has no lagoon, and shallow-water reef in the form of fringing reef is of varying width. Most reef flat lies near the water surface or is exposed during low tide. At the reef edge, most areas are subject to a high degree of wave action and in some areas the reef slope falls off quickly into deep water.

Socioeconomics: Futuna

Fisheries are not an important income source on Futuna. Only 7% of all households reported that fisheries provide their first income source, and 13% their second income. In contrast, salaries are the most important, complemented by income from agriculture and from other sources, such as small business, retirement pensions and other social fees. All households consume fresh fish but less than half consume invertebrates regularly. Fresh fish consumption is above the regional average but below the average estimated across all PROCFish/C sites investigated on Futuna and Wallis. Invertebrate consumption is low, ~3.5 kg/person/year. Both men and women fish for finfish, but men mostly fish for finfish and women mostly collect invertebrates. Most fishers, males and females, walk to the reef edge at low tide where they use castnets or lines. Only a few men fish the outer-reef slope, using motorised or non-motorised boats. Invertebrate collection focuses on reeftops, and some fishers (males only) free-dive for lobsters, trochus and giant clams. From a commercial point of view, shell collection for handicrafts, lobsters for export and trochus for local demand are important.

Finfish resources: Futuna

The assessment indicated that the status of finfish resources in this site is relatively poor. This is probably a consequence of Futuna being naturally poor in terms of availability of reef habitats (mainly coral slab with very little live coral) and productivity of outer reefs. Biomass and density of fish are in fact the lowest in the country (Wallis and Futuna). The dominance of herbivore fish may be explained by the type of habitat. Most fishing is done for subsistence and occurs mainly on the reef crest surrounding the island (using handlines for deep-water fish). Fishing on the outer reefs is mainly done off the west (leeward) coast. Species normally assessed in the shallower 10 m were not reported by the underwater surveys but were caught by line fishing. The fact that these species were found at deeper depths than normal might indicate a first impact on some carnivorous families, such as Lethrinidae.

Invertebrate resources: Futuna

The fringing reefs at Futuna provided a less diversified habitat for invertebrates generally, were isolated from other sources of recruitment, and were subject to high wind and storm surges. There was a limited amount of shallow, protected reef habitat suitable for giant clams, which were restricted to the exposed fringing reef (and some small pools in the pseudo lagoon on Alofi). Elongate clams, *Tridacna maxima*, were not severely impacted by fishing, although mean density estimates were low in many locations and the size-frequency distribution revealed that fishing was taking place. A single fluted clam, *Tridacna squamosa*, was noted.

Habitat suitable for the commercial topshell, *Trochus niloticus*, at Futuna was extensive; however, adult habitat was more common than areas for juvenile settlement and development. The density of trochus in the main fishing areas suggests that stocks are moderately impacted by fishing. In these surveys only two stations recorded densities considered to be above the ‘threshold’ density (500–600 per ha) that is recommended before commercial fishing can be considered. The size of trochus shells recorded in Futuna suggests that large broodstock are present in the population and recruitment is ongoing. Reefs at Futuna support a moderately impacted trochus population, but exposed conditions within the open reefs of Futuna make stocks somewhat more susceptible to fishing. The blacklip pearl oyster, *Pinctada margaritifera*, was absent, although other mother-of-pearl stocks, such as the green topshell, *Tectus pyramis* (of low commercial value), were recorded at moderate density.

Habitat suitable for sea cucumbers in Futuna was limited, as reef areas were generally exposed to oceanic swell, and sheltered areas of soft benthos were rare. Presence and density suggest that sea cucumbers are marginally impacted by fishing pressure, and that environmental conditions largely dictate the current status of stocks. In contrast to most species groups, black teatfish (*Holothuria nobilis*) were common and at high density, which indicates that they may not have been commercially fished in recent years. This preliminary survey suggests that occurrence and density of sea cucumbers are too low for general commercial collection at this time, although black teatfish are abundant enough to allow controlled fishing.

Recommendations for Futuna

Based on the survey work undertaken and the assessments made, the following recommendations are made for Futuna:

- Commercial exploitation of reef fisheries should not be developed. However, the small-scale artisanal development of oceanic fisheries, which has already started, should be pursued to supply the demand for fish on Futuna, and for export to Wallis.

- Currently, the lack of transport facilities and the cost of transport limit any commercial, export fisheries in Futuna. A programme should be established to closely monitor the effects of fishing pressure on finfish and other marine resources. Appropriate management measures should be implemented to avoid overexploitation, especially if market and transport infrastructure is improved in the future.

- Income generation from fisheries should focus on shells collected by women's handicraft groups, and on trochus and lobster catches. Lobster fishing should be accompanied by monitoring and control of sizes, particularly in view of the share caught for export to New Caledonia, French Polynesia, and Wallis. To maximise returns from trochus resources, local fisheries services should advise fishers to properly store the shells for future commercial export (Current trochus fishing on Futuna is only for meat, and the shells are discarded due to the lack of an agent or transport facilities to Wallis.).

- Major harvests of the commercial topshell, *Trochus niloticus*, should be postponed until stocks build up to 500–600 per ha in the major aggregations. In addition, size controls that limit the sale of trochus larger than 12 cm should continue to be enforced to ensure the most productive-sized shells (over 11–12 cm basal width) continue to provide ongoing production for the fishery.

- The occurrence and density of sea cucumbers are too low for commercial collection at this time, except for black teatfish (*Holothuria nobilis*), which are at sufficient abundance for controlled fishing.

RÉSUMÉ

Des travaux de terrain ont été menés à Wallis et Futuna d'août à décembre 2005 et en mars 2006 au titre de la composante côtière du Programme régional de développement des pêches océaniques et côtières (PROCFish/C). Wallis et Futuna est l'un des 17 pays et territoires où des enquêtes ont été réalisées pendant six à sept ans au titre de PROCFish ou de son programme connexe, CoFish (Programme de développement de la pêche côtière dans le Pacifique).

Les enquêtes visaient à réunir des informations de référence sur l'état des pêcheries récifales, pour contribuer à combler l'énorme déficit d'information qui fait obstacle à la bonne gestion de ces pêcheries.

D'autres réalisations sont à inscrire au crédit du programme :

- la mise en œuvre de la première évaluation comparative globale des ressources récifales (poissons, invertébrés et paramètres socioéconomiques) jamais réalisée dans plusieurs pays et de nombreux sites du Pacifique insulaire au moyen de méthodes identiques ;
- la diffusion de rapports sur les pays qui comprennent un ensemble de « profils des pêcheries récifales » pour les différents sites de chaque pays afin de fournir les informations nécessaires à la planification de la gestion et du développement de la pêche côtière ;
- l'élaboration d'un ensemble d'indicateurs (ou de points de référence sur l'état des pêcheries) offrant des orientations pour l'élaboration des plans locaux et nationaux de gestion des pêcheries récifales et des programmes de suivi ; et,
- la mise au point de systèmes de gestion des données et de l'information, notamment des bases de données régionales et nationales.

Trois domaines (les poissons, les invertébrés et les enquêtes socioéconomiques) entraient dans les enquêtes conduites à Wallis et Futuna à chaque mission de l'équipe, qui était composée de quatre chargés de recherche et de quatre homologues locaux, deux du Service de la pêche et deux autres du Service de l'environnement. Les travaux de terrain ont permis de renforcer les capacités des quatre correspondants locaux qui se sont familiarisés avec les méthodes d'enquête employées dans les trois domaines précités, en particulier la collecte de données et leur saisie dans la base de données du programme.

Résultats des travaux de terrain effectués à Vailala et à Halalo (Wallis)

Wallis est une île volcanique isolée (Uvea). C'est une île assez basse (volcanisme basaltique) qui culmine à 149 mètres au Mont Lulu, avec une masse terrestre relativement importante (environ 76,14 km^2, sans îlot lagonaire) et une forte pluviosité annuelle (plus de 3 000 mm). Elle est ceinturée par un grand lagon (154,3 km^2) et un récif-barrière ponctué de petits îlots de sable (près de 20 au nord-est et au sud). De vastes récifs intermédiaires de faible profondeur et des marges récifales constituées d'un benthos associant des substrats durs et meubles ont été observés dans le lagon qui est soumis à la gamme complète des influences terrestres et océaniques. Les alizés du sud-est soumettent cette partie du récif-barrière à l'action des vagues la plus forte, et les pentes récifales sont généralement plus abruptes de ce côté du système. Le lagon oriental offre un environnement plus protégé, et de larges zones peu profondes, caractérisées par un substrat meuble et des herbiers, jalonnent le littoral d'Uvea, particulièrement au nord-ouest.

Enquêtes socioéconomiques : Vailala et Halalo (Wallis)

Bien que les salaires constituent l'essentiel des revenus de la plupart des ménages des deux villages, la pêche n'en demeure pas moins une source importante de rentrées. Plus de 70 pour cent des ménages de Halalo sont financièrement dépendants de la pêche, contre 40 pour cent à Vailala. À Halalo, ~38 pour cent (à Vailala ~19 %) d'entre eux tirent leur revenu principal de la pêche, et elle constitue la deuxième source de revenu pour ~35 pour cent (Vailala ~22 %). À Halalo, tous les ménages mangent du poisson frais, et la plupart (83 %) consomment régulièrement des invertébrés. La consommation de poisson frais est élevée (80,5 kg/personne/an), supérieure à la moyenne régionale, et c'est la plus forte de tous les sites prospectés à Wallis et Futuna. La consommation d'invertébrés est faible (~5 kg/personne/an). En revanche, à Vailala, la plupart des ménages mangent du poisson frais, mais seulement 35 pour cent d'entre eux consomment régulièrement des invertébrés. Dans les deux villages, les hommes et les femmes pêchent le poisson, mais seuls les hommes pêchent à des fins commerciales, les femmes se limitant à une pêche vivrière de poissons et d'invertébrés sur les récifs côtiers protégés et à la collecte de coquillages sur les *motu* (petits îlots coralliens) pour la fabrication d'objets d'artisanat. Seuls les hommes plongent pour pêcher des invertébrés comme les trocas et les langoustes. À l'exception de la pêche sur les récifs côtiers protégés, toutes les sorties de pêche se font avec des bateaux à moteur. C'est à Halalo que la pêche des trocas est la plus importante, en poids humide, en productivité et en utilisation commerciale.

À Vailala, les captures varient entre seulement 200 et 700 kg/pêcheur/an ; lorsque la pêche est pratiquée dans le lagon et les zones bordant le récif extérieur, les captures atteignent ~1300 kg/pêcheur/an, et les CPUE sont également au maximum. À Halalo, les captures sont de l'ordre de 700 kg/pêcheur/an pour la pêche dans le lagon et dans les passes ; la productivité est supérieure dans les passes où la CPUE s'établit à 3 kg/heure de pêche contre 1,5 kg/heure dans le lagon. À Vailala, les invertébrés sont principalement pêchés à des fins commerciales plutôt que vivrières. Le volume total des prises (poids humide) ne représente pourtant que ~3 tonnes/an. Les prises de langoustes constituent à elles seules plus de la moitié de cet impact annuel, suivies des captures réalisées à la main en parcourant les récifs ou les zones intertidales. A contrario, les invertébrés sont principalement destinés à la consommation à Halalo. Le troca est l'espèce la plus pêchée dans un but commercial, avec ~37 pour cent du volume total des captures (poids humide), même s'il ne représente que ~2,7 tonnes/an.

Ressources en poissons : Vailala et Halalo (Wallis)

Les ressources en poissons de Vailala paraissent globalement en assez bon état, légèrement meilleur qu'à Halalo (moyennes plus élevées en densité, biomasse, tailles, ratio des tailles et biodiversité). L'habitat récifal est plutôt riche, et les populations de poissons sont diversifiées et abondantes. Toutefois, les populations de Lutjanidae, de Kyphosidae et de Siganidae présentent des ratios de tailles inférieurs à 50 pour cent, témoignant de l'impact de la pêche sélective, probablement au fusil au harpon. Une évaluation détaillée à l'échelle du récif a également mis en évidence une forte biodiversité ainsi qu'une abondance et une biomasse égales de poissons herbivores et carnivores. À Vailala, la pêche a une vocation vivrière ; la plupart des prises proviennent des récifs intérieurs, mais les ressources de l'arrière-récif semblent reculer (baisse de la densité et de la biomasse, des tailles et du ratio des tailles, et prédominance des herbivores par rapport aux carnivores).

À Halalo, les ressources en poissons semblent en bon état. La nature du substrat ainsi que la densité, la biomasse et la biodiversité des poissons sont très inférieures à Vailala. Toutefois, on constate des différences marquées entre l'abondance des récifs extérieurs et la pauvreté du lagon et des récifs côtiers protégés. Les récifs extérieurs présentent les valeurs les plus importantes en densité, tailles, biomasse et diversité des espèces de tous les habitats analysés, ce qui atteste la bonne santé des stocks et la faible exploitation des ressources de ce milieu. À l'inverse, les tailles des poissons et les ratios de tailles sont particulièrement faibles sur les récifs intermédiaires. L'incidence de la pêche sur la taille moyenne des poissons est principalement due aux techniques de pêche employées (principalement le filet maillant et le fusil à harpon) plutôt qu'à la fréquence des prises. La pêche au filet maillant et au fusil à harpon est particulièrement néfaste pour les communautés de poissons.

Ressources en invertébrés : Wallis

Bien que l'on trouve à Wallis une large gamme d'habitats récifaux de faible profondeur convenant aux bénitiers, ces derniers accusent nettement la pression de pêche, notamment dans les zones aisément accessibles. On constate une faible densité de *Tridacna maxima*, au point que leur éparpillement pourrait porter préjudice à la ponte et au succès de la fécondation et, partant, à la viabilité de cette ressource. *Tridacna squamosa* est supposé présent à Wallis, mais aucun spécimen n'a été observé au cours de cette enquête, ce qui permet de considérer l'espèce comme « disparue d'un point de vue commercial »[3] à Wallis.

Wallis offre de vastes habitats aux trocas, et tous les éléments sont présents pour soutenir une pêche commerciale. Toutefois, la faible densité des trocas dans les principales zones de pêche laisse à penser que les stocks ont subi un impact modéré du fait de la pêche. Les profils de taille des coquillages portent à conclure que la population compte des géniteurs adultes, et qu'un recrutement se produit. Des trocas de moins de 9 cm (nouvelles recrues) ont été observés durant l'enquête, notamment au sud-est de Wallis (sur le dessus du récif). Ces jeunes spécimens doivent être protégés jusqu'à ce qu'ils aient assuré au moins une saison de ponte avant d'intégrer les classes de tailles disponibles pour la capture. L'huître perlière à lèvres noires, *Pinctada margaritifera,* ne figurait pas dans les relevés d'enquête bien que d'autres nacres, telles que le troca *Tectus pyramis* (de faible valeur commerciale), aient été observées, à de faibles densités.

Wallis présente une grande diversité de milieux et de profondeurs convenant aux holothuries avec, dans le lagon nord-ouest, de larges enfoncements protégés contrastant avec les récifs et les passes soumis à l'influence océanique au sud-est. Une grande diversité d'holothuries a été observée dans l'île compte tenu de sa situation géographique, à l'est du Pacifique, et donc loin des zones de forte abondance spécifique proches du centre de biodiversité. Les données de répartition et de densité recueillies pendant l'enquête laissent à penser que les holothuries subissent la pression de pêche, même si la pêche commerciale n'a d'incidence réelle que sur certaines espèces.

[3] L'expression « espèce disparue d'un point de vue commercial » renvoie à une rareté de l'espèce telle que les prélèvements ne suffiraient pas à satisfaire une pêche de rente ou de subsistance, bien que l'espèce soit toujours présente à très faible densité.

Recommandations pour Wallis

D'après les enquêtes réalisées et les évaluations correspondantes, les recommandations suivantes sont formulées en ce qui concerne Wallis :

- compte tenu de l'importance de la pêche — tant vivrière que commerciale — pour les habitants de l'île, du fait que la plupart des gens pratiquent la pêche d'une manière ou d'une autre, et du libre accès aux zones de pêche qui prévaut dans le pays, il convient de créer des zones marines protégées représentatives des habitats les plus importants afin de préserver la biodiversité et la reproduction des espèces pour les années à venir.

- Les efforts engagés par le Service de la pêche pour resserrer les liens et renforcer la coopération avec l'association des pêcheurs doivent être poursuivis, avec notamment les objectifs suivants : amélioration de l'enregistrement des petits pêcheurs pratiquant la pêche commerciale et des embarcations motorisées ; fixation d'un maillage minimum pour les filets maillants ; et contrôle de la pêche de loisirs ou traditionnelle.

- Le Service territorial de la pêche doit maintenir le contrôle exercé sur les produits d'exportation, principalement la bêche-de-mer et le troca, et envisager de l'étendre à d'autres espèces comme les langoustes. Une surveillance doit être mise en place à l'appui des quotas annuels de pêche, par espèce et par taille, et l'application de la réglementation existante doit être mieux encadrée.

- Il convient de réglementer l'utilisation des filets maillants et la pêche au fusil à harpon, en particulier dans le lagon, et d'interdire la pêche de nuit au fusil à harpon.

- Divers rapports attestent une persistance de la pêche à la dynamite à Wallis. Cette technique, tout comme l'utilisation d'eau de Javel, sont des pratiques hautement destructrices, tant pour les ressources que pour les habitats ; il convient d'y mettre un terme immédiat, et de mettre à l'amende tout pêcheur qui y aurait recours.

- Les grandes récoltes de trocas doivent être repoussées jusqu'à ce que les stocks se reconstituent et atteignent 500 à 600 individus par hectare dans les principales concentrations. À cet effet, les contrôles interdisant la vente de coquilles de plus de 12 cm doivent être maintenus afin d'assurer la protection des spécimens ayant atteint une bonne taille de reproduction (plus de 11–12 cm de largeur à la base). Par ailleurs, la protection des trocas de moins de 9 cm (nouvelles recrues) doit être maintenue jusqu'à ce qu'ils aient assuré au moins une saison de ponte avant d'intégrer les classes de tailles disponibles pour la capture. On pourrait aussi envisager de déplacer certains spécimens des zones de recrutement et de forte densité au sud-est vers les différents habitats de l'île abritant des adultes (y compris le nord-ouest).

- Si Wallis souhaite assurer la pérennité de ses stocks, la pêche des holothuries doit être soumise à une gestion prudente. Les prélèvements de *Holothuria scabra* doivent être interrompus le plus vite possible pour permettre aux stocks limités de se remettre des niveaux critiques où ils ont chuté du fait de la surpêche.

Résultats des travaux de terrain réalisés à Vele et à Leava (Futuna)

Futuna est une île volcanique d'assez grande taille (environ 64 km^2) qui s'élève en pente raide depuis une étroite plaine côtière pour culminer à 875 mètres (401 mètres sur l'île d'Alofi). La pluviosité est importante, avec plus de 2 500 mm. Le milieu récifal est globalement dynamique, sans grande protection des vents et de la houle océanique. Les marges récifales présentant un benthos composé de substrats durs et meubles sont peu fréquentes bien qu'une seconde terrasse (haut-fond) s'étende juste au-delà des platiers récifaux, à une profondeur de cinq à 10 mètres, où prédomine un réseau de plaques coralliennes formant des terrasses pentues, entrecoupées çà et là d'habitats en éperons-sillons et de zones sableuses. Ce système s'étend sur encore 200 à 400 mètres de la côte, jusqu'à une profondeur de 40 mètres, à partir de laquelle le gradient de profondeur s'accroît brutalement. Dans certaines zones, on estime que la couverture corallienne est de l'ordre de 30 à 50 pour cent. L'île voisine d'Alofi offre parfois une barrière de protection contre les ondes poussées par les vents. À la différence de Wallis, Futuna n'a pas de lagon, et le récif frangeant de faible profondeur est de largeur variée. La plupart des platier récifaux sont proches de la surface ou exposés à marée basse. Au bord du récif, la plupart des endroits sont soumis à une forte action des vagues, avec parfois une chute abrupte de la pente récifale jusqu'en eau profonde.

Enquêtes socioéconomiques : Futuna

La pêche n'est pas une source de revenu importante à Futuna. Elle est la première source de revenus pour seulement 7 pour cent de l'ensemble des ménages, et la seconde pour 13 pour cent d'entre eux. Les revenus salariaux prédominent, et sont complétés par les rentrées tirées de l'agriculture et d'autres sources telles que les petites entreprises, les retraites et autres aides sociales. Si tous les ménages consomment du poisson frais, seule la moitié d'entre eux mange régulièrement des invertébrés. La consommation de poisson frais est supérieure à la moyenne régionale, mais inférieure à la moyenne estimée pour tous les sites PROCFish/C étudiés sur Futuna et Wallis. La consommation d'invertébrés est faible, de l'ordre de ~3.5 kg/personne/an. Les hommes et les femmes pêchent le poisson, mais les hommes se concentrent plutôt sur les poissons, et les femmes sur les invertébrés. La plupart des pêcheurs des deux sexes marchent à marée basse jusqu'au bord du récif d'où ils pêchent à la ligne ou à l'épervier. Seuls quelques hommes pêchent sur le tombant récifal externe à partir de bateaux, motorisés ou non. La collecte des invertébrés se fait principalement sur le dessus des récifs, et certains pêcheurs (uniquement des hommes) pêchent la langouste, le troca et le bénitier en plongée. Le ramassage des coquillages pour la fabrication d'objets d'artisanat, la pêche des langoustes destinées à l'exportation et celle des trocas pour satisfaire la demande locale jouent un rôle important d'un point de vue commercial.

Ressources en poissons : Futuna

L'évaluation montre que les ressources en poissons sont relativement pauvres sur ce site. Cela tient probablement au fait que Futuna abrite peu d'habitats récifaux (essentiellement des dalles coralliennes présentant très peu de corail vivant), et que les récifs extérieurs sont peu productifs. En effet, la biomasse et la densité de poissons sont les plus faibles du Territoire. La prédominance des poissons herbivores peut s'expliquer par le type d'habitat. La pêche est essentiellement vivrière, et elle est principalement pratiquée depuis la crête récifale qui entoure l'île (à l'aide de palangrottes pour les poissons de fond). La pêche sur le tombant externe du récif se pratique surtout au large de la côte ouest, sous le vent. Les espèces généralement signalées dans les premiers 10 mètres de fond n'ont pas été observées durant les comptages visuels en plongée bien qu'elles soient pêchées à la palangrotte. Leur présence à des profondeurs supérieures à la normale pourrait signaler un début d'impact sur certaines familles de poissons carnivores tels que les Lethrinidae.

Ressources en invertébrés : Futuna

Les récits frangeants de Futuna fournissent globalement un habitat peu diversifié pour les invertébrés ; ils sont isolés des autres sources de recrutement, et sont exposés aux vents forts et aux ondes de tempête. Il y a peu d'habitats récifaux protégés et de faible profondeur pouvant abriter les bénitiers qui n'ont été observés que sur le récif frangeant exposé (et dans de petites dépressions du pseudo-lagon d'Alofi). Le bénitier *Tridacna maxima* n'est pas gravement touché par la pêche bien que les estimations de densité moyenne soient faibles dans plusieurs endroits, et que la répartition des fréquences de taille montre que l'espèce est exploitée. Un seul spécimen de *Tridacna squamosa* a été observé.

On trouve à Futuna de nombreux habitats propices au troca d'importance commerciale *Trochus niloticus* ; toutefois, les habitats de spécimens adultes sont plus nombreux que ceux adaptés à la fixation et à la croissance des juvéniles. La densité des trocas dans les principales zones de pêche montre que les stocks sont modérément affectés par la pêche. Durant ces enquêtes, seuls deux endroits présentaient des densités jugées supérieures à la densité « seuil » (500–600 individus par hectare) recommandée en vue d'une éventuelle pêche commerciale. La taille des coquilles de trocas enregistrée à Futuna permet de penser que la population comporte des géniteurs de grande taille, et qu'il y a recrutement. Les récifs de l'île abritent une population de trocas modérément touchée par la pêche bien que les stocks soient davantage susceptibles d'être exploités du fait de l'exposition des récifs ouverts. L'huître perlière à lèvres noires *Pinctada margaritifera* n'a pas été observée bien que d'autres nacres, comme *Tectus pyramis* de faible valeur commerciale, aient été repérées à des densités modérées.

Futuna ne comporte guère d'habitats convenant aux holothuries étant donné que les zones récifales sont globalement exposées à la houle du large, et qu'il y a peu de zones protégées aux fonds meubles. Les données de répartition et de densité laissent à penser que les holothuries subissent une pression de pêche marginale, et que les conditions environnementales sont largement responsables de l'état actuel des stocks. Contrairement à la plupart des autres groupes d'espèces, l'holothurie noire à mamelles (*Holothuria nobilis*) est très répandue et à des densités élevées, indiquant que l'espèce n'a pas été commercialement exploitée durant les dernières années. Cette enquête préliminaire montre que la répartition et la densité des holothuries sont trop faibles pour envisager une pêche commerciale à ce stade, même si *Holothuria nobilis* est suffisamment abondante pour autoriser une pêche contrôlée.

Recommandations pour Futuna

D'après les enquêtes réalisées et les évaluations correspondantes, les recommandations suivantes sont formulées en ce qui concerne Futuna :

- l'exploitation commerciale des pêcheries récifales ne doit pas être développée. En revanche, il convient d'appuyer le développement de la pêche artisanale en haute mer, qui a déjà démarré, pour satisfaire la demande en poisson à Futuna et l'exportation vers Wallis.

- À l'heure actuelle, l'insuffisance et le coût des transports font obstacle à toute exportation des pêches commerciales à Futuna. Un programme rigoureux doit être mis en place pour surveiller les effets de la pression de pêche sur les poissons et autres ressources marines. Des mesures de gestion appropriées doivent être mises en œuvre pour éviter toute surexploitation, notamment si les marchés et les moyens de transport venaient à s'améliorer.

- La création de revenus issus de la pêche doit être centrée sur la collecte de coquillages par les femmes en vue de la fabrication d'objets d'artisanat ainsi que sur la capture des trocas et des langoustes. La pêche à la langouste doit faire l'objet d'une surveillance et d'un contrôle des tailles, en raison notamment de l'exportation d'une partie des captures vers la Nouvelle-Calédonie, la Polynésie française et Wallis. Pour optimiser les recettes provenant de la ressource en trocas, le Service de la pêche doit conseiller les pêcheurs pour leur apprendre à entreposer les coquilles dans de bonnes conditions et les exporter ultérieurement (à l'heure actuelle, le troca est uniquement pêché pour sa chair, et les coquilles sont jetées du fait de l'absence d'un intermédiaire ou de moyens de transport vers Wallis.).

- Il convient de repousser les grandes récoltes du troca d'importance commerciale *Trochus niloticus* jusqu'à ce que les stocks atteignent 500 à 600 individus par hectare dans les principales concentrations. De plus, les contrôles interdisant la vente de coquilles de plus de 12 cm doivent être maintenus pour assurer la protection des spécimens ayant atteint une bonne taille de reproduction (plus de 11–12 cm de largeur à la base) et leur permettre de maintenir la productivité de la pêcherie.

- La répartition et la densité des holothuries sont encore trop faibles pour justifier des prélèvements commerciaux à ce stade, sauf en ce qui concerne l'holothurie noire à mamelles (*Holothuria nobilis*) qui est suffisamment abondante pour envisager une pêche contrôlée.

ACRONYMS

ACP	African, Caribbean and Pacific Group of States
BdM	bêche-de-mer (or sea cucumber)
CoFish	Pacific Regional Coastal Fisheries Development Programme
COTS	crown of thorns starfish
CPUE	catch per unit effort
Ds	day search
D-UVC	distance-sampling underwater visual census
EDF	European Development Fund
EEZ	exclusive economic zone
EU/EC	European Union/European Commission
FAD	fish aggregating device
FAO	Food and Agricultural Organization (UN)
FL	fork length
GPS	global positioning system
ha	hectare
HH	household
MCRMP	Millennium Coral Reef Mapping Project
MIRAB	Migration, Remittances, Aid and Bureaucracy (model explaining the economies of small island nations)
MOP	mother-of-pearl
MOPt	mother-of-pearl transect
MSA	medium-scale approach
NASA	National Aeronautics and Space Administration (USA)
NCA	nongeniculate coralline algae
Ns	night search
OCT	Overseas Countries and Territories
OGAF	Organisation des Agriculteurs Futuniens
PICTs	Pacific Island countries and territories
PL	fishing in passages at full moon
PROCFish	Pacific Regional Oceanic and Coastal Fisheries Development programme
PROCFish/C	Pacific Regional Oceanic and Coastal Fisheries Development programme (coastal component)
RBt	reef-benthos transect
RFID	Reef Fisheries Integrated Database
RFs	reef-front search
RFs_w	reef-front search: walking
SBq	soft-benthos infaunal quadrat
SCUBA	self-contained underwater breathing apparatus
SE	standard error

SPC	Secretariat of the Pacific Community
USD	United States dollar(s)
WHO	World Health Organization

1. INTRODUCTION AND BACKGROUND

Pacific Island countries and territories (PICTs) have a combined exclusive economic zone (EEZ) of about 30 million km^2, with a total surface area of slightly more than 500,000 km^2. Many PICTs consider fishing to be an important means of gaining economic self-sufficiency. Although the absolute volume of landings from the Pacific Islands coastal fisheries sector (estimated at 100,000 tonnes per year, including subsistence fishing) is roughly an order of magnitude less than the million-tonne catch by the industrial oceanic tuna fishery, coastal fisheries continue to underpin livelihoods and food security.

SPC's Coastal Fisheries Management Programme provides technical support and advice to Pacific Island national fisheries agencies to assist in the sustainable management of inshore fisheries in the region.

1.1 The PROCFish and CoFish programmes

Managing coral reef fisheries in the Pacific Island region in the absence of robust scientific information on the status of the fishery presents a major difficulty. In order to address this, the European Union (EU) has funded two associated programmes:

1. The Pacific Regional Oceanic and Coastal Fisheries Development Programme (PROCFish); and
2. The Coastal Fisheries Development Programme (CoFish)

These programmes aim to provide the governments and community leaders of Pacific Island countries and territories with the basic information necessary to identify and alleviate critical problems inhibiting the better management and governance of reef fisheries and to plan appropriate future development.
The PROCFish programme works with the ACP countries: Fiji, Kiribati, Papua New Guinea, Vanuatu, Samoa, Solomon Islands, Tonga, Tuvalu, and the OCT French territories: French Polynesia, Wallis and Futuna, and New Caledonia, and is funded under European Development Fund (EDF) 8.
The CoFish programme works with the Cook Islands, Federated States of Micronesia, Marshall Islands, Nauru, Niue and Palau, and is funded under EDF 9.

The PROCFish/C (coastal component) and CoFish programmes are implementing the first comprehensive multi-country comparative assessment of reef fisheries (including resource and human components) ever undertaken in the Pacific Islands region using identical methodologies at each site. The goal is to provide baseline information on the status of reef fisheries, and to help fill the massive information gap that hinders the effective management of reef fisheries (Figure 1.1).

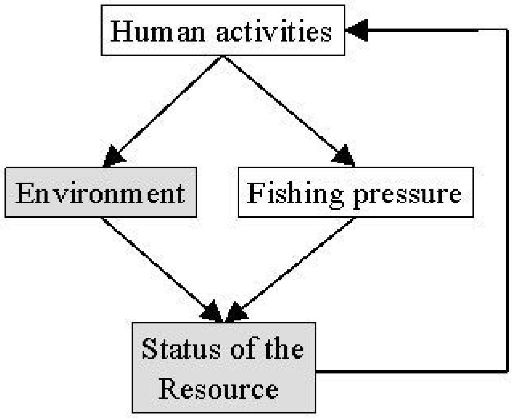

Figure 1.1: Synopsis of the PROCFish/C* multidisciplinary approach.
PROCFish/C conducts coastal fisheries assessment through simultaneous collection of data on the three major components of fishery systems: people, the environment and the resource. This multidisciplinary information should provide the basis for taking a precautionary approach to management, with an adaptive long-term view.

* PROCFish/C denotes the coastal (as opposed to the oceanic) component of the PROCFish project.

Expected outputs of the project include:

- the first-ever region-wide comparative assessment of the status of reef fisheries using standardised and scientifically rigorous methods that enable comparisons among and within countries and territories;
- application and dissemination of results in country reports that comprise a set of 'reef fisheries profiles' for the sites in each country, in order to provide information for coastal fisheries development and management planning;
- development of a set of indicators (or fishery status reference points) to provide guidance when developing local and national reef fishery management plans and monitoring programmes;
- toolkits (manuals, software and training programmes) for assessing and monitoring reef fisheries, and an increase in the capacity of fisheries departments in participating countries in the use of standardised survey methodologies; and
- data and information management systems, including regional and national databases.

1.2 PROCFish/C and CoFish methodologies

A brief description of the survey methodologies is provided here. These methods are described in detail in Appendix 1.

1.2.1 Socioeconomic assessment

Socioeconomic surveys were based on fully structured, closed questionnaires comprising:

1. **a household survey** incorporating demographics, selected socioeconomic parameters, and consumption patterns for reef and lagoon fish, invertebrates and canned fish; and
2. **a survey of fishers** (finfish and invertebrate) incorporating data by habitat and/or specific fishery. The data collected addresses the catch, fishing strategies (e.g. location, gear used), and the purpose of the fishery (e.g. for consumption, sale or gift).

Socioeconomic assessments also relied on additional complementary data, including:

3. **a general questionnaire targeting key informants**, the purpose of which is to assess the overall characteristics of the site's fisheries (e.g. ownership and tenure, details of fishing

gear used, seasonality of species targeted, and compliance with legal and community rules); and

4. **finfish and invertebrate marketing questionnaires** that target agents, middlemen or buyers and sellers (shops, markets, etc.). Data collected include species, quality (process level), quantity, prices and costs, and clientele.

1.2.2 Finfish resource assessment

The status of finfish resources in selected sites was assessed by distance-sampling underwater visual census (D-UVC) (Labrosse *et al.* 2002). Briefly, the method involves recording the species name, abundance, body length and distance to the transect line of each fish or group of fish observed; the transect consists of a 50 m line, represented on the seafloor by an underwater tape (Figure 1.2). Mathematical models were then used to infer fish density (number of fish per unit area) and biomass (weight of fish per unit area) from the counts. Species surveyed included those reef fish of interest for marketing and/or consumption, and species that could potentially act as indicators of coral reef health (See Appendix 1.2 for a list of species.).

The medium-scale approach (MSA; Clua *et al.* 2006) was used to record habitat characteristics along transects where finfish were counted by D-UVC. The method consists of recording substrate parameters within twenty 5 m x 5 m quadrats located on both sides of the transect (Figure 1.2).

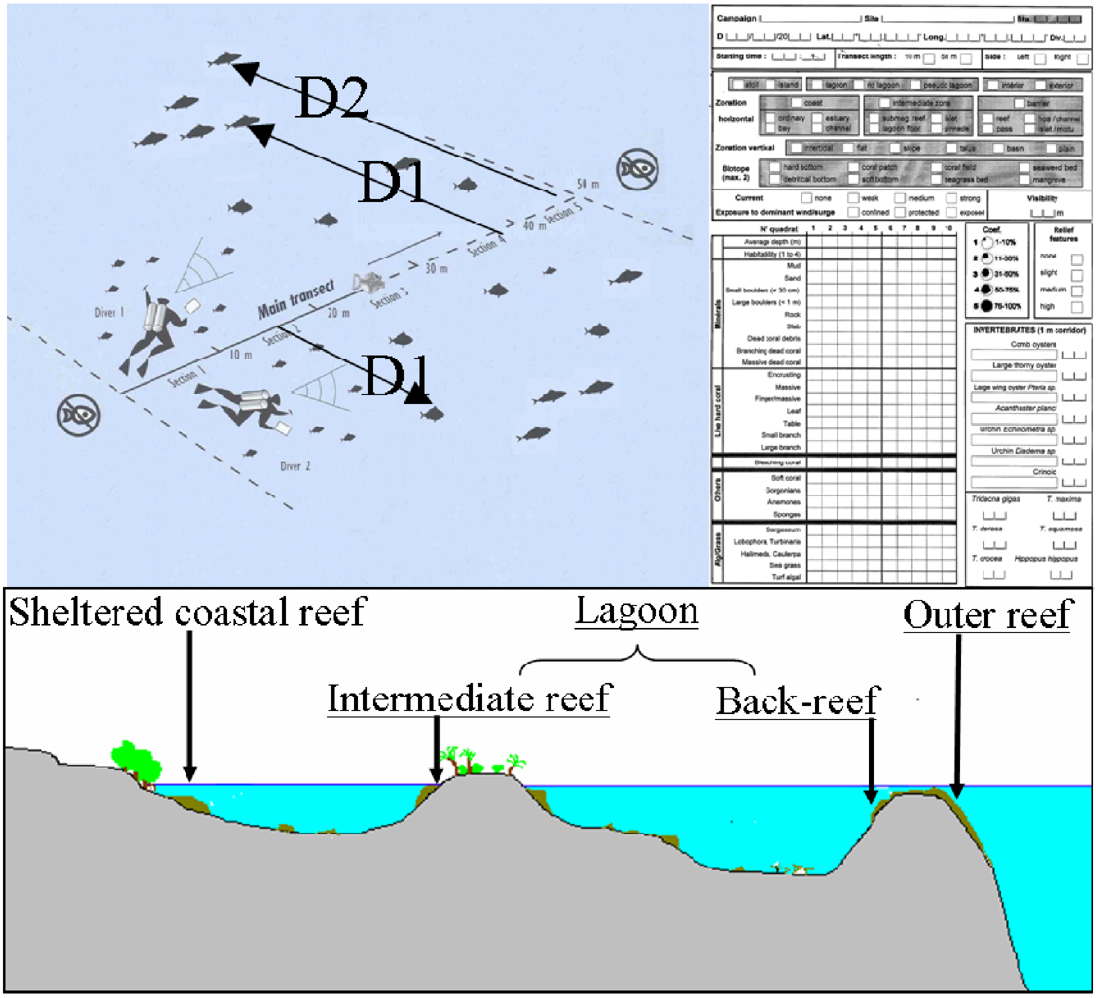

Figure 1.2: Assessment of finfish resources and associated environments using distance-sampling underwater visual censuses (D-UVC).
Each diver recorded the number of fish, fish size, distance of fish to the transect line, and habitat quality, using pre-printed underwater paper. At each site, surveys were conducted along 24 transects, with six transects in each of the four main geomorphologic coral reef structures: sheltered coastal reefs, intermediate reefs and back-reefs (both within the grouped 'lagoon reef' category used in the socioeconomic assessment), and outer reefs.

Fish and associated habitat parameters were recorded along 24 transects per site, with an equal number of transects located in each of the four main coral reef geomorphologic structures (sheltered coastal reef, intermediate reef, back-reef, and outer reef). The exact position of transects was determined in advance using satellite imagery; this assisted with locating the exact positions in the field and maximised accuracy. It also facilitated replication, which is important for monitoring purposes.

Maps provided by the NASA Millennium Coral Reef Mapping Project (MCRMP) were used to estimate the area of each type of geomorphologic structure present in each of the studied sites. Those areas were then used to scale (by weighted averages) the resource assessments at any spatial scale.

1.2.3 Invertebrate resource assessment

The status of invertebrate resources within a targeted habitat, or the status of a commercial species (or a group of species), was determined through:

1. resource measures at scales relevant to the fishing ground;
2. resource measures at scales relevant to the target species; and
3. concentrated assessments focussing on habitats and commercial species groups, with results that could be compared with other sites, in order to assess relative resource status.

The diversity and abundance of invertebrate species at the site were independently determined using a range of survey techniques, including broad-scale assessment (using the manta tow technique) and finer-scale assessment of specific reef and benthic habitats.

The main objective of the broad-scale assessment was to describe the large-scale distribution pattern of invertebrates (i.e. their relative rarity and patchiness) and, importantly, to identify target areas for further fine-scale assessment. Broad-scale assessments were used to record large sedentary invertebrates; transects were 300 m long × 2 m wide, across inshore, midshore and more exposed oceanic habitats (See Figure 1.3 (1).).[4]

Fine-scale assessments were conducted in target areas (areas with naturally higher abundance and/or the most suitable habitat) to specifically describe resource status. Fine-scale assessments were conducted of both reef (hard-bottom) and sandy (soft-bottom) areas to assess the range, size, and condition of invertebrate species present and to determine the nature and condition of the habitat with greater accuracy. These assessments were conducted using 40 m transects (1 m wide swathe, six replicates per station) recording most epi-benthic resources (those living on the bottom) and potential indicator species (mainly echinoderms) (See Figure 1.3 (2) and (3).).

In soft bottom areas, four 25 cm × 25 cm quadrats were dug at eight locations along a 40 m transect line to obtain a count of targeted infaunal molluscs (molluscs living in bottom sediments, which consist mainly of bivalves) (See Figure 1.3 (4).).

For trochus and bêche-de-mer fisheries, searches to assess aggregations were made in the surf zone along exposed reef edges (See Figures 1.3 (5) and (6).); and using SCUBA (7). On occasion, when time and conditions allowed, dives to 25–35 m were made to determine the availability of deeper-water sea cucumber populations (Figure 1.3 (8)). Night searches were conducted on inshore reefs to assess nocturnal sea cucumber species (See Appendix 1.3 for complete methods.).

[4] In collaboration with Dr Serge Andrefouet, IRD-Coreus Noumea and leader of the NASA Millennium project: http://imars.usf.edu/corals/index.html/.

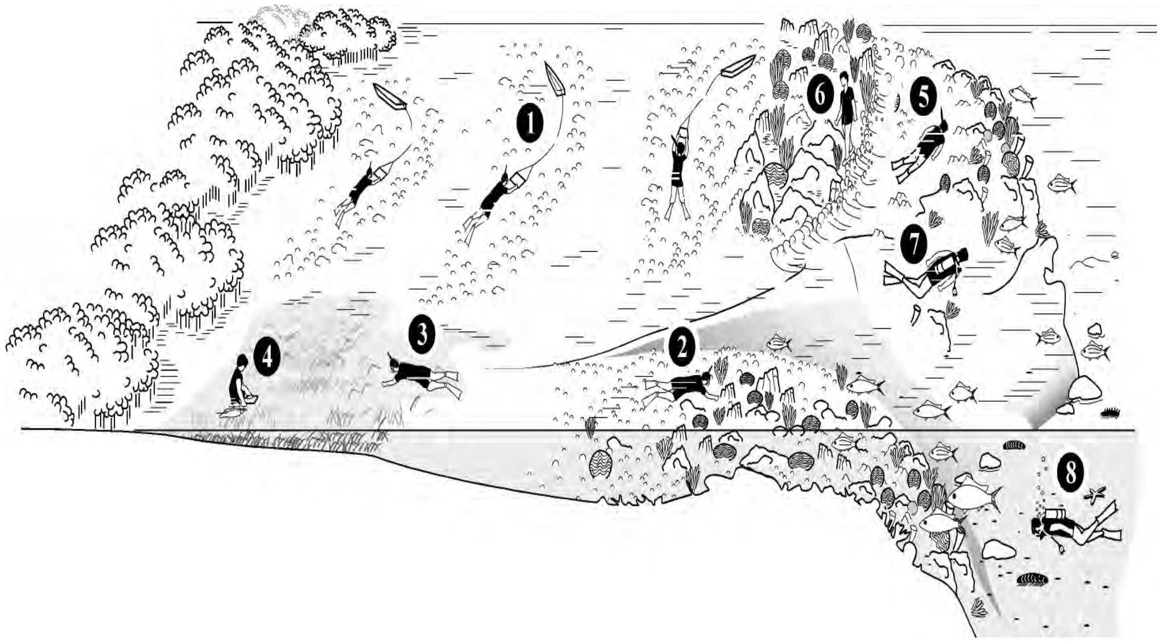

Figure 1.3: Assessment of invertebrate resources and associated environments.
Techniques used include: broad-scale assessments to record large sedentary invertebrates (1); fine-scale assessments to record epi-benthic resources and potential indicator species (2) and (3); quadrats to count targeted infaunal molluscs (4); searches to determine trochus and bêche-de-mer aggregations in the surf zone (5), reef edge (6), and using SCUBA (7); and deep dives to assess deep-water sea cucumber populations (8).

1.3 Wallis and Futuna

1.3.1 General

The islands that make up the territory of Wallis and Futuna (Figure 1.4) are located in the South Pacific at 13–15°S latitude and 175–178°W longitude. Wallis and Futuna has an economic exclusion zone (EEZ) of 242,000 km^2, and shares EEZ boundaries with the Kingdom of Tonga to the southeast, Fiji Islands to the southwest, Tuvalu to the northwest, Tokelau to the northeast and Samoa to the east, with only a small part of the EEZ bordering international waters to the north (Chapman 2004).

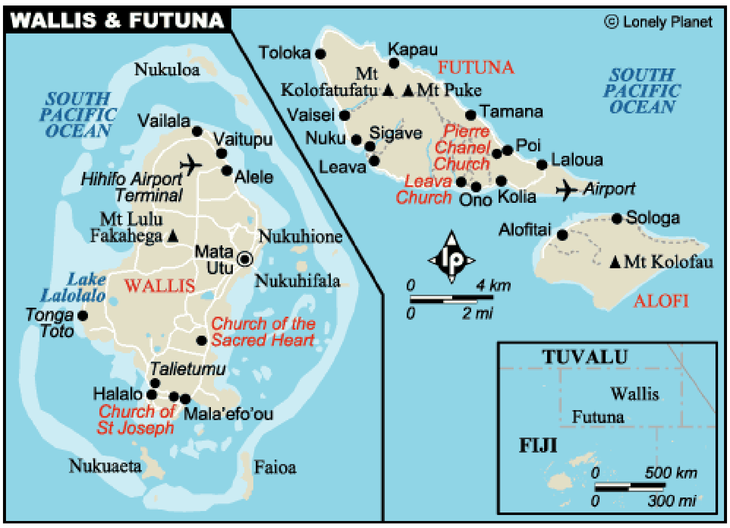

Figure 1.4 : Map of Wallis and Futuna.

1: Introduction and background

The island group is made up of two sets of islands with differing histories and geologies. The Wallis Islands to the north are made up of Uvea Island and 19 small coral or basalt islands. Uvea Island is a former volcano with a lagoon that is over 6 km wide in places. Three of the four main reef passages face west and one to the south. Mt Lulu Fakahega (145 m) is the highest point on the 80 km^2 island, dotted with lakes and craters. The Horn Islands, 230 km to the southwest of Uvea Island, are made up of Futuna (46 km^2) and Alofi (18 km^2), which are less than two kilometres apart. Due to their recent geological history, they do not have a lagoon and their narrow, fringing reef rarely exceeds a width of 400 m. The highest point is Mount Puke (524 m) on Futuna Island (Anon. 2008a; Anon. 2006).

The territory is located in the intertropical zone and has a typical tropical maritime climate: consistently warm, wet, rainy and very cloudy, without any dry season. The climate experiences diurnal variations in terms of thermal amplitude and very slight seasonal variations. Average temperatures are stable throughout the year at around 27.5°C and average relative humidity ranges from 82 to 84%. Absolute temperature extremes are approximately 33–35°C maximum and 19°C minimum. Rainfall is abundant at around 3 m/year for Wallis and 4 m/year for Futuna. Wallis and Futuna are affected by cyclones, with the last major cyclone hitting in 1986.

The 2003 census reported a total population of 14,944, with 10,071 people on Wallis and 4873 on Futuna, i.e. a 5.7% rise since the 1996 census. Significantly, the Wallisian and Futunese community in New Caledonia is larger than at home, with the 1996 New Caledonian census reporting 17,563 in Noumea and surrounding areas (Anon. 2006).

Wallis Island was colonised in the 15th century by Tongans who settled there permanently and became independent from the Kingdom of Tonga, while Futuna was settled by Samoans during the 17th century (Anon. 2008c). The islands, therefore, have different languages, but Tongans still communicate easily today with Wallisians, and Samoans with Futunans.

Following a landslide vote in a 1961 referendum, the protectorate of Wallis and Futuna took on French overseas territory status. Under the constitutional amendment in 28 March 2003, the island group became a special-status overseas region without altering the 1961 system (Anon. 2008a). The islands differ from other French overseas territories in that their traditional institutions were maintained; both the kingdoms of Alo and Sigave on Futuna and the Uvea Kingdom on Wallis. The King and his ministers, appointed by the nobility, enforce customary regulations. Although subject to French law, the regulations are legally binding in some areas, such as land tenure.

The islands are affected by scarce natural resources, particularly fresh water on Futuna. Production is essentially based on subsistence farming and small-scale lagoon fisheries. Agriculture is mainly based on pig and poultry farming. There is little arable land and any extensive farming is restricted by the land tenure system, although cultivated land meets subsistence needs. The travel industry is not very developed, as the island group is remote, airfares are high and flights infrequent (Anon. 2006).

Yearly lagoon fishery production is ~200–300 tonnes. All catches are consumed by the fishers themselves and production does not fully meet local demand (Anon. 2008b). Also, overfishing may affect the small lagoon, which is under pressure from a growing population and the arrival of outboard motors and modern fishing equipment. In recent years, development has concentrated on oceanic fisheries with the planned fishing harbour and related infrastructure. In the meantime, negotiations are underway for fishing agreements with a New Zealand fishing company. There are currently two foreign-currency earning export lines, namely trochus and bêche-de-mer. The latter is a minor industry involving only a few hundred kilograms of dry weight a year, while trochus harvesting ranges from 15 to 154 tonnes (Emmanuel Tardy pers. comm. 2006; customs department records).

1.3.2 The fisheries sector

Fisheries in Wallis and Futuna comprise a yet-to-be-developed offshore fishery for tuna and other pelagic species, the small-scale tuna fishery around fish aggregating devices (FADs), the deep-water snapper fishery, and reef fisheries for a range of fish and invertebrate species. In addition, work has been undertaken in the past on small-scale aquaculture projects.

Offshore tuna fishery

There is no domestic offshore tuna fishery in Wallis and Futuna; however, fishing trials and catches taken by distant water fishing nations, especially before the declaration of the 200 nm EEZ in 1982, indicate there is potential for a small fishery to be established. The first tuna survey was conducted by the Japan Marine Fishery Resource Research Center (JAMARC) in 1973, with a pole-and-line vessel baiting in the Wallis lagoon and fishing for skipjack around Wallis and Futuna (JAMARC 1974). The next survey, using the same methods, was undertaken by the SPC's Skipjack Survey and Assessment Programme, which baited and fished around the country for the month of May 1978 (Kearney and Hallier 1978). During this survey, 13,534 skipjack and 239 yellowfin tuna were tagged and released. Wallis and Futuna was again visited by the SPC tagging vessel on 10–22 May 1980, with 2552 skipjack and 521 yellowfin tuna tagged (SPC 1984).

Japanese and Taiwanese fleets have fished the waters around Wallis and Futuna since 1972 and Korean vessels since 1975. After the EEZ was declared in 1982, bilateral agreements were signed by France and the distant-water fishing nations, particularly Japan and Korea, but the negotiations held in 1999 with Japan and 2000 with Korea were unsuccessful, as the agreement included the waters around New Caledonia and French Polynesia, and these countries had developed their own domestic fleets. Longline vessels from Korea, Taiwan and Japan reported a combined catch of 189 t in 1975 and 386 t in 1976 (Klawe 1978) from the waters around Wallis and Futuna. Japanese pole-and-line vessels, using bait transported from Japan, caught 257 t of tuna (98% skipjack) from 1972 to 1978 over 61 fishing days (SPC 1980). There were also several reports of US purse-seine vessels fishing in the waters around Wallis and Futuna, with one vessel catching 228 t over four sets in 1978 (Souter and Broadhead 1978).

The available longline catch data for Wallis and Futuna was assessed by SPC in 2001. The data covered the periods 1962–1980 (annual average of 560,000 hooks set for a catch of 395 mt) and 1981–1999 (annual average of 260,000 hooks set for a catch of 110 mt), with a catch composition of 64% albacore, 25% yellowfin tuna and 11% bigeye tuna (Anon. 2001). One longline vessel from New Caledonia also fished in the waters of Wallis and Futuna in 1991, 1997 and 1999, setting a total of 150,000 hooks and catching 3495 fish, primarily albacore tuna. Further trial longline fishing was undertaken 12 May – 20 July 2005 by a French Polynesian vessel, which made 42 sets, setting a total of 132,720 hooks and catching 44.4 mt of fish, mainly albacore tuna (Anon. 2007).

The fisheries department and local authorities have developed a project to establish a small fishing port, with the focus on establishing a small tuna longline fleet, mainly to supply the local market. This project has been developed over several years, although funding is not fully assured. Coupled with this was the delivery of a 15 m longline vessel in 2008, and it is anticipated this vessel will catch around 60 mt of fish annually for the local market (Anon. 2007).

Small-scale tuna fishery around FADs

Traditionally, fishers from Wallis and Futuna fished from three- or four-man outrigger paddling canoes, using a pole and pearlshell lure, the same as used in other Polynesian countries (Burrows 1936, 1937). However, this tradition ceased in the late 1800s, apparently due to: the influence of the church, which restricted canoe movements (Fusimalohi and Grandperrin 1980; Anon. 1977); the danger involved (Phillipps 1953), this being a strenuous activity (Burrows 1936); and the poor manoeuvring ability of these canoes (Hinds 1969). Hinds (1969) reported that some tuna fishing from traditional canoes commenced again around the time of the First World War, when Tokelauan and Chinese fishers assisted Wallisians, and catches of 80 skipjack per canoe per day were recorded. This was short lived, as tuna fishing activities ceased by the 1930s (Burrows 1937). Then in the early 1950s, a large proportion of the able-bodied men, including most of the fishers, emigrated to New Caledonia to work in the nickel mines (Anon. 1977).

Through the 1950s and 1960s little fishing was done. The remaining canoes were occasionally used in the lagoon, but not outside the reef for tuna fishing. In 1963, the Société Mutuelle de Développement Rural (SMDR) was created. Its duties were, among other things, to promote fishery development, focusing outside the reef (Virmaux *et al.* 2002). The art of canoe building was also disappearing, with few people in Wallis and Futuna having the traditional skills and knowledge (Anon. 1977). In 1970, the SMDR set up a boat-building centre to train local boat builders. Between November 1970 and June 1972, 35 boats (19–23 feet, 5.5–6.5 m long) were built, with orders for another 25 boats (Anon. 1972). Four designs were constructed during the first two years; however, none were appropriate for fishing outside the reef. In 1974, several 8 m Saint-Pierre dories with Volvo 10 hp inboard diesel engines were constructed. From 1974 to 1996, seven boats of this design were constructed (Anon. 1997). By the end of 1976, 115 boats and canoes were built at the boatyard in a range of shapes and sizes. Unfortunately, many boats fell into disrepair within a couple of years, due to a lack of maintenance, to a point where the boats were inoperable and beyond repair (Anon. 1977).

In 1979, the Territorial Assembly of Wallis and Futuna adopted a long-range development plan to create a small-scale offshore fleet (Taumaia and Cusack 1997; Virmaux *et al.* 2002). Part of this plan focused on construction of FAO-designed Samoan *alia* catamarans for use outside the reef. In 1984, there were 10 plywood *alia* in Wallis and another five on Futuna, although some of these vessels were falling into disrepair. Also in 1984, a private company (‘Technic’eau’) started to build fibreglass boats. In 1987, one slipway was built on each island to facilitate boat repairs (Virmaux *et al.* 2002).

Fish aggregating devices (FADs) were introduced to Wallis and Futuna in the early 1990s, to encourage fishers to fish outside the reef, away from the lagoon. The first three FADs were deployed in late 1992, with technical assistance provided by SPC and the French Navy vessel *La Glorieuse* used for the deployments. Catch records were collected during 1993 for the catch taken around the FADs by species. High-quality tuna, *mahi mahi* and marlin started showing up in the market for sale (Anon. 2006). Unfortunately, two of the FADs were lost in late 1994. Following the success of the FADs, SPC provided further technical assistance in 1995 to train fisheries department staff to rig and deploy FADs. Another FAD was deployed off Wallis and a fifth off Futuna, again using the vessel *La Glorieuse* (Beverly *et al.* 1999). The FADs continued to be successful in aggregating tunas and other pelagic species, and were fished when weather permitted.

Sportsfishing or gamefishing is done by a few recreational fishers. Whitelaw (2001) reported there were fewer than 10 private vessels, all smaller than 10 m, with these vessels fishing around the FADs from time to time, catching tunas and other associated species.

More recently, in 2005, the Wallis and Futuna fisheries department deployed a further three FADs with assistance from the French Navy and the Wallis Big Game Fishing Association. Also in November 2005, the Territorial Assembly passed new fishing regulations, instituted professional fisher status and voted tax exemptions on fishing equipment for professionals, as requested by the rural economy and fisheries departments. The measures were intended as incentives for developing the fishing industry outside the reef. Up to 60% of the value of suitable boats (to survey standards) was provided through government subsidy (Emmanuel Tardy pers. comm.).

Deep-water snapper fishery

The first fishing trials for deep-water snappers around Wallis and Futuna were undertaken in 1980, when SPC provided technical assistance and training in this fishing method. Around Wallis, outboard-powered monohull vessels were used for the fishing trials and training, with catch rates of around 9 kg/line-hour recorded. The fishing trials at Futuna were conducted from *alia*, with a catch rate of around 5.5 kg/line-hour recorded (Fusimalohi and Grandperrin 1980; Dalzell and Preston 1992).

Further fishing trials and training were undertaken in Wallis and Futuna in late 1983 and early 1984, when SPC was requested to provide technical assistance. At this time there were only two vessels engaged in fishing for deep-water snappers, so the aim was to further encourage fishers to target these species outside the reef (Taumaia and Cusack 1997). During these fishing trials and training activities, *alia* were the main vessels used. Catch rates from Wallis (<6 kg/line-hour) were much lower than in the first trials; at Futuna, a similar catch rate (5.7 kg/line-hour) to the 1980 trial was recorded (Taumaia and Cusack 1997).

Dalzell and Preston (1992) assessed the potential of deep-water snapper fishing around Wallis and Futuna and found the stock to be almost unfished. The study analysed the catch data from the two fishing trials conducted by SPC in 1980 and 1983/1984, although these catches had been taken from virgin stocks, and a decrease in catch rates was expected. Overall it was found that eteline snappers, the main target species for this type of fishing, dominated the catch at 51.3% at Wallis and 68.3% at Futuna. Dalzell and Preston (1992) also estimated the unexploited biomass to be ~102.2 t, which would allow a fishing rate of 10.2–30.7 t/year. It was also highlighted in this report that there had been no consistent commercial fishing for deep-water snappers since the 1984 trials, and anecdotal information indicates this was true for the 1990s and into the 2000s.

Aquaculture

Aquaculture seems to have started on Wallis Island around 1966, with tilapia introduced into the Lalolalo and Lanutavake crater lakes (Hinds 1969). Hinds (1969) states that the introduction of tilapia had been very successful in these lakes; however, Wallisians do not like the taste of this fish, much preferring sea fish. Hinds (1969) also indicates the potential for the introduction of other freshwater aquaculture species, such as the black bass for both sportsfishing and for food, and large freshwater crayfish; and, for saltwater mariculture, mother-of-pearl shell, mullet and milkfish in some areas of the lagoon (species already present in Wallis), and edible oysters.

It appears that Hinds' suggestions were not followed; SPREP (1982) suggested that aquaculture trials to test the viability of introductions were needed before such projects could be developed.

More recently, in 2005, the SPC Aquaculture Section conducted a freshwater prawn (*Macrobrachium lar*) farming experiment in taro fields in Futuna. The experiment showed that potential production would be small but could satisfy subsistence requirements (Nandlal 2005).

Reef and reef fisheries (finfish and invertebrates)

Fishers in Wallis and Futuna have traditionally fished the lagoon (in Wallis) and reef flats, especially since the late 1800s, when traditional tuna fishing from large outrigger canoes ceased. Since that time, the harvesting of seafood and fish from the lagoon and reef flats has increased as a result of fishing pressure from a growing population. Burrows (1937) reported overfishing in the Wallis lagoon in the early 1930s, while overfishing was first mentioned for Futuna in 1932 (Burrows 1936). In 1969, Hinds (1969) estimated that the 25 previous years had seen a 75% decline in the number of fishers and catching effort. The main cause of the overfishing in the past has been attributed to: the use of destructive fishing methods, especially explosives; a range of poisons, including poisonous plant extracts (SPREP 1982; Fusimalohi and Grandperrin 1980; Taumaia and Cusack 1997); and the use of small-mesh gillnets.

According to an Agriculture and Fisheries Department study and a fisher census (Fourmy 2002), most fishing is carried out in the protected areas inside the barrier reef; the reef flats (31%), inside the lagoon (30%), on the outer slope (24%), on the barrier reef (13%) and outside the reef within sight of land (2%). Fishing methods include a large variety of traditional and modern techniques: speargun fishing (29% of responses), nets (27%), on foot (17%), handline fishing (15%), trolling (11%) and other methods (1%). The study (Fourmy 2002) did not cover practices such as the use of toxic plant extracts or illegal dynamite, which are still practised today. Fishing produce was distributed as follows: own consumption (36%), customary rituals (32%), sales to individuals (15%), and sales to businesses (17%).

Bêche-de-mer harvesting

Bêche-de-mer harvesting is a relatively recent and minor industry. It is mainly conducted by women who walk along the fringing reef at night harvesting sea cucumbers and men who snorkel for other species during the day. Available data (provided by the customs department) record bêche-de-mer exports only since 2001, with amounts ranging from 260 to 500 kg/year.

Only two families currently export bêche-de-mer from Wallis. While a proportion (10%) of a low-value species (*loli*, *Holothuria atra*) can be seen in customs records in 2001, only high-value bêche-de-mer were harvested in 2006. The high cost of living on Wallis Island currently makes the collection of low-value species unattractive.

In addition to commercial bêche-de-mer, Wallisians also collect *Stichopus horrens* or *funa funa* and eat the inner part (Tahimili pers. comm. 2006). The younger generation is, however, much less partial to this food.

Trochus harvesting

Trochus harvesting is now the main fishing industry and generates foreign currency earnings for the territory. Between 2001 and 2006, export figures from Wallis ranged from 15 to 154 t. Declining catch rates in 2004 led the environment department to restrict harvesting to an annual quota of 34 t (Chauvet *et al.* 2005). Chauvet *et al.* (2006) reported that, in 2006, trochus harvesting was mainly practised by six fishers. They noted that harvesting was mainly concentrated on the island's west coast, although trochus were found from the northernmost point to the south of the island. The eastern reef faced the trade winds and did not appear conducive to colonisation by trochus. They estimated the population at that time to be 1.3 million individuals (Chauvet *et al.* 2006). Currently, applicable legislation stipulates a minimum catch size of 90 mm and a maximum of 120 mm base width. There are no data on trochus harvesting on Futuna.

Clamshell harvesting

There is no commercial clamshell harvesting on either Wallis or Futuna, although clams are considered a delicacy and highly sought after. There are only two clam species on Wallis and Futuna; the giant clam (*Tridacna maxima*), which is the main species and actively harvested for subsistence, and the fluted clam (*T. squamosa*), which have virtually disappeared. (Emmanuel Tardy pers. comm. 2006).

Crustaceans

Crustaceans are not extensively marketed in Wallis and Futuna, although lobster is fairly regularly available at fish shops and restaurants. Lobsters (*Panilurus versicolor, P. albiflagellum* and *P. penicilatus*) and mitten lobsters (*Parribacus caledonicus* and *antarcticus*) can be found here and are commonly fished. Squillid lobsters, locally known as *valo* (*Lysiosquillina maculata*), which are abundant in places, are totally overlooked by most of the population (Emmanuel Tardy pers. comm. 2006).

1.3.3 Inshore fisheries research

There has been very little research undertaken on inshore resources around Wallis and Futuna in the past. The first major study on the potential resources of the Wallis lagoon was conducted in 1981 by a group made up of teams from the École Pratique des Hautes Études (advanced applied research school), National Natural History Museum, Malardé Institute in Tahiti and Montpellier Botanical Institute (Richard *et al.* 1982). This first exhaustive study prepared an inventory of the lagoon's marine fauna and flora as well as the island's geological features. Since then, the University of New Caledonia Living Resource and Marine Environment Research Laboratory has carried out considerable work on fish inventories as well as trochus and bèche-de-mer stocks at the request of Wallis and Futuna's environment department.

1.3.4 Inshore fisheries management

The development and management of the marine resources within Wallis and Futuna falls under the jurisdiction of the Service de l'Économie Rurale et de la Pêche (SERP). There is currently no specific fisheries Act under which SERP works. In the interim, a fisheries development policy statement, 'General Fishing Industry Development Policy for Wallis and Futuna (TAWF 2003) or politique générale du développement des filières pêche du territoire de Wallis et Futuna' was developed, and implemented in February 2003.

In November 2005, the Territorial Assembly passed new fishing regulations, instituted professional fisher status and voted tax exemptions on fishing equipment for professionals, as requested by SERP. These measures were intended as incentives for developing the fishing industry while making fishers accountable and preventing further depletion of lagoon resources. The lack of policing capacity may, however, make the measures unenforceable, particularly with regard to net mesh sizes, dynamite use and minimum fish lengths, seeing that many of these measures were already stipulated in previous regulations and largely ignored (Emmanuel Tardy pers. comm. 2006).

1.4 Selection of sites in Wallis and Futuna

Under normal operations, the PROCFish/C and CoFish programmes select four representative sites for work in each country. A site is defined as a fishing community and its associated fishing ground. Given the size of Wallis and Futuna, two main areas (Vailala and Halalo) were selected on Wallis for socioeconomic surveys, although Wallis was actually considered as a single site for resource surveys. Futuna was also considered a single site. Therefore the results for the most part are presented as two sites: Wallis, and Futuna. These sites shared most of the required characteristics for our study: they had active reef fisheries, were representative of the country, were relatively closed systems,[5] were appropriate in size, possessed diverse habitats, presented no major logistic limitations that would make fieldwork unfeasible, had been investigated by previous studies, and presented particular interest for the Wallis and Futuna department of fisheries.

[5] A fishery system is considered 'closed' when only the people of a given site fish in a well identified fishing ground.

2. PROFILE AND RESULTS FOR WALLIS

2.1 Site characteristics: Wallis

Wallis is a solitary island of volcanic origin (Uvea). The island is relatively low-lying (basaltic volcanism, maximum elevation 149 m at Mt Lulu), with a relatively large land mass (approximately 76.14 km^2, without lagoon islands) and high annual rainfall (over 3000 mm). It is surrounded by a large lagoon (154.3 km^2) and barrier reef with small sand islands (up to 20 in the northeast and south). Extensive shallow-water intermediate reefs and reef margins comprising mixed hard and soft benthos were noted in the lagoon. This lagoon at Wallis is subjected to a full range of terrestrial (rainfall over 3000 mm/year) and oceanic influences. The southeast trade winds subject this sector of the barrier reef to the greatest wave action and the reef slopes generally fall off more quickly into deep water on this side of the system. The easterly lagoon presents a more protected environment and extensive areas of shallow-water soft benthos and seagrass are found along the coastline of Uvea, especially in the northwest.

2.2 Socioeconomic surveys: Wallis

Socioeconomic fieldwork was carried out on Wallis during September 2005 and March 2006. The survey was designed to target the two communities of Vailala and Halalo. However, at the time when the survey took place, elections were being held; half of the population of Wallis supported a new king, while the other half remained in support of the existing king. This strong division into two political groups was occurring in both village populations, which made survey work difficult. As a result, in Vailala, the sample needed to be extended to include half of the neighbouring village of Tufuone. For the sake of consistency, both are referred to as 'Vailala' in this report. In Halalo, the village population size was large enough to allow half of its population to make up the sample group.

The two villages are located at the opposite ends of Wallis, and they also differ both in socioeconomic terms and in fishing strategies. Both villages were chosen as they represent the most active coastal fisheries communities, i.e. they have the most fishers that could be classified as professionals. For these reasons, these villages are not necessarily representative of the entire population on Wallis. Therefore, and unlike the survey results from Futuna, the survey results from both these villages are presented separately. However, the discussion of commercialisation issues and the conclusions of the survey are presented together.

Wallis enjoys an open-access system for fishing. In order to estimate the current fishing pressure imposed on reef and lagoon resources by both villages, we calculated the reef, lagoon and other habitat areas according to an assumed 'North Wallis' fishing ground to represent the fishing area of Vailala and Tufuone fishers, and a 'South Wallis' fishing ground to represent the fishing area of Halalo fishers. The assumed boundaries as shown in Figure 2.1 are based on discussions held with local fishers and the distance that they usually travel.

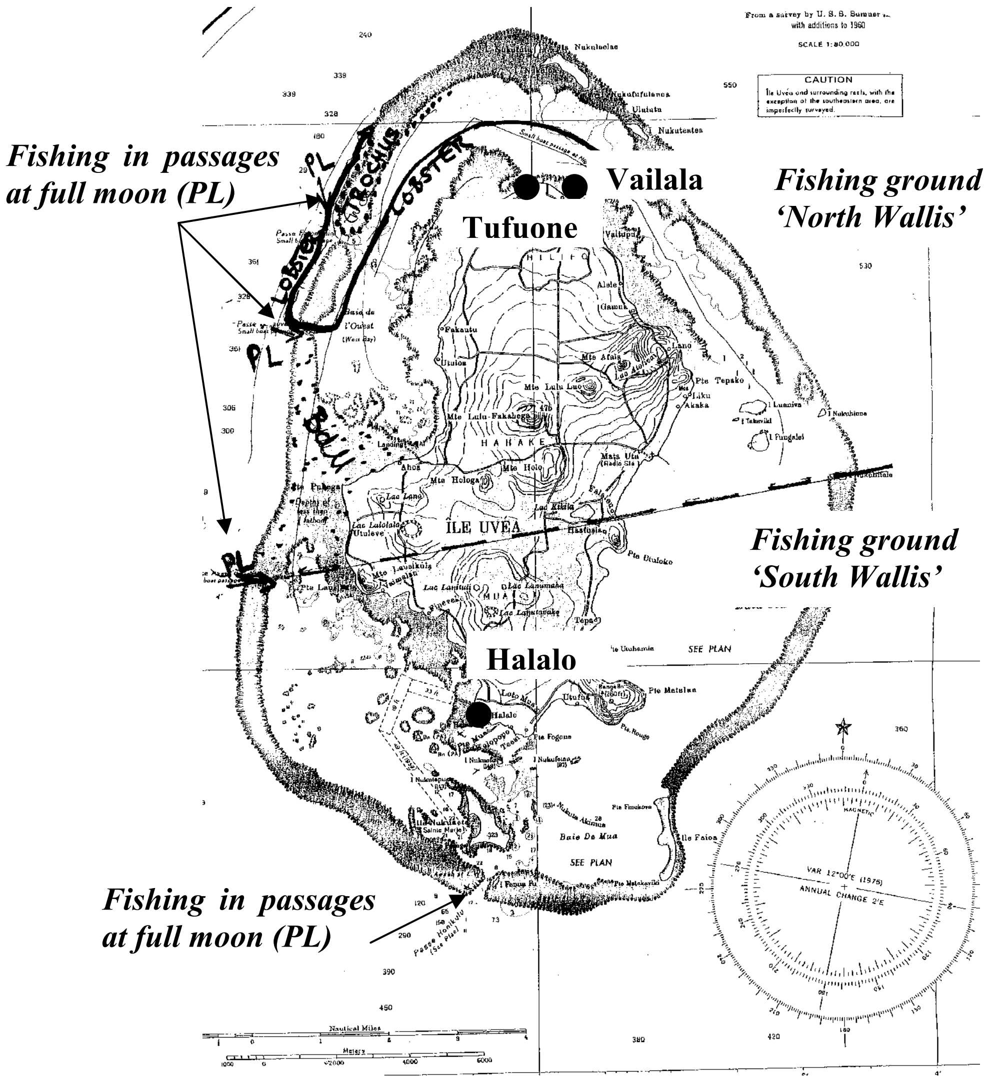

Figure 2.1: Fishing grounds of Wallis.
'North Wallis' is the area where fishers from Vailala and Tufuone fish; 'South Wallis' is the area where fishers from Halalo fish.

2.2.1 Vailala

In total, 32 households were surveyed that included 168 people, representing 40% of the total number of households (80) and population (420) in the community. Household interviews aimed to collect general demographic, socioeconomic and consumption parameters. A total of 27 individual interviews of finfish fishers (26 males, 1 female) and 15 invertebrate fishers (4 males, 11 females) were conducted. These fishers belonged to one of the 32 households surveyed. Sometimes, the same person was interviewed for both finfish and invertebrate fishing.

2.2.1.1 The role of fisheries in the Vailala community: fishery demographics, income and seafood consumption patterns

Our survey results (Table 2.1) suggest an average of 1.5 fishers per household. If we apply this average to the total number of households, we arrive at a total of 123 fishers in Vailala. Applying our household survey data concerning the type of fishers (finfish fisher, invertebrate fisher) by gender, we can project a total of 75 fishers who only fish for finfish

(75 males, 0 female), a total of 23 fishers who only fish for invertebrates (3 males, 20 females) and 15 male and 10 female fishers who fish for both finfish and invertebrates.

Table 2.1: Fishery demography, income and seafood consumption patterns in Vailala

Survey coverage	Site (n = 32 HH)	Average across sites (n = 137 HH)
Demography		
HH involved in reef fisheries (%)	90.6	87.6
Number of fishers per HH	1.53 (±0.22)	1.47 (±0.09)
Male finfish fishers per HH (%)	61.2	40.6
Female finfish fishers per HH (%)	0.0	8.4
Male invertebrate fishers per HH (%)	2.0	1.5
Female invertebrate fishers per HH (%)	16.3	16.3
Male finfish and invertebrate fishers per HH (%)	12.2	13.4
Female finfish and invertebrate fishers per HH (%)	8.2	19.8
Income		
HH with fisheries as 1st income (%)	18.8	16.1
HH with fisheries as 2nd income (%)	21.9	19.7
HH with agriculture as 1st income (%)	9.4	5.8
HH with agriculture as 2nd income (%)	18.8	18.2
HH with salary as 1st income (%)	53.1	46.7
HH with salary as 2nd income (%)	3.1	4.4
HH with other source as 1st income (%)	21.9	32.1
HH with other source as 2nd income (%)	34.4	32.8
Expenditure (USD/year/HH)	13,047.42 (±2054.13)	10,991.98 (±847.25)
Remittance (USD/year/HH) (1)	4404.26 (±1452.31)	1738.04 (±330.62)
Consumption		
Quantity fresh fish consumed (kg/capita/year)	47.85 (±8.68)	52.99 (±5.13)
Frequency fresh fish consumed (times/week)	3.23 (±0.32)	3.44 (±0.16)
Quantity fresh invertebrate consumed (kg/capita/year)	0.56 (±0.34)	3.11 (±5.13)
Frequency fresh invertebrate consumed (times/week)	0.19 (±0.07)	0.45 (±0.07)
Quantity canned fish consumed (kg/capita/year)	4.18 (±1.15)	1.68 (±0.39)
Frequency canned fish consumed (times/week)	0.67 (±0.15)	1.19 (±0.10)
HH eat fresh fish (%)	96.9	99.3
HH eat invertebrates (%)	34.4	48.9
HH eat canned fish (%)	65.6	79.6
HH eat fresh fish they catch (%)	90.6	77.6
HH eat fresh fish they buy (%)	34.4	40.8
HH eat fresh fish they are given (%)	50.0	76.3
HH eat fresh invertebrates they catch (%)	34.4	36.8
HH eat fresh invertebrates they buy (%)	3.1	1.3
HH eat fresh invertebrates they are given (%)	6.3	7.9

HH = household; n/a = no information available; (1) average sum for households that receive remittances; numbers in brackets are standard error.

Only 28% of all households in Vailala own a boat, but all boats are equipped with an outboard engine (100%).

Ranked income sources (Figure 2.2) suggest that fisheries is quite an important sector, providing ~40% of all households either with first (~19%) or second income (~22%). Agriculture is far less important by comparison; only 9% of households depend on agriculture for first income, ~19% as second income. However, overall, salaries provide the most important income for over half of Vailala's population. Retirement payments (and some social fees) and handicrafts provide first income for 22% of all households and second income for 34%. In summary, the sources of revenue in Vailala are very diverse. While salaries are the most important source of income, fisheries play a crucial role for 40% of all households surveyed. The average annual household expenditure level is low to moderate, ~13,000 USD/year, suggesting that people in Vailala spend a bit more than the average across all sites investigated in Wallis and Futuna.

The importance of fisheries also shows in the fact that almost all households reported eating fresh fish (~97%), but only 35% eat invertebrates. The fish that is consumed is mostly caught by a member of the household (91%), but also often bought (34%) or received as a gift (50%). The proportion of invertebrates caught by a member of the household where it is eaten is low (34%). However, invertebrates are rarely ever bought in Vailala (~3%) and are also much less frequently given as a gift compared to finfish (6%). These results suggest that finfish is an important food source for the people of Vailala, and that some finfish is locally marketed. Invertebrates play a minor role, not only as food items but also for local marketing.

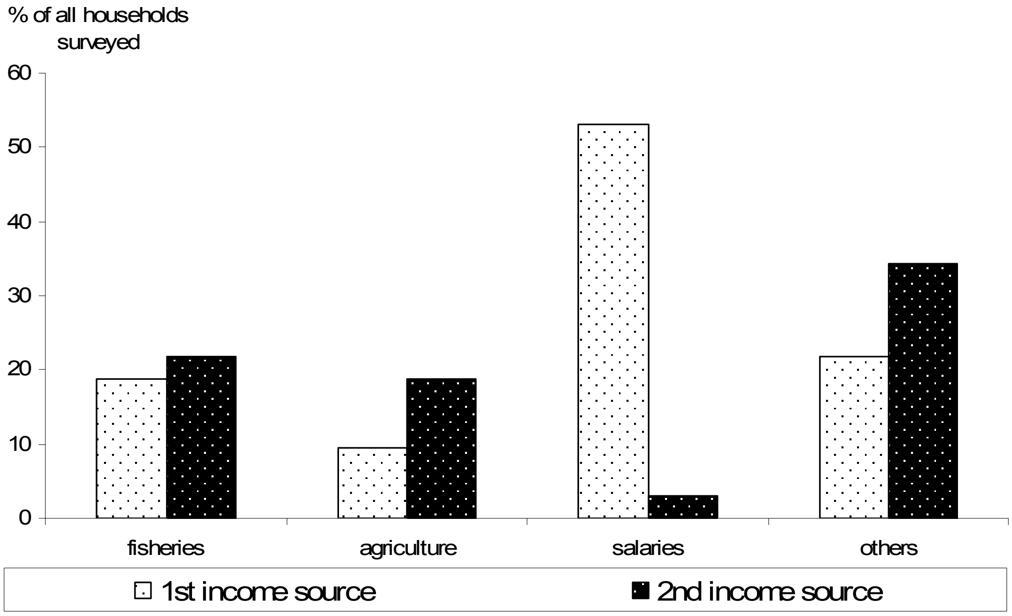

Figure 2.2: Ranked sources of income (%) in Vailala.
Total number of households = 32 = 100%. Some households have more than one income source and those may be of equal importance; thus double quotations for 1st and 2nd incomes are possible. 'Others' are mostly retirement payments and sales of handicraft.

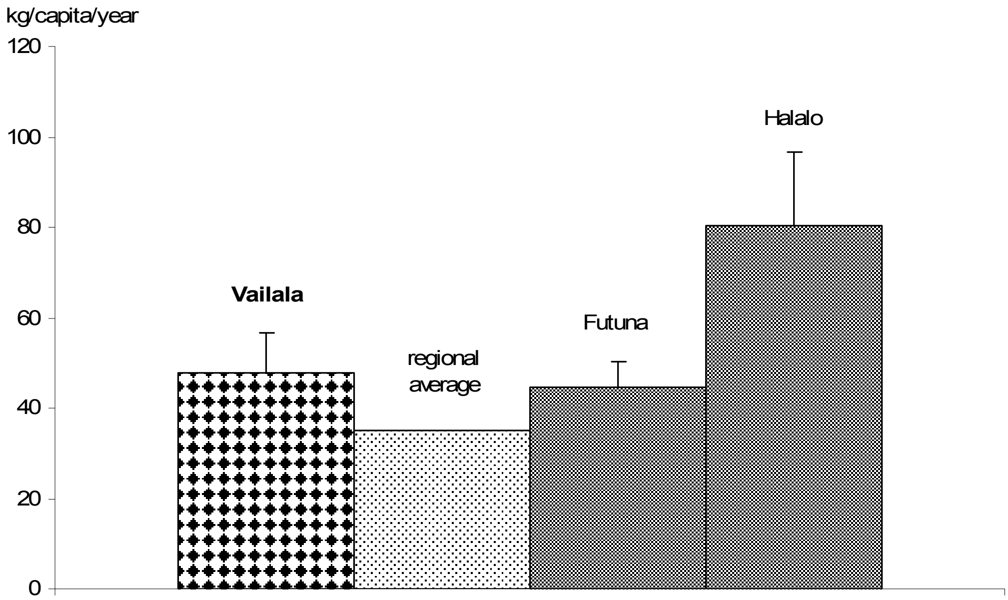

Figure 2.3: Per capita consumption (kg/year) of fresh fish in Vailala (n = 32) compared to the regional average (FAO 2008) and the other two PROCFish/C sites Halalo and Futuna.
Figures are averages from all households interviewed, and take into account age, gender and non-edible parts of fish. Bars represent standard error (+SE).

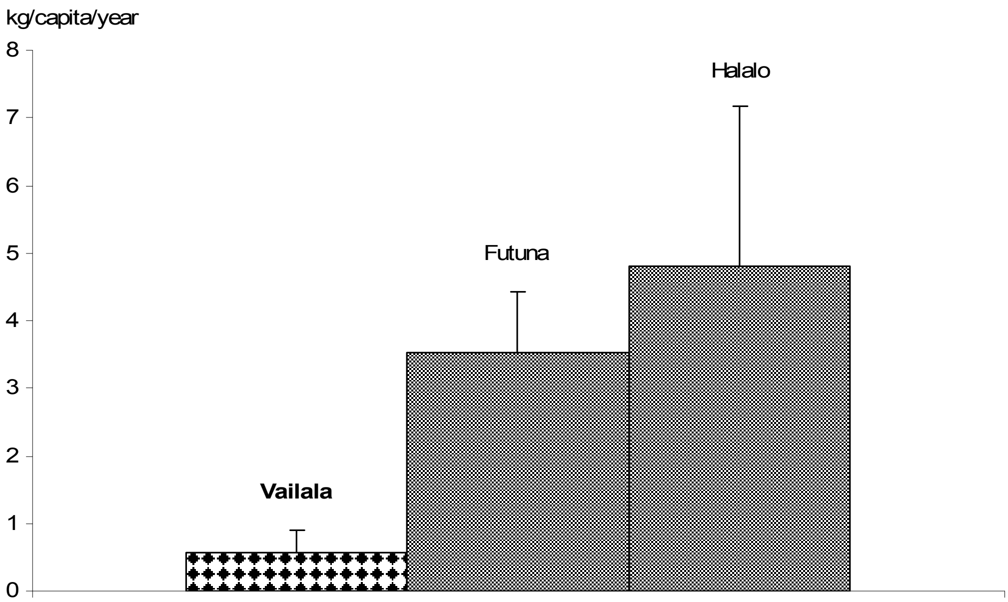

Figure 2.4: Per capita consumption (kg/year) of invertebrates (meat only) in Vailala (n = 32) compared to the other the two PROCFish/C sites Halalo and Futuna.
Figures are averages from all households interviewed, and take into account age, gender and non-edible parts of invertebrates. Bars represent standard error (+SE).

The per capita consumption of fresh fish (~48 kg/capita/year ±8.68) in Vailala is above the regional average (FAO 2008) (Figure 2.3), but is lower than the average for Wallis and Futuna combined. The per capita consumption of invertebrates (meat only) is ~0.6 kg/capita/year (Figure 2.4) and insignificant if compared to finfish and also below the average consumption figures calculated for all sites on Wallis and Futuna. More than half of the people (66%) reported eating canned fish on average about once a fortnight, and the per capita canned fish consumption is extremely low (<1 kg/capita/year). This trend seems to apply for all sites surveyed. In fact, data collected suggest that people on Wallis and Futuna prefer other alternatives, probably meat, and fresh seafood rather than canned fish (Table 2.1).

Comparing results among all sites investigated on Wallis and Futuna (Table 2.1), people in Vailala are more dependent on fisheries for income generation, but eat less fresh fish in a year. Nevertheless, there is no difference between Vailala and the average of all sites concerning the number of fishers per household and access to boat transport. People in Vailala spend more on basic living expenditures, and receive most from remittances.

2.2.1.2 Fishing strategies and gear: Vailala

Degree of specialisation in fishing

Figure 2.5 shows that only males fish exclusively for finfish and, therefore, most commercial fishers are males. In contrast, almost 20% of female fishers target invertebrates exclusively, with only a few males in this group. The small group of fishers who target both finfish and invertebrates contains only ~10% of male fishers and ~5% of female fishers.

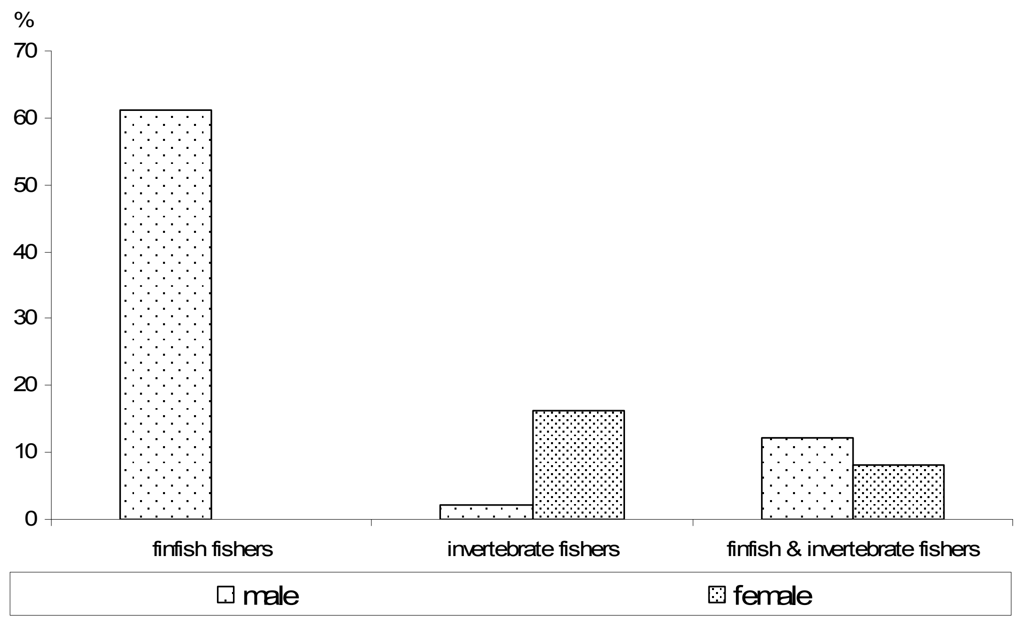

Figure 2.5: Proportion (%) of fishers who target finfish or invertebrates exclusively, and those who target both finfish and invertebrates in Vailala.
All fishers = 100%.

Targeted stocks/habitat

Table 2.2: Proportion (%) of interviewed male and female fishers harvesting finfish and invertebrate stocks across a range of habitats (reported catch) in Vailala

Resource	Habitat / Fishery	% of male fishers interviewed	% of female fishers interviewed
Finfish	Sheltered coastal reef	34.6	100.0
	Sheltered coastal reef & lagoon	46.2	0.0
	Sheltered coastal reef & lagoon & outer reef	7.7	0.0
	Lagoon & outer reef	7.7	0.0
	Outer reef	15.4	0.0
Invertebrates	Lobster	75.0	0.0
	Reeftop	0.0	27.3
	Intertidal & reeftop	0.0	63.6
	Intertidal & reeftop	0.0	9.1
	Seagrass & intertidal & reeftop	0.0	9.1
	Trochus	25.0	0.0

Finfish fisher interviews, males: n = 29; females: n = 1. Invertebrate fisher interviews, males: n = 4; females: n = 12.

The small number of invertebrate fishers reflects the fact that invertebrate fisheries are less important than finfish fisheries. The smaller proportion of females engaged in fishing suggests they are mainly fishing for subsistence needs, which is also supported by Table 2.2, which shows that female finfish fishers only target the sheltered coastal reef. The sheltered coastal reef, but often in combination with the lagoon area or even the outer reef, is also the main habitat targeted by male fishers. About 16–20% of all males prefer fishing at the outer reef or in combination with the lagoon, depending on weather and sea conditions. Male invertebrate fishers target mainly lobsters (75%) or trochus (25%), while females collect invertebrates on reeftops, in intertidal areas and in seagrass habitats. Often, females collect invertebrates from two or more habitats combined during one fishing trip.

Fishing patterns and strategies

The combined information on the number of fishers, the frequency of fishing trips and the average catch per fishing trip are the basic factors used to estimate the fishing pressure imposed by people from Vailala on their fishing grounds (Tables 2.2 and 2.3).

Our survey sample suggests that fishers in Vailala have a good choice of fishing habitats, including the sheltered coastal reef, an extended lagoon area that includes coral reef heads, some passages, and the outer reef. Reefs, mostly the outer reef, also represent the main habitat for fishers diving for lobsters and trochus (Figure 2.1). However, females collecting shells and other invertebrates walk along the beach, targeting sandy, seagrass and reeftop patches. If the data on all male and female invertebrate fishers is combined, it can be seen that most fishers target the intertidal areas along the beach front (47%) and the reeftops (26%). Seagrass, lobster and trochus harvesting are much less popular by comparison (Figure 2.6). Females dominate the invertebrate fishery but do not engage in any of the dive fisheries (Figure 2.7).

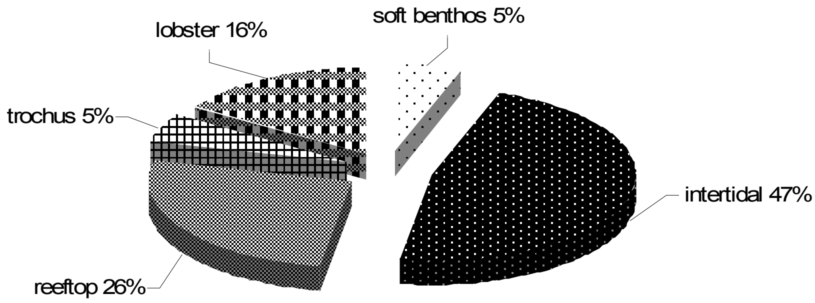

Figure 2.6: Proportion (%) of fishers targeting the five primary invertebrate habitats found in Vailala.
Data based on individual fisher surveys; data for combined fisheries are disaggregated.

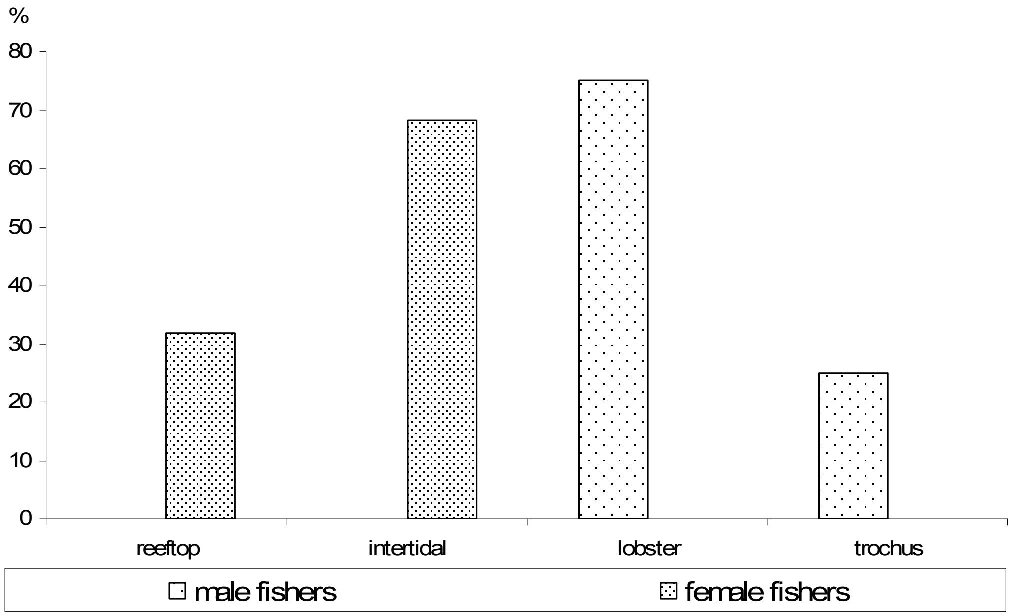

Figure 2.7: Proportion (%) of male and female fishers targeting various invertebrate habitats in Vailala.
Data based on individual fisher surveys; data for combined fisheries are disaggregated; fishers commonly target more than one habitat; figures refer to the proportion of all fishers that target each habitat: n = 4 for males, n = 11 for females.

Gear

Figure 2.8 shows that fishers in Vailala use a wide range of techniques to catch fish. However, gillnetting and, to some extent, spear diving (or the combination of both) are the main techniques used at the sheltered coastal reef, and also the sheltered coastal reef and lagoon combined in one fishing trip. Handlining is also performed when the coastal reefs and lagoon are both fished. The more the outer reef is targeted, the more a combination of gillnetting, handlining, spear diving, trolling and longlining is used. While finfish fishing at the sheltered coastal reef is usually done by walking (90% of respondents reported that they never use boats.), all other fishing trips rely on motorised boats. The techniques reported by respondents confirm the information provided by the chief of Tufuone, who considered gillnets, castnets and spear diving as the main fishing techniques used. He also indicated that, in total, about six motorised boats are available in the community.

Gleaning and free-diving for invertebrates are done using only very simple tools. Reeftop gleaning is usually done by walking during the day to pick up shells for artisanal work, or during the night with torches, baskets and knifes to collect edible gastropods or other species. Lobsters and trochus are picked up by hand; mask, snorkel and fins are used for apnoea diving, and sometimes a knife or a spear gun are used to catch lobsters. Mostly, diving for lobsters and trochus is done with motorised boat transport to reach the outer reef. Gleaning of intertidal and seagrass habitat and, to some extent, reeftop gleaning do not require boat transport. However, when reeftops are gleaned on any of the outer *motu*, motorised boats are used.

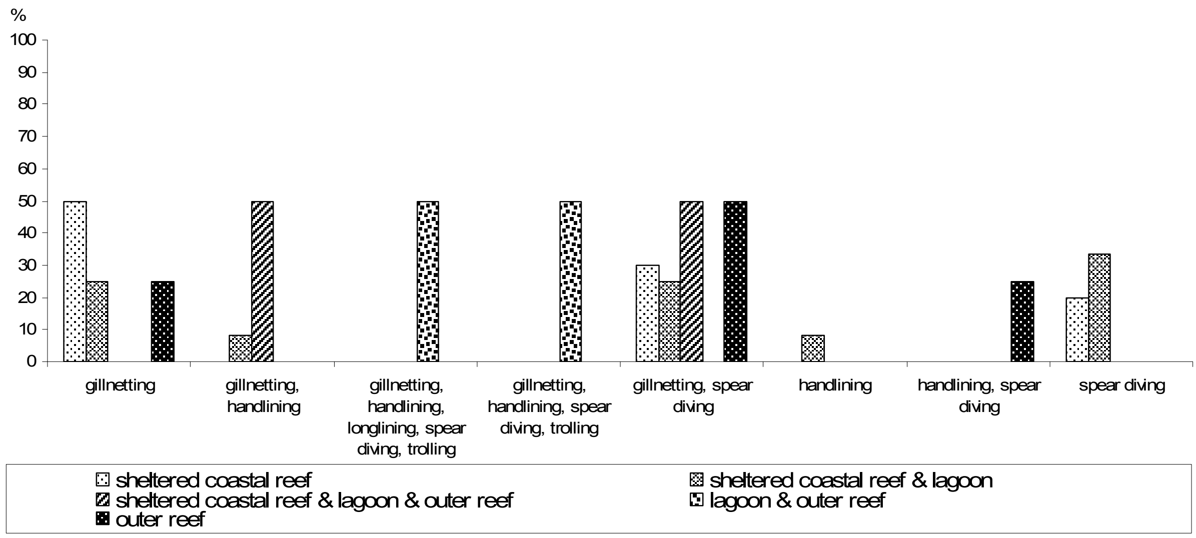

Figure 2.8: Fishing methods commonly used in different habitat types in Vailala.
Proportions are expressed in % of total number of trips to each habitat. One fisher may use more than one technique per habitat and target more than one habitat in one trip.

Frequency and duration of fishing trips

As shown in Table 2.3 the frequency of fishing trips varies considerably according to the habitat targeted. While female finfish fishers may go fishing a couple of times per week, male fishers go out between once and twice a week on average. Unfavourable conditions at the outer reef may explain why it has lowest frequency of fishing trips. Fishers who target the combined sheltered coastal reef, lagoon and outer-reef areas in one single fishing trip go fishing the most often (3 times/week) as they can adjust their fishing location to suit to weather and sea conditions. Trip durations for male fishers are on average relatively long (5–7 hours/trip) compared to two hours for female fishers. This long duration may be explained by the fact that often gillnets are set at a suitable location, and fishers will spend some time on a *motu*, sometimes even sleeping until the catch has to be cleaned from the net after the tide has changed.

Lobster fishers reported going fishing about once a week, while trochus are collected once a month. Females collect once a fortnight or up to once a week. Trip duration for invertebrate collection is long (3–4 hours/trip for females; 5 hours/trip for males diving for lobsters or trochus).

There is a strong preference for females to fish during the day, while males either prefer night fishing or fish according to tidal conditions. In general, one can assume that spear divers fish at night, while gillnets are set according to the tides. For invertebrates, only lobster harvesting is performed exclusively at night; all other invertebrate fisheries are performed during the day.

In Vailala, fishing for finfish and invertebrates continues throughout the year.

Table 2.3: Average frequency and duration of fishing trips reported by male and female fishers in Vailala

Resource	Habitat / Fishery	Trip frequency (trips/week)		Trip duration (hours/trip)	
		Male fishers	Female fishers	Male fishers	Female fishers
Finfish	Sheltered coastal reef	1.20 (±0.22)	3.00 (n/a)	5.44 (±0.85)	2.00 (n/a)
	Sheltered coastal reef & lagoon	1.37 (±0.22)	0	6.33 (±0.70)	0
	Sheltered coastal reef & lagoon & outer reef	3.00 (±1.00)	0	7.00 (±2.00)	0
	Lagoon & outer reef	1.25 (±0.25)	0	6.00 (±2.00)	0
	Outer reef	0.87 (±0.24)	0	6.38 (±1.07)	0
Invertebrates	Lobster	1.29 (±0.15)	0	4.67 (±0.88)	0
	Reeftop	0	0.38 (±0.15)	0	4.67 (±1.20)
	Intertidal	0	0.82 (±0.38)	0	4.64 (±0.45)
	Intertidal & reeftop	0	1.00 (n/a)	0	3.00 (n/a)
	Soft benthos & intertidal & reeftop	0	0.23 (n/a)	0	4.00 (n/a)
	Trochus	0.23 (n/a)	0	5.00 (n/a)	0

Figures in brackets denote standard error; n/a = standard error not calculated.
Finfish fisher interviews, males: n = 29; females: n = 1. Invertebrate fisher interviews, males: n = 4; females: n = 12.

2.2.1.3 Catch composition and volume – finfish: Vailala

Catches from the sheltered coastal reef include a great variety of fish species and species groups, with Acanthuridae alone determining about 40% of the reported catch. Lethrinidae determine >21% and Mullidae ~8%. Somewhat surprisingly, Scaridae only account for about 3% of the reported catch. At the outer reef, the share of Acanthuridae in the reported catch declines to about 22%; however, not surprisingly, Carangidae dominate with about 34%. Here, Scaridae account for 10% of the reported catch and Lutjanidae for about 8%. If considering reported catches from fishing combined habitats in one fishing trip, Acanthuridae, Lutjanidae and Lethrinidae continue to make up a large amount of the total reported catch. However, if the lagoon is combined with the outer-reef area, catches are determined by Acanthuridae (>14%), Serranidae (~16%), Scaridae (~12%), Lutjanidae (~12%) and Lethrinidae (~9%) (Detailed data are provided in Appendix 2.1.1.).

Our survey sample of finfish fishers interviewed represents about 27% of the projected total number of finfish fishers in Vailala. The surveys largely included commercial fishers as well as those who fish regularly for subsistence needs. Hence we have extrapolated our results to estimate the total annual fishing pressure imposed by the people of Vailala. However, the total estimated annual impact by Vailala fishers is not the only fishing pressure imposed on the fishing ground considered. Wallis enjoys an open-access system and hence anyone may fish wherever they want. However, our figure may provide some indication of the current scale of fishing activities on the lagoon system of Wallis.

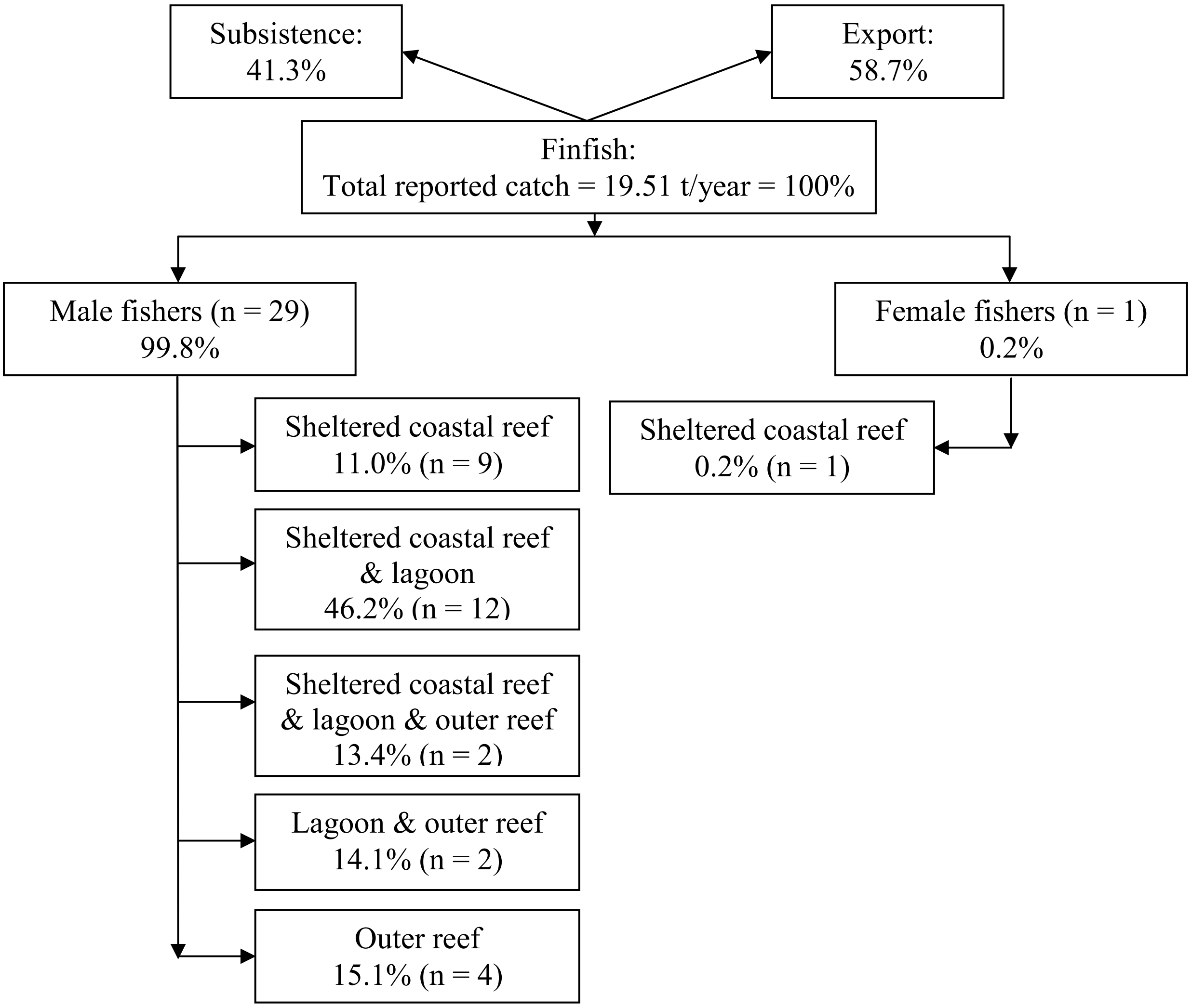

Figure 2.9: Total annual finfish catch (tonnes) and proportion (%) by fishery and gender (reported catch) in Vailala.
n is the total number of interviews conducted per each fishery; total number of interviews may exceed total number of fishers surveyed as one fisher may target more than one fishery and thus respond to more than one fishery survey.

As shown in Figure 2.9 the major share (>58%) of fishing impact is due to the commercial demand of people outside the Vailala community. Most of the catch is sourced from the sheltered coastal reef and lagoon resources (>57% of total catch) and much less from the outer-reef area (~30% in combination with the lagoon area). Females' participation is almost insignificant. Thus, we can assume that, while females fish mainly for subsistence, males are responsible for providing both the major share of fish needed to satisfy the demand of their own families and friends for food, and income.

The high impact on the sheltered coastal reef is a function of the number of fishers targeting this habitat rather than the average annual catch rate. As shown in Figure 2.10, average catches range between 200 and 700 kg/year/fisher with the lowest figure if only the sheltered coastal reef is targeted, and higher average catch rates if combining the sheltered coastal reef and the lagoon. Highest average annual catch rates are achieved if two or three major habitats i.e. sheltered coastal reef, lagoon and outer reef or lagoon and outer-reef areas are combined. Apparently, combining areas allows fishers to adjust to fluctuating weather and sea conditions and thus to optimise their productivity. Reported average annual catches for this fishing strategy exceed 1300 kg/fisher/year.

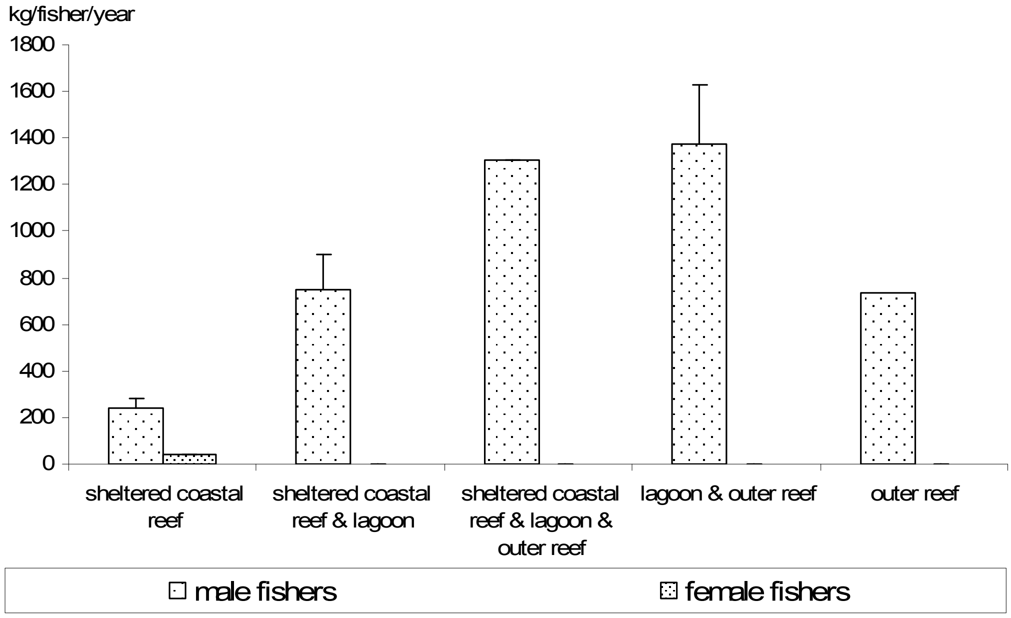

Figure 2.10: Average annual catch (kg/year, +SE) per fisher by gender and habitat in Vailala (based on reported catch only).

CPUE data as shown in Figure 2.11 show the same trend; highest CPUE is reached when lagoon and outer-reef areas are combined in one fishing trip (4–5 kg/hour fished). The outer-reef CPUE (3 kg/hour fished) is again much higher than CPUEs reached at the sheltered coastal reef (1 kg/hour fished) or during combined fishing trips of the sheltered coastal reef and lagoon habitats (2 kg/hour fished). Both, the average annual catch rates and CPUEs of female fishers are very low.

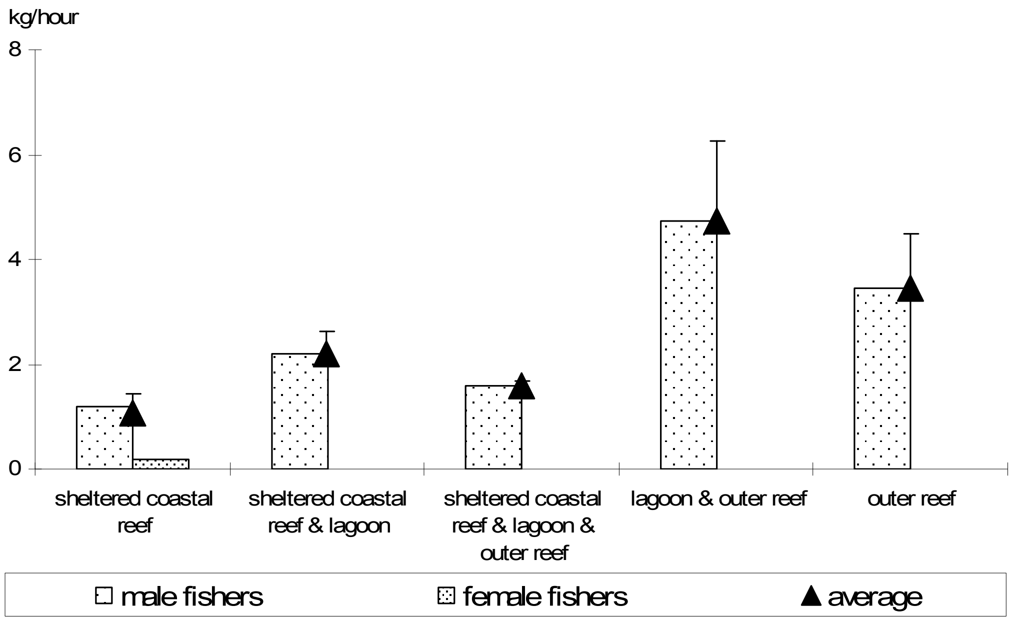

Figure 2.11: Catch per unit effort (kg/hour of total fishing trip) for male and female fishers by habitat in Vailala.
Effort includes time spent in transporting, fishing and landing catch. Bars represent standard error (+SE).

Comparing data on the purpose of fishing trips, provided by respondents (Figure 2.12), we see that fishing is done for both subsistence and commercial purposes. The sheltered coastal reef is fished more for subsistence needs, while the lagoon and outer-reef habitats are targeted more for commercial catches. Traditional values, represented by the proportion of the catch taken for distributing among relatives and friends, are high. Catches from all habitats are shared in this way.

In addition to the normal catches presented here, intensive group fishing is also sometimes conducted for certain events. About once or twice a year, major customary events may occur and most community members will perform some joint gillnetting to provide the protein for the feast. Other such events are performed for fund-raising purposes; all the males of the community go fishing for this purpose and all the females are engaged in cooking and marketing the catch.

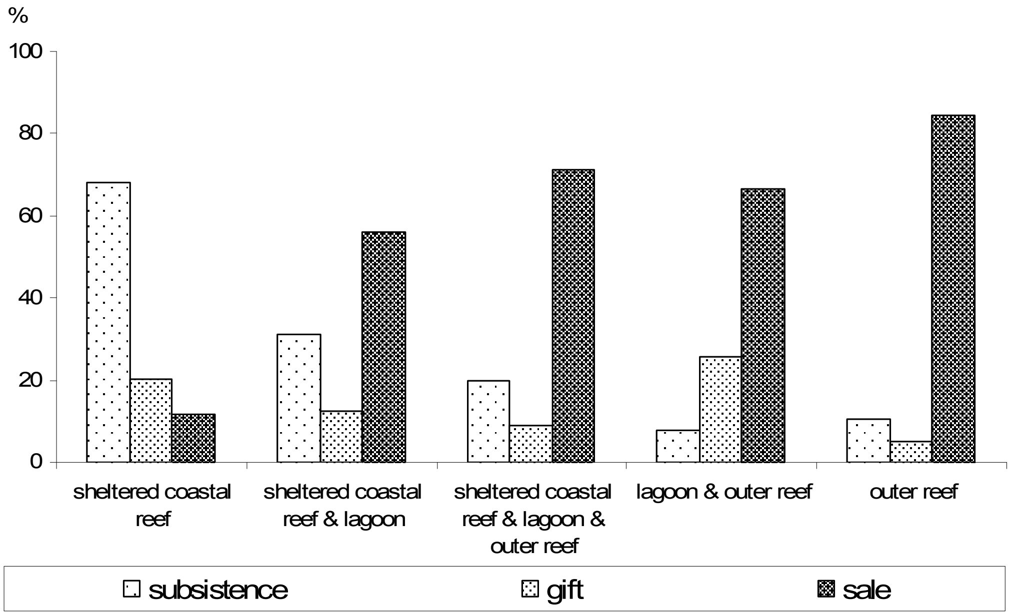

Figure 2.12: The use of finfish catches for subsistence, gift and sale, by habitat in Vailala.
Proportions are expressed in % of the total number of trips per habitat.

Data on the average reported finfish sizes by family and habitat (Figure 2.13) show a great variability in fish sizes by family. Average fish sizes reported for catches at the sheltered coastal reef are around 20 cm fork length, while lagoon and outer reef present average reported fish sizes of about 30 cm fork length. Average fish sizes reported for catches from fishing combined habitats range between both these extremes. A general trend is apparent of smaller sizes for fish from the sheltered coastal reef compared to fish from the outer reef. This trend is particularly visible for the major fish groups, i.e. Acanthuridae, Lethrinidae and Lutjanidae, and also for the less important groups, such as Mugilidae and Mullidae. For Scaridae, the reported average fish sizes at the sheltered coastal reef are significantly smaller than those reported for catch from other habitats. This observation is similar for Carangidae; however, this may be due to habitat preferences rather than fishing impact.

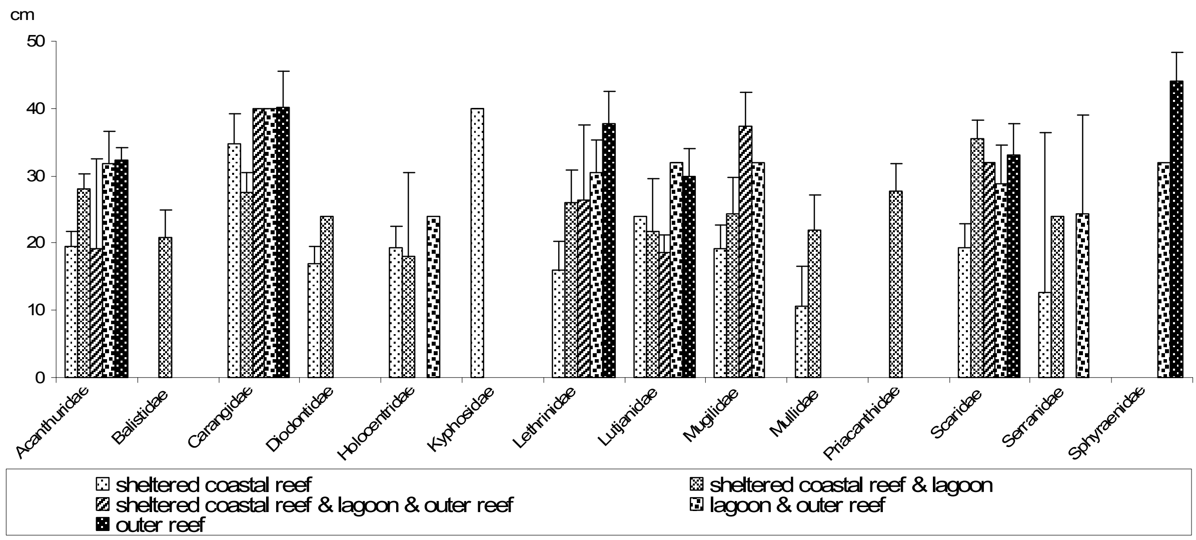

Figure 2.13: Average sizes (cm fork length) of fish caught by family and habitat in Vailala.
Bars represent standard error (+SE).

Some parameters selected to assess the current fishing pressure on Vailala's living reef resources are shown in Table 2.4. Fishing pressure on reef fisheries applies for all three major habitat areas: sheltered coastal reef, lagoon and outer reef. Catch figures for the combined fishing of various habitats in one fishing trip, quite a common practice among Vailala's fishers, cannot be separated per habitat and thus are not included in the assessment of fishing pressure. The habitat surface area for sheltered coastal and outer reef varies considerably, and so does the total reef area, including back-reef and reef areas within the lagoon as compared to the total fishing ground area, which takes into account all lagoon surfaces. Total population and number of fishers are not very high and, taking into account the considerable habitat areas, result in low densities of both fishers and population. Also, fishing pressure determined by the subsistence needs of Vailala's community is very low. However, it should be noted that we have divided the total lagoon system of Wallis into a northern and a southern zone, the northern zone fished by Vailala community and the southern zone fished by Halalo community. Both these communities together, as investigated by PROCFish/C, represent one of the most, if not the most active fishing communities in Wallis, even though the rest of the population is involved in fisheries too. Thus, the general conclusion that the fishing impact estimated for the Vailala community is relatively low, must be seen relative to the total population of ~9780 people as compared to the sample of ~1070 people from Vailala and Halalo only. Thus, bearing in mind that this sample only represents ~7% of the total population, final conclusions on the level of fishing pressure must take into account the results from the underwater resource surveys.

Table 2.4: Parameters used in assessing fishing pressure on finfish resources in Vailala

Parameters	Habitat						
	Sheltered coastal reef	Sheltered coastal reef & lagoon	Sheltered coastal reef & lagoon & outer reef	Lagoon & outer reef	Outer reef	Total reef area	Total fishing ground
Fishing ground area (km^2)	46.77	n/a		47.89	11.58	62.34	106.25
Density of fishers (number of fishers/km^2 fishing ground) (1)	1				1	2	1
Population density (people/km^2) (2)						7	4
Average annual finfish catch (kg/fisher/year) (3)	218.72 (±43.58)	750.87 (±145.85)	1302.86 (±0.00)	1374.67 (±253.91)	738.13 (±297.39)		
Total fishing pressure of subsistence catches (t/km^2)						0.3	0.2

Figures in brackets denote standard error; (1) total number of fishers is extrapolated from household surveys; (2) total population = 420; total number of fishers = 100; total subsistence demand = 20 t/year; (3) catch figures are based on recorded data from survey respondents only.

2.2.1.4 Catch composition and volume – invertebrates: Vailala

Calculations of the reported annual catch rates per species group are shown in Figure 2.14. The graph shows that the major impact by wet weight is mainly due to lobster catches. *Cypraea* and trochus further account for 400–600 kg/year. All other species, including some bêche-de-mer and giant clams, are insignificant (Detailed data are provided in Appendices 2.1.3 and 2.1.5.). Results shown here are extrapolated figures based on our sample size.

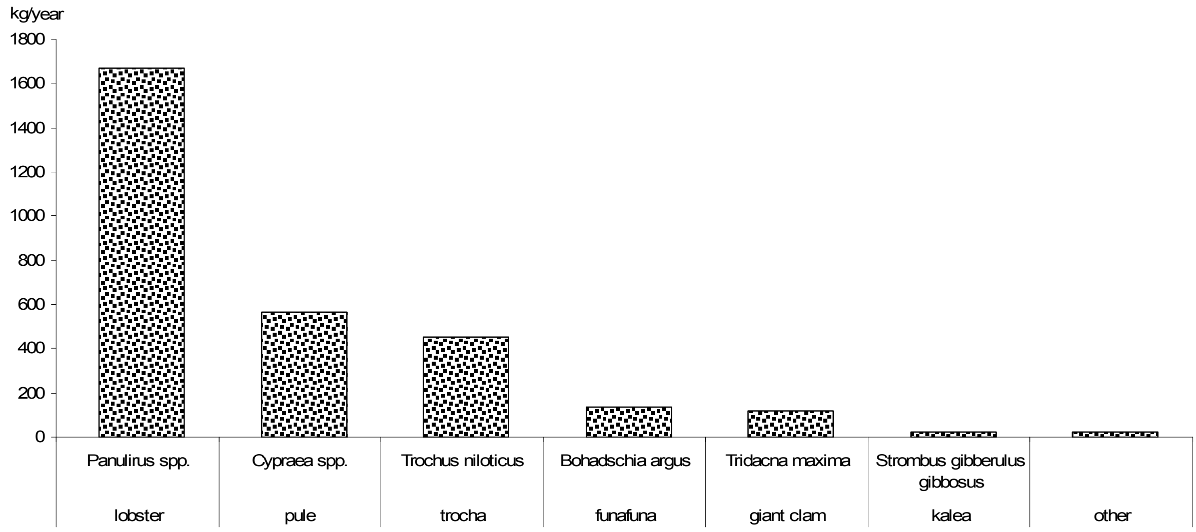

Figure 2.14: Total annual invertebrate catch (kg wet weight/year) by species (reported catch) in Vailala.

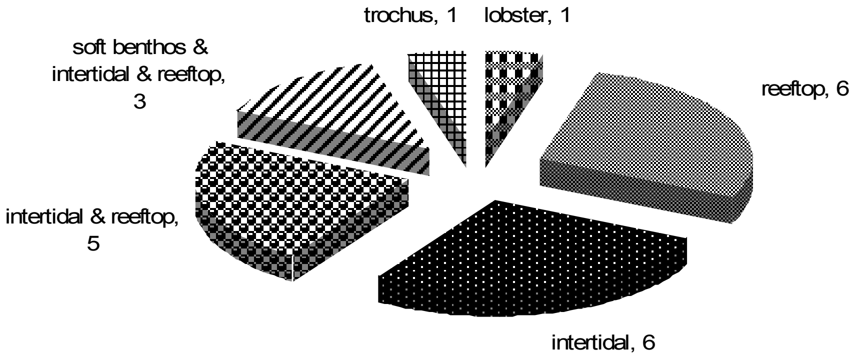

Figure 2.15: Number of vernacular names recorded for each invertebrate fishery in Vailala.

As already stated, invertebrate fisheries are limited and not of great importance for Vailala. Accordingly, the limited biodiversity reported for catches is not surprising. In fact, the highest diversity was for reeftop and intertidal gleaning; six species were distinguished each by different vernacular names. Most of these species include gastropods, giant clams and octopus in the case of reeftop gleaning, and bêche-de-mer and bivalves for collection in intertidal habitats. Because of the degree of specialisation, the number of species is low, e.g. trochus and lobster fisheries were assigned only one vernacular name (Figure 2.15).

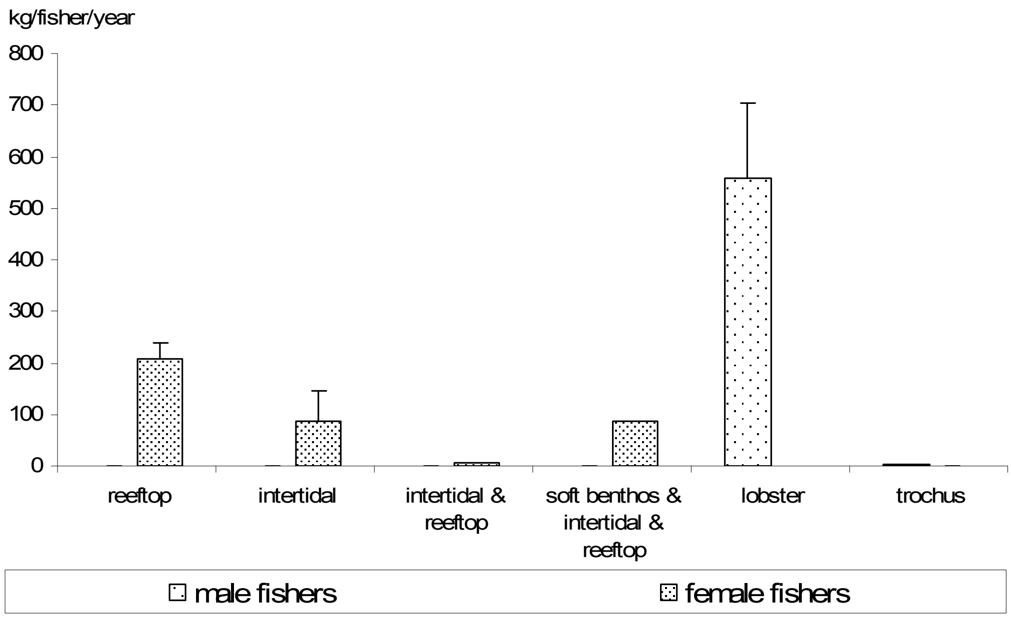

Figure 2.16: Average annual invertebrate catch (kg wet weight/year) by fisher, gender and fishery in Vailala.
Data based on individual fisher surveys. Figures refer to the proportion of all fishers that target each habitat (n = 4 for males, n = 12 for females).

Females from Vailala only participate in gleaning and not in dive fisheries. Thus, Figure 2.16 shows catch data for lobster and trochus fisheries only for male fishers. On the other hand, average annual catches for gleaning are restricted to female fishers only. While participation of males in gleaning is lower, our data should not lead us to conclude that males do not glean at all, it is simply due to the fact that few males were included in gleaning interviews. Catch rates for female fishers vary according to habitat (Figure 2.16). Highest catch rates were reported for reeftop gleaning (~200 kg/fisher/year) and lowest for intertidal collection (<100 kg/fisher/year). Lobster fishers achieve the highest catch rates of ~550 kg/fisher/year.

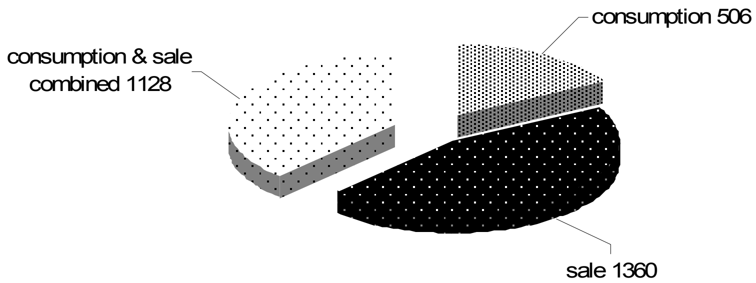

Figure 2.17: Total annual invertebrate biomass (kg wet weight/year) used for consumption, sale, and consumption and sale combined (reported catch) in Vailala.

Similar to finfish fishing, invertebrate fishing is mainly pursued for commercial purposes. The amount caught for sale on Wallis may amount to 64% of the total reported catch if we assume that half of all catches targeted for either subsistence or commercial purposes are sold (Figure 2.17). Taking into account that lobsters are the main commercial target species, most of the impact on Vailala's invertebrate fisheries is determined by commercial rather than subsistence fishing.

The total volume of catch (expressed in wet weight based on recorded data from all respondents interviewed) amounts to ~3 t/year only (Figure 2.18). Catches from lobster fisheries alone determine over half of the total catch (55.8%) followed by catches from reeftop gleaning (21%) and intertidal harvesting (20%). All other invertebrate harvesting activities are insignificant by comparison. Again, data suggest that commercial interests, represented by the lobster catch, account for the main impact on the invertebrate resources.

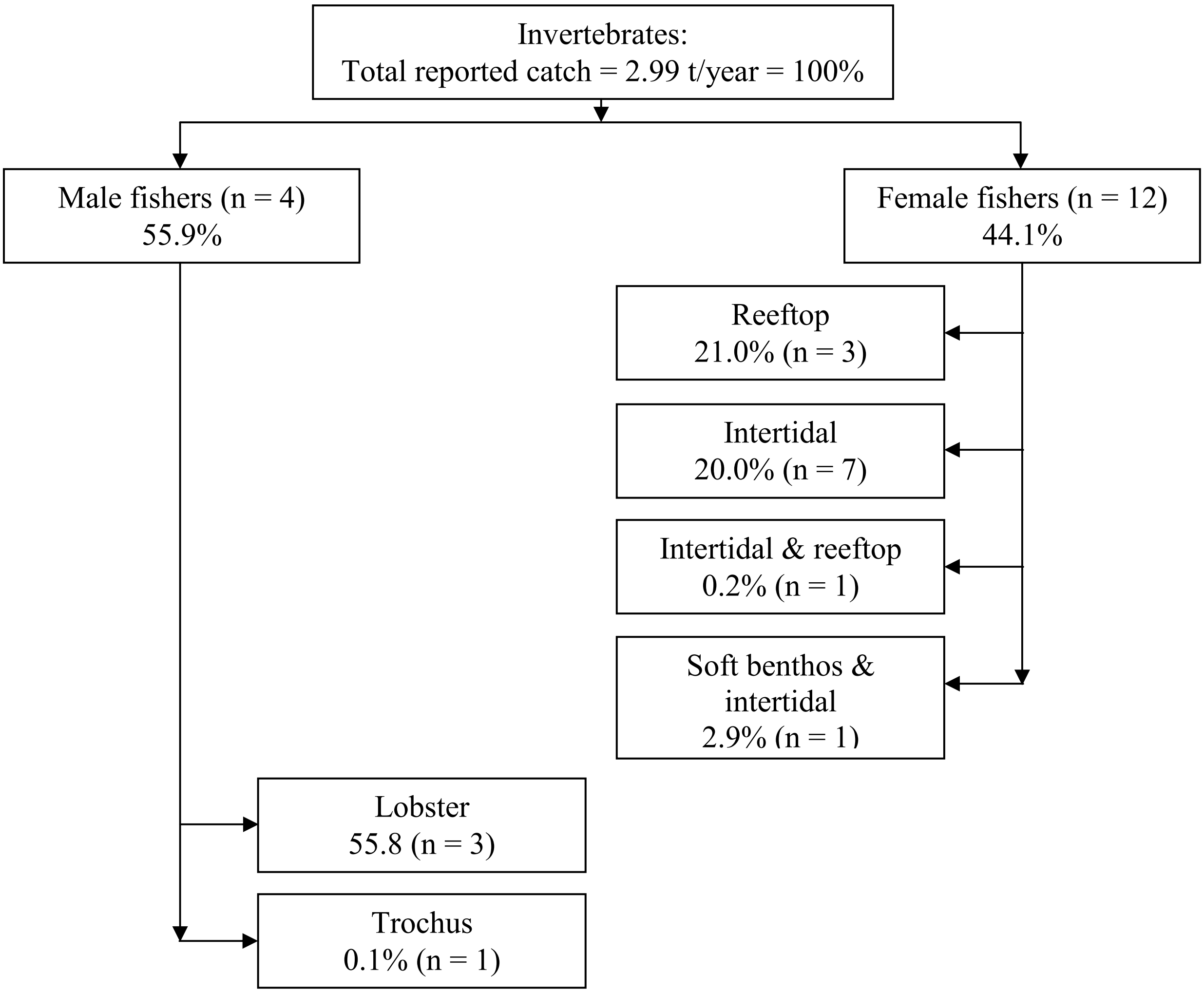

Figure 2.18: Total annual invertebrate catch (tonnes) and proportion (%) by fishery and gender (reported catch) in Vailala.
n is the total number of interviews conducted per each fishery; total number of interviews may exceed total number of fishers surveyed as one fisher may target more than one fishery and thus respond to more than one fishery survey.

The parameters presented in Table 2.5 show that the reef length and reef areas that support two of the main invertebrate fisheries are quite substantial. As is the case for finfish fisheries, it should be noted that only the impact from Vailala's fishers is considered here, while there are many more potential fishers accessing the same fishing grounds if the total population of Wallis is taken into consideration. However, if comparing the available data for Vailala, none of the parameters shown in Table 2.5 suggest any detrimental impact on the invertebrate resources: fisher densities are low, and so are the average catch rates/fisher, and supporting habitat sizes are large.

Table 2.5: Parameters used in assessing fishing pressure on invertebrate resources in Vailala

Parameters	Habitat / Fishery					
	Lobster [(1)]	Reeftop	Intertidal	Intertidal & reeftop	Soft benthos & intertidal & reeftop	Trochus
Fishing ground area (km^2)	18.5	19.5	n/a	n/a	n/a	11.2
Number of fishers (per fishery) [(2)]	13	8	19	3	3	4
Density of fishers (number of fishers/km^2 fishing ground)	0.7	0.4				0.4
Average annual invertebrate catch (kg/fisher/year) [(3)]	556.98 (±145.51)	209.10 (±28.47)	85.51 (±59.60)	7.32 (n/a)	87.66 (n/a)	2.00 (n/a)

Figures in brackets denote standard error; n/a: no information available or standard error not calculated; [(1)] linear measure in km; [(2)] total number of fishers is extrapolated from household surveys; [(3)] catch figures are based on recorded data from survey respondents only.

2.2.1.5 Discussion and conclusions: socioeconomics in Vailala

- Fisheries are quite an important sector for income generation in Vailala. About 40% of all households reported that they were financially dependent upon fisheries, ~19% as their first income source and ~22% as their second income source. While agriculture is less important, overall, salaries provide the first income for most of Vailala households.

- Almost all households consume fresh fish but only 35% regularly consume invertebrates. The per capita consumption of fresh fish is above the regional average but below the average consumption calculated across all PROCFish/C sites investigated on Futuna and Wallis. Invertebrate consumption is low and reaches only 0.6 kg/person/year.

- The average household expenditure level is not of particular note, other than to mention that people in Vailala spend on average a bit more than communities in the other survey sites in Wallis and Futuna, and benefit the most from remittances.

- Both men and women fish for finfish, but men are the only commercial fishers, while only women focus on subsistence fishing for finfish and invertebrates. This conclusion shows in the fact that only male fishers exclusively fish for finfish, while most of the female fishers target both finfish and invertebrates. Women collect shells for handicrafts or for subsistence purposes on reeftops, intertidal areas and from soft-benthos habitats. Men, however, exclusively target invertebrate species that require diving, such as trochus and lobsters. Differences in the objectives for fishing also show in the habitats targeted. Female finfish fishers only target the sheltered coastal reef. Male fishers target a combination of sheltered coastal reef, lagoon and/or outer reef in order to maximise catch according to the highly variable local weather and sea conditions. Finfish fishing at the sheltered coastal reef is usually done by walking, while all other fishing activities include motorised boat transport. Similarly, gleaning activities only require motorised boat transport if the collection takes place at one of the outer *motu* (small coral islands). In the case of trochus and lobster fisheries, however, male fishers always use motorised boat transport to go out to the outer reef.

- Various fishing techniques are used for finfish, mainly gillnets and, to some extent, spear diving, or a combination of both. A greater variety of techniques are used for fishing the outer reefs, including gillnetting, handlining, spear diving, trolling and longlining.

- Fishing pressure is highest on the sheltered coastal reef and lagoon area, where most of the reported annual catch is taken. However, impact is mainly due to the number of fishers rather than the productivity. Catch data showed that average annual catches range between 200 and 700 kg/fisher/year only. If the lagoon and outer-reef areas are jointly fished, average annual catch rates reach ~1300 kg/fisher/year on average and CPUEs are also highest.

- Taking into consideration the large surface areas of all habitats, total reef and total fishing ground area, the reported and extrapolated catch from the Vailala community at present does not indicate any alarming degree of impact on the resources. However, it should be borne in mind that Wallis enjoys an open-access fishing system and that we have only surveyed one major fishing community located in the northern part of the country's lagoon system. Thus, the total impact imposed by the entire population that may target this northern fishing area of Wallis may be much higher.

- Invertebrate fisheries mainly serve commercial rather than subsistence needs. However, total catch (expressed in wet weight) amounts to only ~3 t/year. Lobster catches alone determine over half of this reported annual impact, followed by catches from reeftop gleaning and intertidal harvesting.

- Considering the extensive reef length and reef areas that support all the reported fisheries in the northern part of the country's lagoon system, the current impact by the Vailala community on invertebrate resources is low; no detrimental effects are evident.

Survey results suggest two major conclusions. Firstly, current pressure on finfish and invertebrate resources on the northern lagoon system of Wallis (as estimated from catch data reported by the Vailala community only) is low. Secondly, if we take into account the overall economic and political situation on Wallis, it is likely that fisheries will continue to be important, both as a source of revenue and as one of the most important sources of protein and nutrition. As reported by Vailala fishers, fishing for both finfish and invertebrate collection is mainly for sale (mostly outside the community), and both fisheries are important sources of revenue for about 40% of all households surveyed. Although current fishing pressure appears low relative to the size of the reef and lagoon area available to the northern part of the country, actual fishing pressure may be much higher if the total population is taken into account. In this regard, the fishing pressure for the whole country is estimated in Section 2.2.3, by combining data from both sites investigated on Wallis, i.e. Vailala and Halalo, and extrapolating this to the national level.

2.2.2 Halalo

In total 29 households were surveyed that included 178 people, representing 27% of the total number of households (106) and population (661) in the community. Household interviews aimed to collect general demographic, socioeconomic and consumption parameters. A total of 24 individual interviews of finfish fishers (19 males, 5 females) and 22 invertebrate fishers (6 males, 16 females) were conducted. These fishers belonged to one of the 29 households surveyed. Sometimes, the same person was interviewed for both finfish and invertebrate fishing.

2.2.2.1 The role of fisheries in the Halalo community: fishery demographics, income and seafood consumption patterns

Our survey results (Table 2.6) suggest an average of 1.9 fishers/household. If we apply this average to the total number of households, we arrive at a total of 201 fishers in Halalo. Applying our household survey data concerning the type of fishers (finfish fisher, invertebrate fisher) by gender, we can project a total of 91 fishers who only fish for finfish (91 males, 0 female), a total of 48 fishers who only fish for invertebrates (48 females, 0 male) and 26 male and 37 female fishers who fish for both finfish and invertebrates.

Almost half (48%) of all households in Halalo own a boat; most (93%) boats are equipped with an outboard engine and only 7% of all boats are non-motorised.

Ranked income sources (Figure 2.19) suggest that fisheries is quite an important sector, providing >70% of all households either with first (~38%) or second income (~35%). Agriculture is of very low importance by comparison; only 9% of all households depend on agriculture for first income. However, 45% of all households reported salaries as first income source, and 14% and 35% respectively sourced cash from retirement payments or handicrafts as first and second income. In summary, fisheries and salaries are most important for first income, and fisheries and others (social fees, handicrafts) are also important as second income sources. The average annual household expenditure level is low (~8800 USD/year), suggesting that people in Halalo spend much less than the average across all sites investigated in Wallis and Futuna.

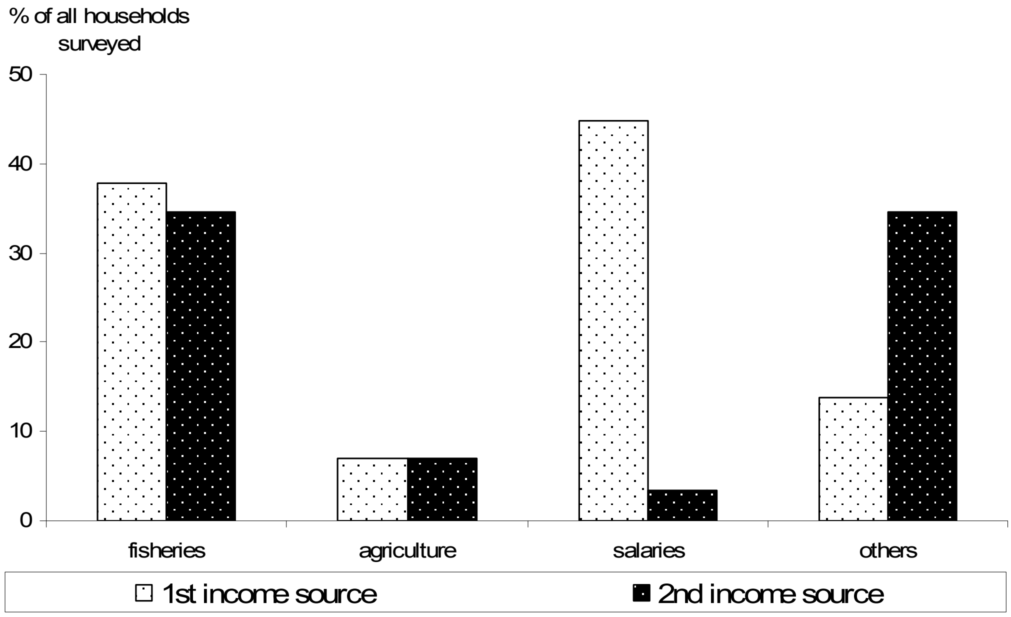

Figure 2.19: Ranked sources of income (%) in Halalo.
Total number of households = 29 = 100%. Some households have more than one income source and those may be of equal importance; thus double quotations for 1st and 2nd incomes are possible.
'Others' are mostly retirement payments and sales of handicraft.

The importance of fisheries also shows in the fact that all households reported eating fresh fish and most also invertebrates (~83%). The fish that is consumed is mostly caught by a member of the household (93%), rarely bought (14%), but often received as a gift (66%). The proportion of invertebrates caught by a member of the household where it is eaten is still high

(83%). However, invertebrates were never bought and rarely received as a gift (14%). These results suggest that finfish and presumably also invertebrates are an important food source for the Halalo community, and that most of the catch that is marketed is sold outside the community.

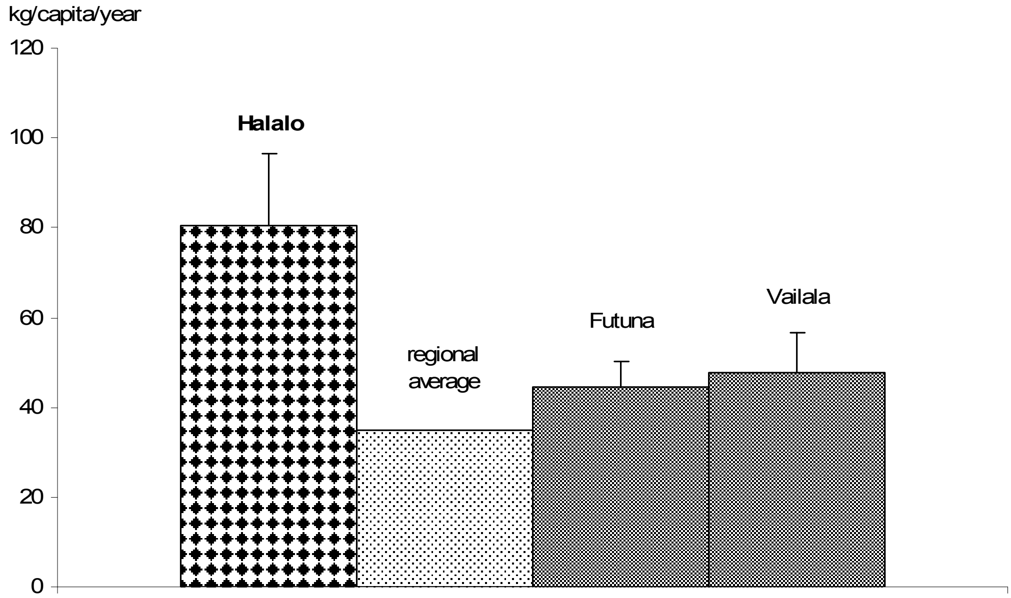

Figure 2.20: Per capita consumption (kg/year) of fresh fish in Halalo (n = 29) compared to the regional average (FAO 2008) and the other two PROCFish/C sites Vailala and Futuna.
Figures are averages from all households interviewed, and take into account age, gender and non-edible parts of fish. Bars represent standard error (+SE).

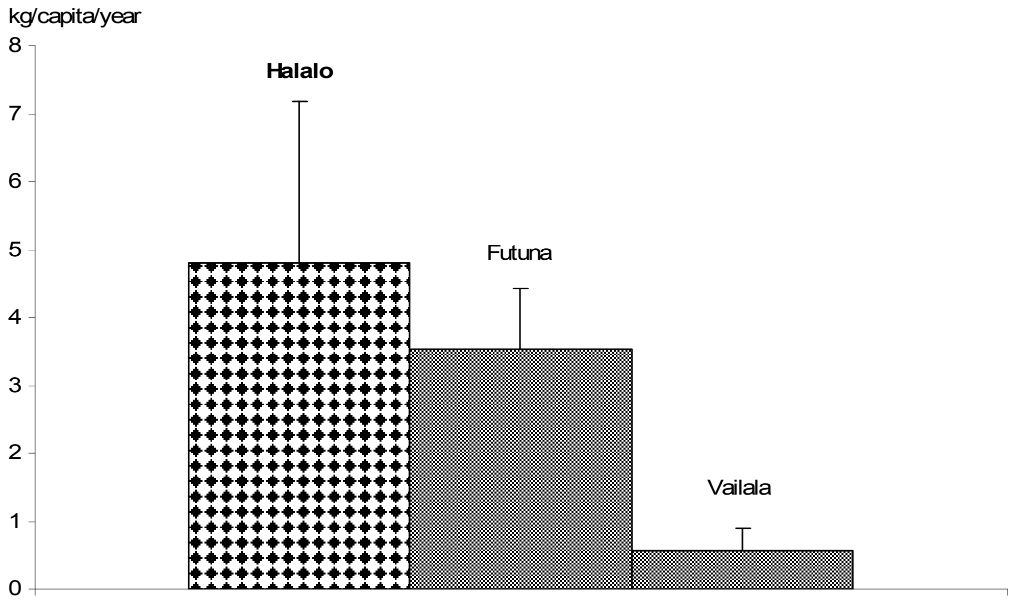

Figure 2.21: Per capita consumption (kg/year) of invertebrates (meat only) in Halalo (n = 29) compared to the other the two PROCFish/C sites Vailala and Futuna.
Figures are averages from all households interviewed, and take into account age, gender and non-edible parts of invertebrates. Bars represent standard error (+SE).

The per capita consumption of fresh fish (80.5 kg/capita/year ±16.12) in Halalo is not only above the regional average (FAO 2008) (Figure 2.20), but also the highest of all sites surveyed in Wallis and Futuna. The per capita consumption of invertebrates (meat only) is 4.8 kg/capita/year (Figure 2.21) and insignificant if compared to finfish, but again the highest compared to all other PROCFish/C sites surveyed in the country. More than half of the people (55%) reported eating canned fish on average about once a fortnight; however, the per capita canned fish consumption is very low (3.3 kg/capita/year). This trend seems to apply for all sites surveyed. In fact, data collected suggest that people on Wallis and Futuna prefer other alternatives, probably meat and fresh seafood rather than canned fish (Table 2.6).

Table 2.6: Fishery demography, income and seafood consumption patterns in Halalo

Survey coverage	Site (n = 29 HH)	Average across sites (n = 137 HH)
Demography		
HH involved in reef fisheries (%)	96.6	87.6
Number of fishers per HH	1.90 (±0.19)	1.47 (±0.09)
Male finfish fishers per HH (%)	45.5	40.6
Female finfish fishers per HH (%)	0.0	8.4
Male invertebrate fishers per HH (%)	0.0	1.5
Female invertebrate fishers per HH (%)	23.6	16.3
Male finfish and invertebrate fishers per HH (%)	12.7	13.4
Female finfish and invertebrate fishers per HH (%)	18.2	19.8
Income		
HH with fisheries as 1st income (%)	37.9	16.1
HH with fisheries as 2nd income (%)	34.5	19.7
HH with agriculture as 1st income (%)	6.9	5.8
HH with agriculture as 2nd income (%)	6.9	18.2
HH with salary as 1st income (%)	44.8	46.7
HH with salary as 2nd income (%)	3.4	4.4
HH with other source as 1st income (%)	13.8	32.1
HH with other source as 2nd income (%)	34.5	32.8
Expenditure (USD/year/HH)	8783.55 (±1016.77)	10,991.98 (±847.25)
Remittance (USD/year/HH) (1)	872.36 (±109.63)	1738.04 (±330.62)
Consumption		
Quantity fresh fish consumed (kg/capita/year)	80.50 (±16.12)	52.99 (±5.13)
Frequency fresh fish consumed (times/week)	4.51 (±0.32)	3.44 (±0.16)
Quantity fresh invertebrate consumed (kg/capita/year)	4.80 (±2.37)	3.11 (±5.13)
Frequency fresh invertebrate consumed (times/week)	0.87 (±0.18)	0.45 (±0.07)
Quantity canned fish consumed (kg/capita/year)	3.31 (±1.10)	1.68 (±0.39)
Frequency canned fish consumed (times/week)	0.55 (±0.13)	1.19 (±0.10)
HH eat fresh fish (%)	100.0	99.3
HH eat invertebrates (%)	82.8	48.9
HH eat canned fish (%)	55.2	79.6
HH eat fresh fish they catch (%)	93.1	77.6
HH eat fresh fish they buy (%)	13.8	40.8
HH eat fresh fish they are given (%)	65.5	76.3
HH eat fresh invertebrates they catch (%)	82.8	36.8
HH eat fresh invertebrates they buy (%)	0.0	1.3
HH eat fresh invertebrates they are given (%)	13.8	7.9

HH = household; (1) average sum for households that receive remittances; numbers in brackets are standard error.

Comparing results among all sites investigated on Wallis and Futuna (Table 2.6), people in Halalo are the most dependent on fisheries for income generation, eat the most fresh fish and invertebrates and, except for canned fish, also eat fresh seafood the most frequently. Nevertheless, there is no significant difference between Halalo and the average of all sites concerning the number of fishers per household and access to boat transport. People in Halalo spend less on basic living and receive less from remittances.

2.2.2.2 Fishing strategies and gear: Halalo

Degree of specialisation in fishing

Fishing in Halalo is performed by both gender groups (Figure 2.22) but only males exclusively target finfish and, therefore, most commercial fishers are males. Only females, on the other hand, exclusively harvest invertebrates. The small group of fishers who target both finfish and invertebrates contains only ~13% of male fishers and ~18% of female fishers. The smaller share of invertebrate fishers suggests that invertebrate fisheries are less important than finfish fisheries.

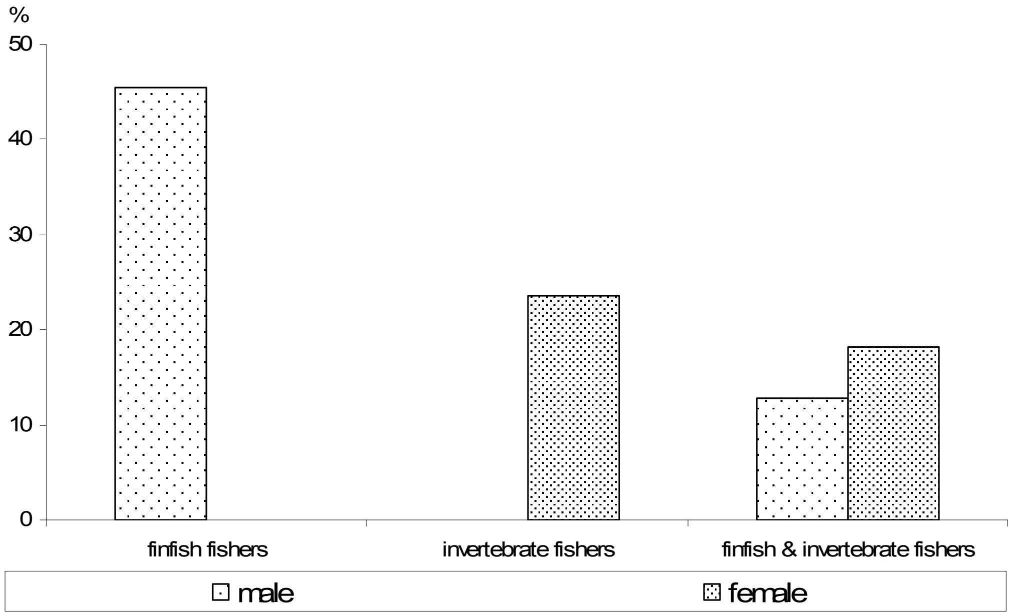

Figure 2.22: Proportion (%) of fishers who target finfish or invertebrates exclusively, and those who target both finfish and invertebrates in Halalo.
All fishers = 100%.

Targeted stocks/habitat

Table 2.7: Proportion of interviewed finfish fishers and invertebrate fishers harvesting the various finfish and invertebrate stocks across a range of habitats in Halalo

Resource	Habitat / Fishery	% of male fishers interviewed	% of female fishers interviewed
Finfish	Lagoon	84.2	100.0
	Passage	57.9	0.0
Invertebrates	Other	16.7	0.0
	Reeftop	0.0	18.8
	Intertidal (sand)	66.7	87.5
	Intertidal (sand) & reeftop	0.0	6.3
	Trochus	16.7	0.0

'Other' refers to the giant clam and octopus fisheries.
Finfish fisher interviews, males: n = 19; females: n = 5. Invertebrate fisher interviews, males: n = 6; females, n = 16.

The smaller proportion of females participating in fishing suggests that they are mainly focusing on subsistence needs, which is also supported by Table 2.7, which shows that female finfish fishers only target the lagoon area. Although most males also target the lagoon, 58% also fish in the passage that faces Halalo village. Male invertebrate fishers target mainly the intertidal areas for gleaning (67%), collecting trochus (17%) or diving for other species, such as giant clams and octopus (17%). Females collect invertebrates mainly in intertidal areas (sandy zones, 88%) and much less on reeftops (19%). In fact, invertebrate collection among Halalo fishers is specialised; only rarely (6%) do females combine two habitats, i.e. reeftops and intertidal areas (sand) in one fishing trip.

Fishing patterns and strategies

The combined information on the number of fishers, the frequency of fishing trips and the average catch/fishing trip are the basic factors used to estimate the fishing pressure imposed by people from Vailala on their fishing grounds (Tables 2.7 and 2.8).

Our survey sample suggests that, while fishers in Halalo have a choice among coastal reef, lagoon and outer reef, they only target the lagoon, with its coral areas, and the passage. The back- and outer reef represent the main habitat for fishers diving for trochus, giant clams and octopus (Figure 2.19). However, males and females collecting shells and other invertebrates walk along the beach, targeting sandy areas, seagrass and, more rarely, reeftop patches. Regarding all invertebrate fishers in Halalo, most target the intertidal areas and least fish for trochus or other species, including giant clams and octopus. Also, reeftop gleaning is rare (Figure 2.23). Gender participation shows that more females fish for invertebrates but they do not engage in any of the dive fisheries (Figure 2.24).

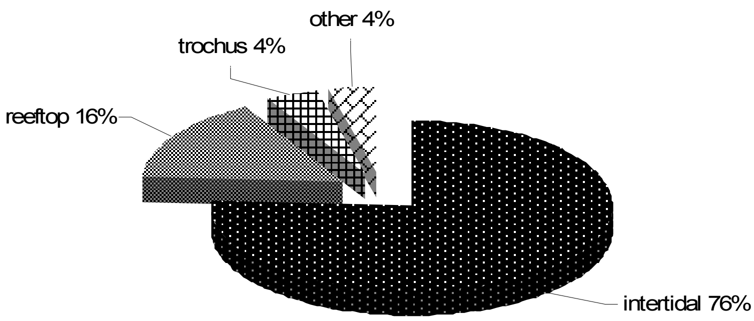

Figure 2.23: Proportion (%) of fishers targeting the four primary invertebrate habitats found in Halalo.
Data based on individual fisher surveys; data for combined fisheries are disaggregated. 'Other' refers to the giant clam and octopus fisheries.

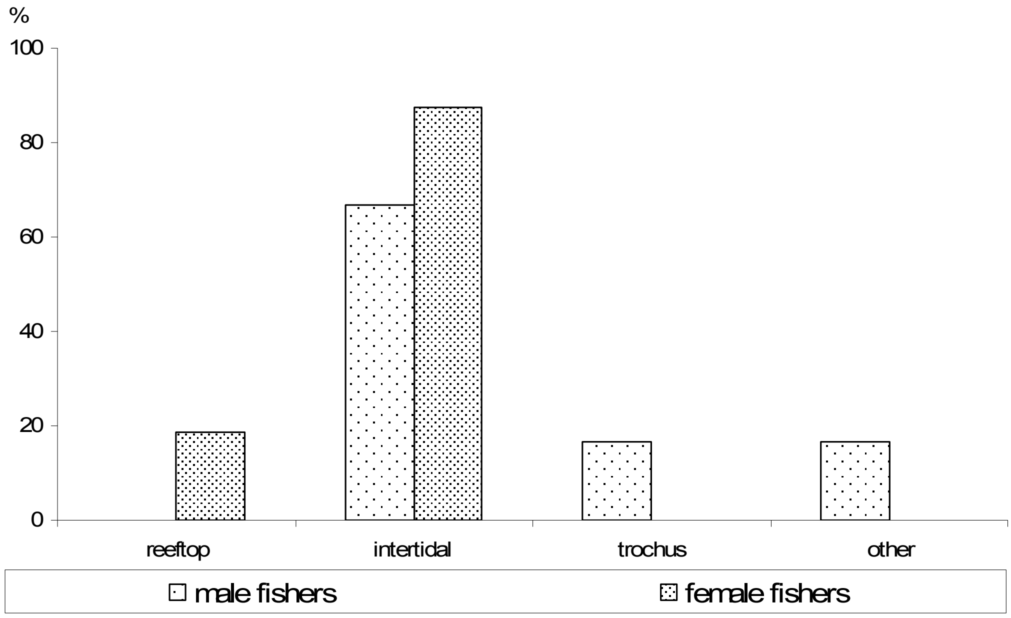

Figure 2.24: Proportion (%) of male and female fishers targeting various invertebrate habitats in Halalo.
Data based on individual fisher surveys; data for combined fisheries are disaggregated; fishers commonly target more than one habitat; figures refer to the proportion of all fishers that target each habitat: n = 6 for males, n = 16 for females; 'other' refers to the giant clam and octopus fisheries.

Gear

Figure 2.25 shows that fishers in Halalo use a wide range of techniques to catch fish. However, data suggests that more fishing techniques are used to fish the lagoon area. Here, gillnets, handlines, spear diving and combinations of these are common. If fishers target the passages, they mainly use handlines; very little spear diving or gillnetting is done. Finfish in the lagoon area are either fished while walking (59% of respondents reported never using boat transport.) or by motorised boat transport (32%, or 41% if also considering the 9% of all fishers who sometimes use motorised boat transport). All passage fishing relies on motorised boat transport.

Gleaning and free-diving for invertebrates are done using very simple tools only. Intertidal gleaning is usually done by walking during the day to pick up shells for artisanal work or during the night with torches, baskets and knives to collect edible gastropods or other species. Trochus, giant clams and octopus are picked up by hand, with mask, snorkel and fins used for apnoea diving, and perhaps using a knife or speargun at times to harvest giant clams or octopus. Diving for trochus or other species is done using motorised boat transport. Motorised boats are also used for some reeftop gleaning if habitats further from shore are targeted. However, most gleaning of intertidal (sandy) areas and also reeftops is done by walking.

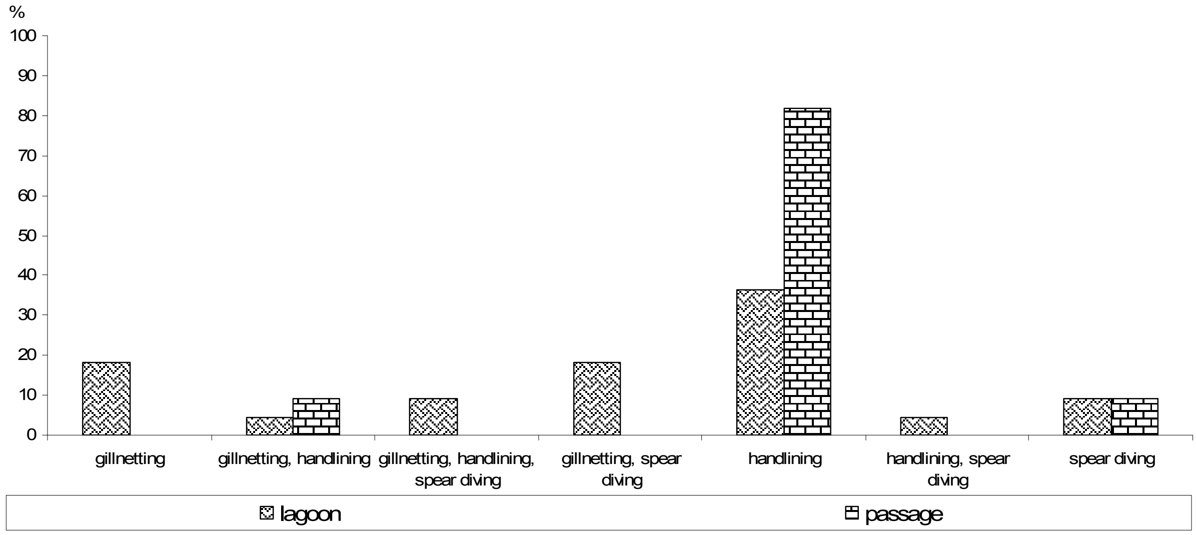

Figure 2.25: Fishing methods commonly used in different habitat types in Halalo.
Proportions are expressed in % of total number of trips to each habitat. One fisher may use more than one technique per habitat and target more than one habitat in one trip.

Frequency and duration of fishing trips

As shown in Table 2.8 the frequency of fishing trips varies considerably according to the habitat targeted. While males fish on average 2.5 times/week in the lagoon, fishing trips to the passage are less frequent (1.5 times/week). Similarly, female fishers go out on average almost twice a week. Invertebrate fishing trips are generally less frequent, and gleaning intertidal areas is done 1–1.5 times/week. Reeftop gleaning occurs much less often, about once a month, while males diving for trochus or other species do so about once every week. Trip durations vary between males and females. Females' fishing trips in the lagoon are short (2.5 hours/trip) on average, while males spend more than double that time. If targeting passages, the average fishing trip takes six hours. Gleaning, which takes on average 3–3.5 hours/trip, is not as time consuming as diving for trochus, which takes 6–7 hours.

There is a strong preference for females to fish during the day in the lagoon, while males either prefer night fishing or fish according to tidal conditions. Males targeting the passages do so only at night. For invertebrates, all activities, regardless whether done by males or females, or if gleaning or diving, were all reported to be done only during the day. In Halalo, fishing for both finfish and invertebrates takes place throughout the year.

Table 2.8: Average frequency and duration of fishing trips reported by male and female fishers in Halalo

Resource	Habitat / Fishery	Trip frequency (trips/week)		Trip duration (trips/hour)	
		Male fishers	Female fishers	Male fishers	Female fishers
Finfish	Lagoon	2.29 (±0.30)	1.65 (±0.45)	5.24 (±0.63)	2.50 (±0.50)
	Passage	1.31 (±0.27)	0	6.09 (±0.79)	0
Invertebrates	Other	1.00 (n/a)	0	3.00 (n/a)	0
	Reeftop	0	0.35 (±0.33)	0	3.67 (±1.20)
	Intertidal (sand)	1.56 (±0.55)	0.82 (±0.19)	3.50 (±1.19)	3.05 (±0.27)
	Intertidal (sand) & reeftop	0	2.50 (n/a)	0	5.00 (n/a)
	Trochus	1.00 (n/a)	0	6.50 (n/a)	0

Figures in brackets denote standard error; n/a = standard error not calculated; ‘other’ refers to the giant clam and octopus fisheries.
Finfish fisher interviews, males: n = 19; females: n = 6. Invertebrate fisher interviews, males: n = 5; females: n = 16.

2.2.2.3 Catch composition and volume – finfish: Halalo

Catches from the sheltered coastal reef include a great variety of fish species and species groups, with Lethrinidae alone determining over 20% of the reported catch. Carangidae, Lutjanidae and Acanthuridae each make up another 17–18% and Scaridae contribute 7% to the total reported catch. For catches reported from passage fishing, Lethrinidae still contribute the lion’s share (~29%); however, barracuda and Carangidae are more important, each providing about 16% of the reported catch. Lutjanidae (11%) and Acanthuridae are of minor importance; Scaridae were not reported at all (Detailed data are provided in Appendix 2.1.2.).

Our survey sample of finfish fishers interviewed represents about 16% of the projected total number of finfish fishers in Halalo. The survey included all kinds of fishers, i.e. those who mainly fish for subsistence and those who have a strong commercial interest in fishing. Hence we have extrapolated our results to estimate the total annual fishing pressure imposed by the people of Halalo. However, the impact by Halalo fishers is not the only fishing pressure imposed on the fishing ground. Wallis enjoys an open access-system and hence any of its people may fish wherever they want. However, our figure may provide some indication of the current scale of fishing activities on the lagoon system of Wallis.

As shown in Figure 2.26 the major share (>64%) of impact is due to the subsistence demand of the Halalo community, and catch for sale elsewhere accounts for only 36%. Most of the catch is sourced from the lagoon system (>66% of the total catch) and much less from passages (~34%). Females’ participation is almost insignificant. Thus, we can assume that while females mainly fish for subsistence, males are responsible for providing both the major share of fish needed to satisfy the demand of their own families and friends for food, and for income.

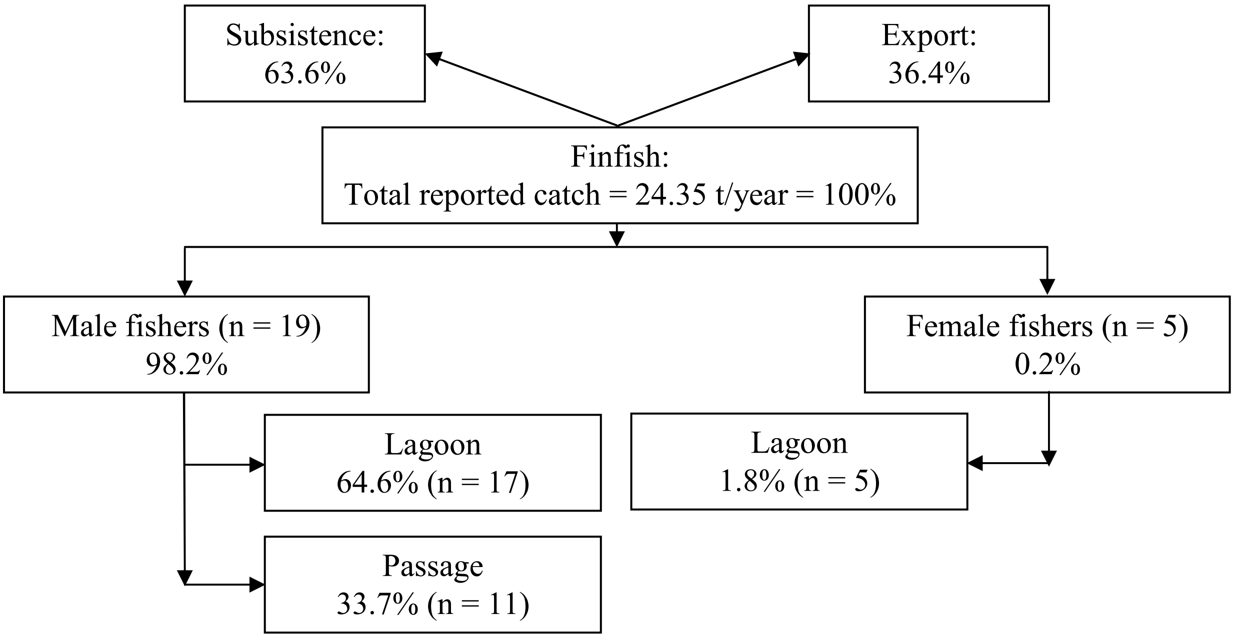

Figure 2.26: Total annual finfish catch (tonnes) and proportion (%) by fishery and gender (reported catch) in Halalo.
n is the total number of interviews conducted per each fishery; total number of interviews may exceed total number of fishers surveyed as one fisher may target more than one fishery and thus respond to more than one fishery survey.

The high impact on the lagoon system is a function of the number of fishers targeting this habitat rather than the average annual catch rate. As shown in Figure 2.27, average catches range between 700 and 900 kg/year/fisher with a slightly lower average figure for passage fishing. Female fishers have an almost insignificant catch, i.e. about 100 kg/fisher/year. These data support the earlier suggestion that female finfish fishers mainly catch for subsistence and not commercial purposes.

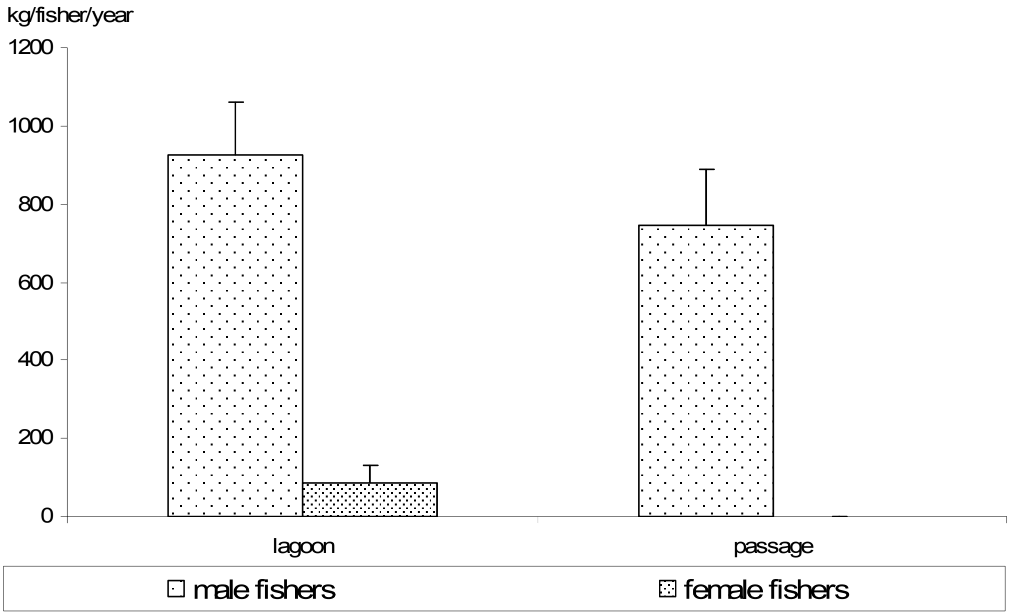

Figure 2.27: Average annual catch (kg/year, +SE) per fisher by gender and habitat in Halalo (based on reported catch only).

The argument that catches between fishers targeting the lagoon and the passages do not vary much is supported when the CPUE data shown in Figure 2.28 is compared. However, highest CPUE is reached for passage fishing, i.e. about 3 kg/hour fished at the passages as compared to 2.5 kg/hour fished in the lagoon. The difference may imply that the general status of fish in passages is a bit better, and/or that the influx of larger fish into the passages is much higher than into the lagoon system. Considering that passages attract both lagoon and pelagic fish, a fact that also shows in the reported catch composition, higher CPUE figures may be due to a higher weight per specimen caught in passages. The average CPUE of females fishing in the lagoon is very low and does not reach half a kg/hour spent fishing.

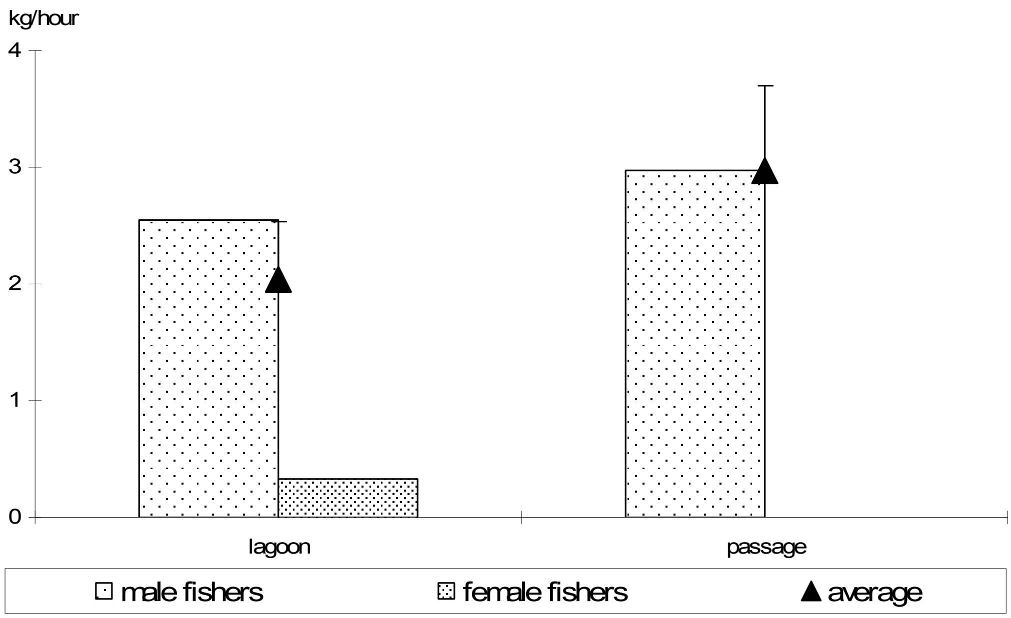

Figure 2.28: Catch per unit effort (kg/hour of total fishing trip) for male and female fishers by habitat in Halalo.
Effort includes time spent in transporting, fishing and landing catch. Bars represent standard error (+SE).

Figure 2.29 shows the proportions of catch taken for subsistence and commercial fishing and gift according to habitat. The share of the catch taken by fishers who are fishing commercially does not vary between the two major habitats targeted. Also, the almost equal shares of the catch taken for subsistence and sharing with others (as gifts) reflects the continued traditional lifestyle of the Halalo community.

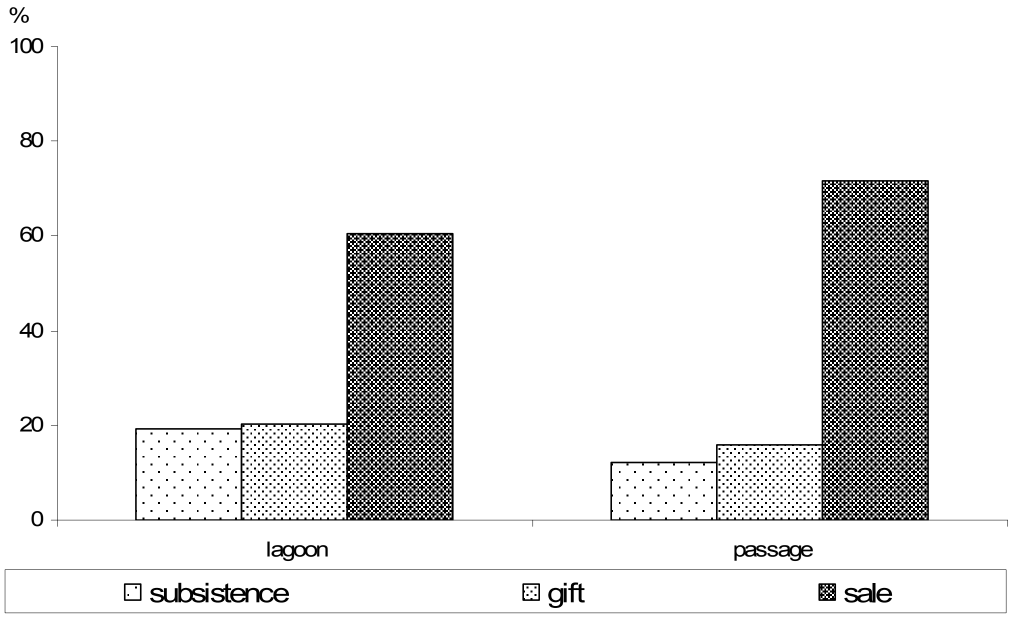

Figure 2.29: The use of finfish catches for subsistence, gift and sale, by habitat in Halalo.
Proportions are expressed in % of the total number of trips per habitat.

In addition to the normal catches presented here, intensive group fishing is also sometimes conducted. The entire community may engage in fishing, preparing meals or marketing for the purpose of feasts, fund-raising, or similar activities, which may occur a few times each year.

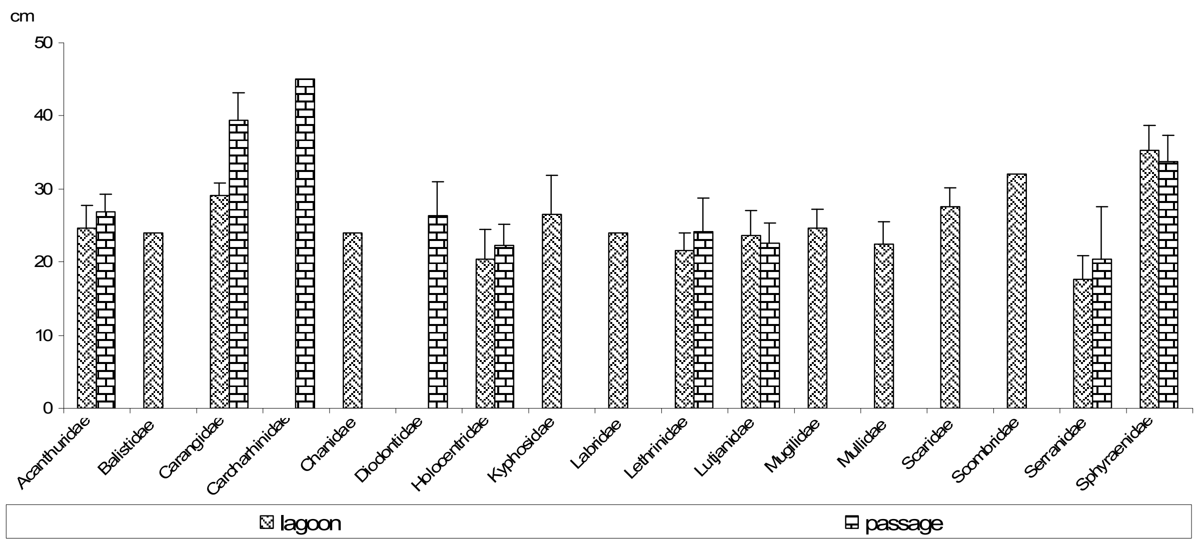

Figure 2.30: Average sizes (cm fork length) of fish caught by family and habitat in Halalo.
Bars represent standard error (+SE).

Data on the average reported finfish sizes by family and habitat as shown in Figure 2.30 suggest that sizes do not vary between habitats or among families. The only exceptions are Carangidae, which are reported to be much larger in catches from the passages than in those from the lagoon. Most average lengths reported for both lagoon and passage catches range around 20–25 cm, with a few families reaching 30 and up to 40 cm. The few variations in the reported average fish size do not permit any conclusions to be drawn concerning possible signs of past or present fishing impact.

Some parameters selected to assess the current fishing pressure on Halalo's living reef resources are shown in Table 2.9. Fishing pressure on reef fisheries applies for the lagoon area only as the catchments for passage fishing are rather impossible to determine. We have, however, further compared the total available reef and the total available fishing ground areas. Overall, if calculating Halalo's fishing data on the southern Wallis lagoon area only, all factors are low, including fisher density, population density and fishing pressure imposed by the subsistence needs of the Halalo community only. However, as said earlier, we have divided the total lagoon system of Wallis into a northern and a southern zone. We have then dedicated the northern zone as impacted by the Vailala community and the southern zone as impacted by the community of Halalo. Both these communities together as investigated by PROCFish/C, represent one of the most, if not the most active fishing communities in Wallis, but the remaining population of Wallis is also involved in fishing. Thus, the general conclusion that the fishing impact estimated for the Halalo community is relatively low must be seen relative to the total population of ~9780 people as compared to the sample of ~1070 people from Vailala and Halalo only. Thus, bearing in mind that this sample only represents ~7% of the total population of Wallis, final conclusions on the level of fishing pressure must take into account the fact that pressure could potentially be much higher and also the results from the underwater resource surveys.

Table 2.9: Parameters used in assessing fishing pressure on finfish resources in Halalo

Parameters	Habitat					
	Sheltered coastal reef	Lagoon	Outer reef	Passage	Total reef area	Total fishing ground [(1)]
Fishing ground area (km^2)	25.04	77.85	10.97	0.23	47.36	114.09
Density of fishers (number of fishers/km^2 fishing ground)		1		198	3	1
Population density (people/km^2)					14	6
Average annual finfish catch (kg/fisher/year)		733.60 (±131.16)		744.15 (±144.33)		
Total fishing pressure of subsistence catches (t/km^2)					0.81	0.34

Figures in brackets denote standard error; n/a: no information available; [(1)] total reef area and fishing ground include outer reef = 10.973 km^2; total population = 651; total number of fishers = 154. Catch figures are based on recorded data from survey respondents only. Total number of fishers is extrapolated from household surveys. Total subsistence demand = 38.23 t/year.

2.2.2.4 Catch composition and volume – invertebrates: Halalo

Calculations of the reported annual catch rates per species groups are shown in Figure 2.31. The graph shows that the major impact by wet weight is mainly due to trochus harvesting. *Scylla serrata* is the only other target species that shows any noticeable impact; however, this species contributes less than 600 kg/year to the total reported catch as compared to trochus catches, which were reported to be over 1.5 t/year. All other species, including some giant clams, *Cardisoma* spp., *Anadara* spp. and octopus, are insignificant (Detailed data are provided in Appendices 2.1.4 and 2.1.6.). Results shown here are extrapolated figures based on our sample size.

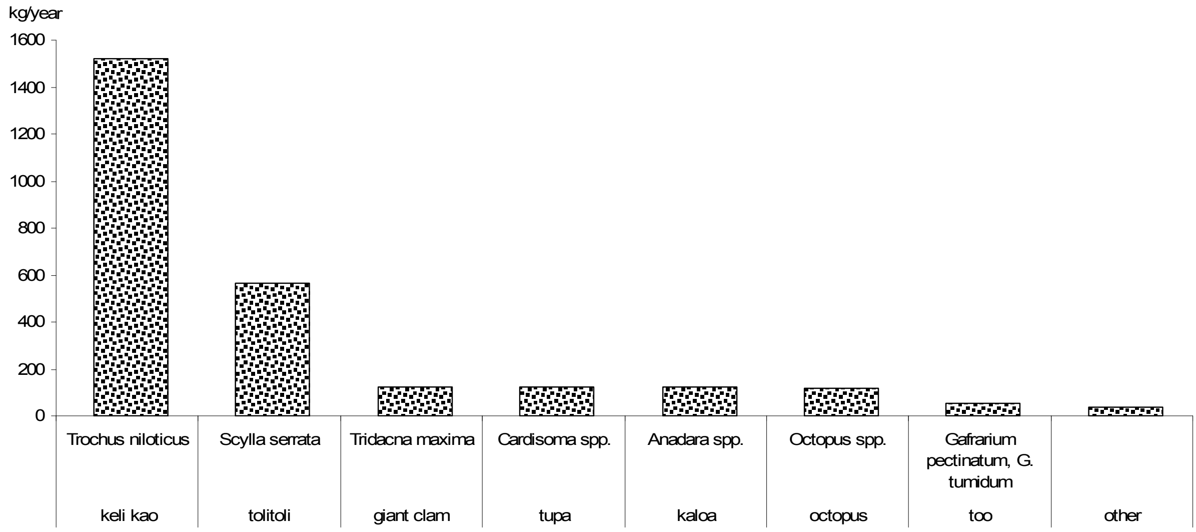

Figure 2.31: Total annual invertebrate catch (t wet weight /year) by species (reported catch) in Halalo.
'Other' refers to the giant clam and octopus fisheries.

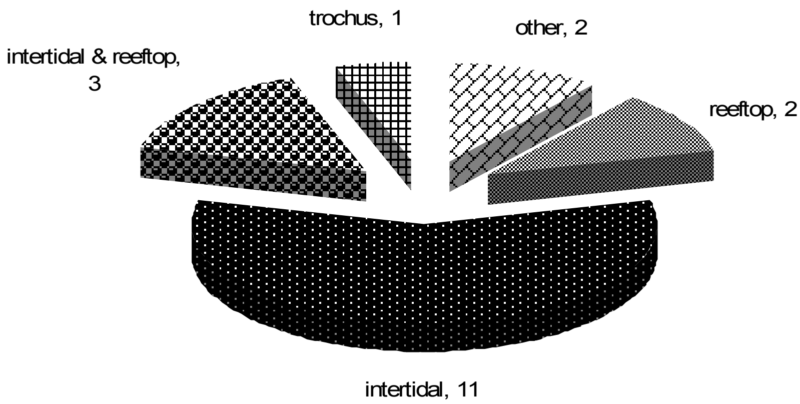

Figure 2.32: Number of vernacular names recorded for each invertebrate fishery in Halalo.
'Other' refers to the giant clam and octopus fisheries.

As already stated, invertebrate fisheries are much more limited and of less importance as compared to finfish fisheries in Halalo. Accordingly, the limited biodiversity reported for catches is not surprising. In fact, only intertidal gleaning had higher diversity; 11 species were distinguished each by different vernacular names. Most of these species include gastropods, crabs and bivalves collected for subsistence, and shells collected for artisanal purposes (Figure 2.32). Trochus and other dive fisheries, as well as reeftop gleaning, are either single-species or two-species fisheries only.

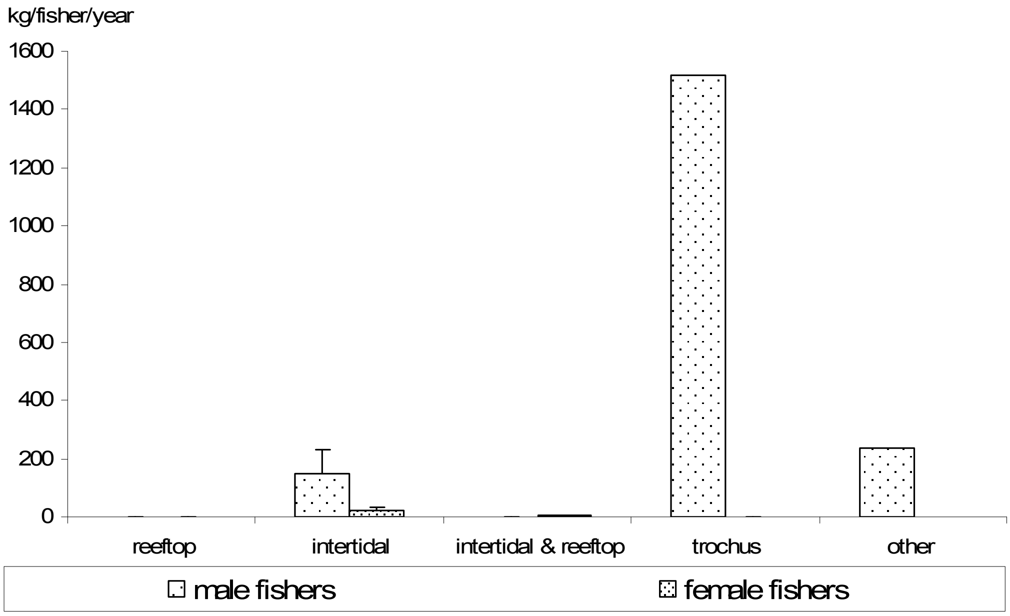

Figure 2.33: Average annual invertebrate catch (kg wet weight/year) by fisher, gender and fishery in Halalo.
Data based on individual fisher surveys. Figures refer to the proportion of all fishers that target each habitat (n = 4 for males, n = 12 for females). Bars represent standard error (+SE). 'Other' refers to the giant clam and octopus fisheries.

Females from Halalo only participate in gleaning and not in dive fisheries. Thus, Figure 2.33 shows catch data for the trochus and dive fisheries for giant clams and octopus only for male fishers. Also, average annual catches for gleaning activities are mostly taken by males, rather than females. The average annual catches also show the importance of each fishery, i.e. the trochus fishery is done by few fishers but very intensively, while all other gleaning is done by many fishers but to a very low extent only. Usually, average annual catches per fisher range between 100 and 200 kg wet weight only.

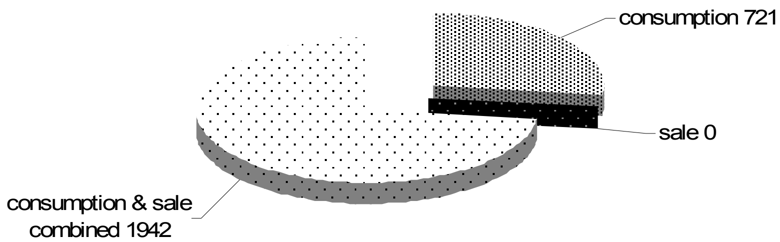

Figure 2.34: Total annual reported invertebrate biomass used for consumption, sale and both purposes (kg wet weight/year) for all respondents from Halalo.

The role that trochus plays in terms of annual catch rates of the few fishers involved is shown in Figure 2.34. Although no species are taken purely for commercial purposes, trochus shells are an exception. Trochus meat may be sold or eaten by families and friends. However, the shells are purely of commercial value and may represent as much as 37% of the total catch if we assume that half of the catch in the combined 'consumption and sale' category is actually sold.

The total annual catch volume (expressed in wet weight based on recorded data from all respondents interviewed) amounts to ~2.7 t/year only (Figure 2.35). Again, catches from trochus fisheries alone determine over half of all reported annual impacts (57%), followed by intertidal gleaning (~32%) and diving for giant clams and octopus (9%). Reeftop gleaning or the combined reeftop and intertidal collection are of insignificant importance.

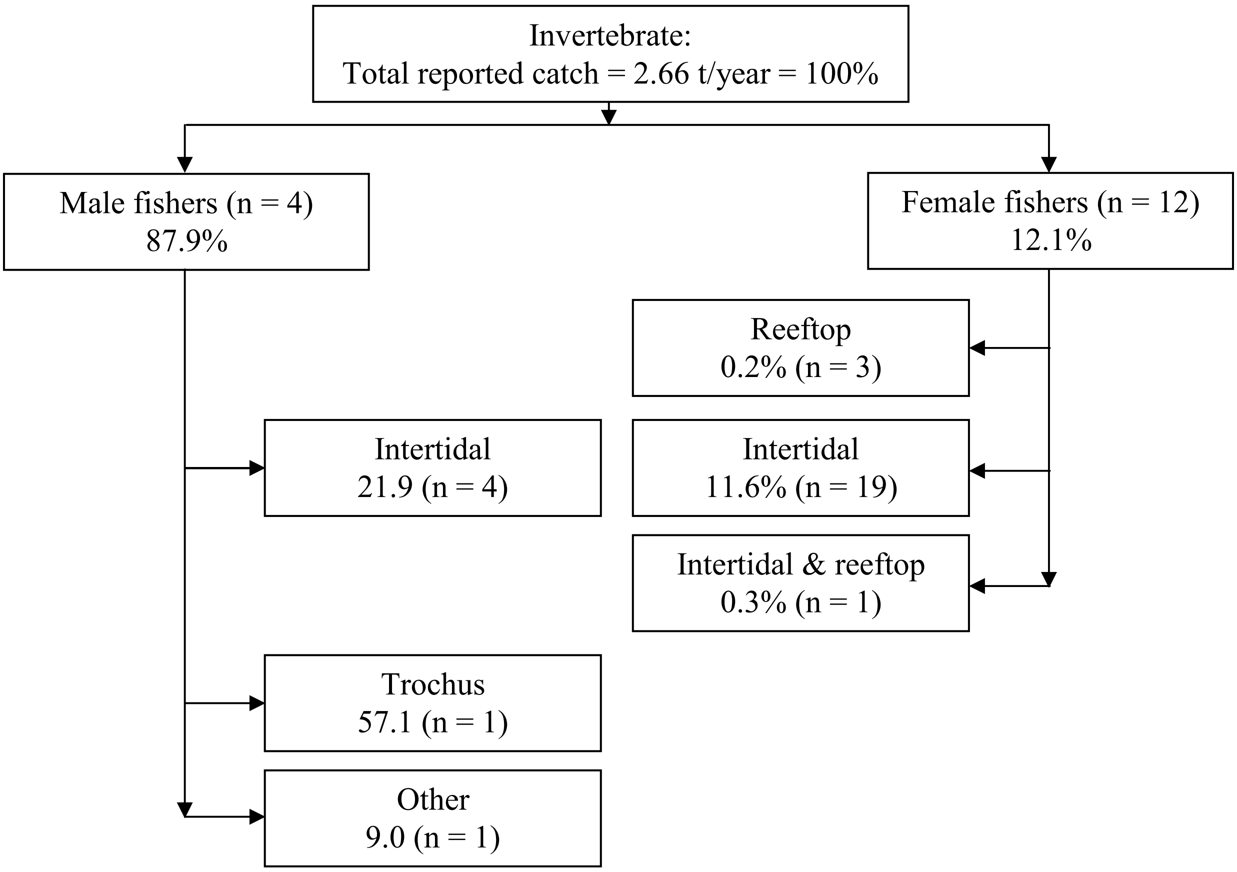

Figure 2.35: Total annual invertebrate catch (tonnes) and proportion (%) by fishery and gender (reported catch) in Halalo.
n is the total number of interviews conducted per each fishery; total number of interviews may exceed total number of fishers surveyed as one fisher may target more than one fishery and thus respond to more than one fishery survey. 'Other' refers to the giant clam and octopus fisheries.

The parameters presented in Table 2.10 show that the reef length and reef and soft-benthos areas that support the main invertebrate fishery are quite substantial. As is the case for finfish fisheries, it should be noted that only the impact from Halalo fishers is considered here, whereas there are many more potential fishers accessing the same fishing grounds if the total population of Wallis is taken into consideration. However, if comparing the available data for Halalo, none of the parameters shown in Table 2.10 suggest any detrimental impact on the invertebrate resources: fisher densities are low and so are the average catch rates per fisher, and supporting habitats sizes are large. In the case of intertidal fisheries, highest fisher density is reached. However, if considering the low individual impact per fisher that was recorded in the survey, total impact remains marginal.

Table 2.10: Parameters used in assessing fishing pressure on invertebrate resources in Halalo

Parameters	Habitat / Fishery				
	Other	Reeftop	Intertidal	Intertidal & reeftop	Trochus
Fishing ground area (km^2)	22.14	20.86	11.39	n/a	10.97
Number of fishers (per fishery) (1)	4	16	117	5	4
Density of fishers (number of fishers/km^2 fishing ground)	0.2	0.8	10.3	n/a	0.4
Average annual invertebrate catch (kg/fisher/year) (2)	238.86 (n/a)	1.68 (±0.52)	49.59 (±21.78)	7.27 (n/a)	1520.00 (n/a)

n/a = no information available or standard error not calculated; (1) number of fishers extrapolated from household surveys; (2) catch figures are based on recorded data from survey respondents only; 'other' refers primarily to the giant clam and octopus fisheries.

2.2.2.5 Discussion and conclusions: socioeconomics in Halalo

- Fisheries are important for income generation in Halalo. Over 70% of all households reported being financially dependent upon fisheries: ~38% as their first income source, and ~35% as their second income source. While agriculture is less important, overall, salaries provide the first income for most (45%) of Halalo households.

- All households consume fresh fish and most (83%) consume invertebrates regularly. Fresh fish consumption is high (80.5 kg/person/year), above the regional average and highest across all sites investigated by PROCFish/C in Wallis and Futuna. Invertebrate consumption is low (~5 kg/person/year).

- The average household expenditure level is not of particular note, except to mention that people in Halalo spend on average a bit less compared to the other survey sites in Wallis and Futuna and receive less in remittances.

- Although both men and women fish for finfish, only men fish commercially, while women focus only on subsistence fishing for finfish and invertebrates. Invertebrate fishers target mainly the intertidal areas for subsistence and handicraft purposes, with males having a higher impact than female fishers. The trochus fishery is the most important by wet weight, productivity and for commercial purposes; however, it is performed only by a few fishers.

- Various techniques are used for catching finfish, mainly gillnetting, handlining and spear diving, or a combination of these; handlining is the main method used for fishing in the passages.

- Fishing pressure is highest in the lagoon, where most of the reported annual catch is taken. However, impact here is mainly due to the number of fishers rather than productivity. Catches are around 700 kg/fisher/year for lagoon and passage fishing. Productivity is higher in the passages, where CPUE is 3 kg/hour fished as compared to 1.5 kg/hour fished in the lagoon. Female fishers contribute very little; both in terms of catch/fisher/year and CPUE.

- Taking into consideration the large surface areas of the lagoon habitat, total reef and total fishing ground area, the reported and extrapolated catch from the Halalo community at present does not indicate any alarming level of impact on resources. However, it should be borne in mind that Wallis enjoys an open-access fishing system and that we have only investigated one major fishing community located in the southern part of the country's lagoon system. Thus, the total impact imposed by the entire population that may target this southern fishing area of Wallis may be much higher.

- Invertebrate fisheries mainly serve subsistence needs, and trochus is the most important commercial fishery (~37% of total catch). However, the total catch (expressed in wet weight) amounts to ~2.7 t/year only. Catches for trochus alone determine over half of the reported impact, followed by intertidal gleaning and diving for giant clams and octopus.

- Considering the extensive reef length, reef and soft-benthos areas that support all the fisheries in the southern part of the country's lagoon system, the current impact of the Halalo community on invertebrate resources is low; no detrimental effects are evident.

Survey results suggest two major conclusions. Firstly, current pressure on finfish and invertebrate resources on the southern lagoon system of Wallis (as estimated from catch data reported by the Halalo community only) is low. Secondly, if we take into account the overall economic and political situation on Wallis, it is likely that fisheries will continue to be important, both as a source of revenue and as one of the most important sources of protein and nutrition. As reported by Halalo fishers, finfish and invertebrates are fished mainly for subsistence purposes and only about 37% (by wet weight) of finfish and invertebrate catches are sold (mostly outside the community). While finfish fisheries serve the local market on Wallis, trochus shells are for international export. While the local finfish market is not controlled, trochus shell export depends on licensing and is subject to size- and other quality-control measures. Taking into account the total share of the Wallis population that may access the southern lagoon and reef system for fishing, the actual fishing pressure may be much higher than that estimated using the Halalo data only. In this regard, the fishing pressure for the whole country is estimated in Section 2.2.3, by combining data from both sites investigated on Wallis, i.e. Vailala and Halalo, and extrapolating this to the national level.

2.2.3 Commercialisation: Wallis

2.2.3.1 Local marketing: Wallis

Fish and seafood marketing on Wallis is substantial. Usually, shops located in most, if not all, villages sell some fish or invertebrates that have been bought from local fishers. These shops usually have a freezer and sell frozen fish and other seafood.

Two examples are given below, one each from the Vailala and Halalo communities.

Village shop at Tufuone

The shop at Tufuone has sold fish and seafood for four years. The monthly turnover of finfish is about 40–50 kg. 'Kanahe' (*Mugil cephalus*), 'kivi' (*Lutjanus bohar*), and 'lupo' (*Caranx ignobilis*) are bought for XFP 600 per kg and sold for XFP 700 per kg, while 'palagi' (*Acanthurus xanthopterus*) is bought from fishers for XFP 500 per kg and sold to clients for XFP 600 per kg. The lowest-value species is 'ika hina' (*Lethrinus harak*) bought from fishers for XFP 400 per kg and sold at XFP 500 per kg. In addition, the monthly turnover also includes: 5–6 kg of lobsters that are bought for XFP 1000 per kg from the fisher and sold at XFP 1200 per kg; and 10–12 octopus ('feke') (sold at XFP 600 per kg).

Village shop at Halalo

There are four shops in the district of Mua and sales vary among shops. One of these is the shop at Halalo, which has been operating for the previous 2.5 years. This owner buys regularly from about 10 fishers based at Halalo, who mainly use gillnets or handlines; and from spearfishers from Mutufua (3) and Vaimatao (2). The monthly turnover is variable and depends on supply. Usually the owner buys about 40 kg/day, although fishers may not sell on each of the six days he opens per week. He buys all fish for XFP 500 per kg gutted and kept on ice, and he sells it for XFP 650 per kg. In addition he sells about 30 kg of octopus per week, bought at XFP 500 per kg and sold for XFP 650 per kg. He only gets about 5–8 kg of lobsters per month, which he buys for XFP 1000 per kg and sells for XFP 1500 per kg. On average, about once a month 20–30 kg of turtle meat is bought for XFP 500 per 5 kg and sold for XFP 650 per 5 kg.

The shop owner also reported that, although on average he has a regular supply of finfish and seafood that he buys and sells, there are irregularities in the demand, particularly during festive seasons, such as Christmas and Easter. He believes that, for feasts, local people prefer finfish and seafood rather than meat. He believes that, in general, the supply of fish is less than the demand, and he could sell more fish if it was available.

During the past 2.5 years that he has dealt with finfish, the composition of the catch and fish sizes have not really changed. In general, most fish sold (~70%) are around 32 cm (fork length), about 20% are larger (~40 cm) and about 10% are small (~24 cm). Fish species that are rarely sold include 'vivaneau' (*Lutjanus* spp.), 'mahi-mahi' (*Coryphaena hippurus*), and tuna. The most frequently sold fish species include 'carangue' (*Caranx* spp.), 'saosao' (*Sphyraena* spp.), 'gatala' (*Epinephelus polyphekadion*), 'ume' (*Naso unicornis*), 'palagi' (*Acanthurus xanthopterus*), 'humu' (*Scarus* spp.), 'nue' *(Kyphosus cinerascens*) and 'ta'elulu' (*Lutjanus gibbus*).

In addition to small village shops, which also sell finfish and seafood, there is one main fish shop at Falaleu. This shop has been operating since 1999, buying fish from regular fishers from Vailala (2–3 fishers), from Kolopo and Tepa in the south of Wallis (3–4), and from Utufua (2). The travel distance between the landing points and the shop is too far for fishers from Halalo. Regular fishers usually sell every second day. Catch that is bought by the shop must be fresh, gutted and well preserved on ice.

The monthly turnover of the shop in 1999–2001was about 4 t/month, which has decreased to 2.5 t/month since 2005. From this 2.5 t/month, about 80% is sourced from reef and lagoon habitats, and 20% is pelagic, mostly tuna.

Larger fish are the main ones sold (average fork length of 32–40 cm, making up 60% of the catch), 20% of the catch are 24 cm and another 20% average 16 cm in fork length. All the fish are classified into three groups:
1. *Scarus* spp. ('humu') and *Lutjanus* spp. ('bossu')
2. *Caranx* spp. ('carangue'), *Parupeneus* spp. ('rouget'), *Lethrinus harak* ('ika hina') *Naso unicornis* ('ume'); and
3. *Acanthurus xanthopterus* ('palagi'), *Mugil cephalus* ('kanahe').

Fish of size classes 8–16 cm fork length are bought at XFP 350–400 per kg and sold for XFP >500 per kg; size classes 24–40 cm fork length are bought at XFP 500 per kg and sold for

XFP >600 per kg. Tuna and deep bottom species are bought at XFP 600 per kg. Prices for octopus are XFP 500 per kg paid to the fisher, and for lobster XFP 1000 per kg if caught with a spear and XFP 1500 per kg when not speared but caught by hand or trap.

In 2004, a total of 495 kg of lobster were sold: 290 kg fresh and not speared, and 205 kg speared. The total amount of octopus sold in 2004 was 532 kg and, in addition to the estimated 2.5 t of fresh fish, 224 kg of moray eels were also sold.

2.2.3.2 Export marketing: Wallis

Trochus

The sole export agent on Wallis holding an annual licence for up to 34 t of trochus shells is located at Mata-utu. This agent also holds the only annual licence for bêche-de-mer exports. Apparently, somebody else from the same family has started bêche-de-mer harvesting and drying; however, this person does not hold a licence and thus, at least in theory, cannot export.

Trochus is bought from one major fisher based at Utufua and another major fisher from Hihifo. There are about 20 fishers who collect trochus and sell it more or less regularly to the sole agent on Wallis. Only the shell is bought, and shells are from both species: *Trochus niloticus* and *Trochus pyramis*. Shells are exported to Italy, Vietnam or Hong Kong. Each shipment is about one container or 17 t shells. In the beginning about 5–6 containers or up to 50 t were shipped each year. Today, the export is down to 1–2 containers/year.

Today, the export agent buys trochus shells from fishers at XFP 300 per kg and sells at Euros 4 per kg in Italy. The loading and transporting of the container in Wallis is organised and paid for by the agent in Wallis, however all sea freight and further transport and shipment costs are paid by the overseas client.

Bêche-de-mer

For bêche-de-mer harvesting, drying and export, all activities are carried out by 3–4 adult members of the agent's families and their children. Bêche-de-mer is collected by walking over the reefs surrounding the *motu* that are reached by boat. Specimens are cleaned, boiled and sun-dried, as electricity is too costly to use for drying. Whenever 200 kg of dried bêche-de-mer product is available, it is shipped by air to Noumea from where it is sold overseas. The air freight is sold by the Noumea-based buyer.

In total, about 800 kg/year are collected from four species: *Holothuria scabra*, *Stichopus chloronotus*, *Stichopus variegatus*, and *Thelenota ananas*, and sold for XFP 1500 per kg when dried. In addition, a total annual export volume of 900–1200 kg consists of the following three species that are sold at XFP 1200–1500 per kg when dried: *H. nobilis*, *H. fuscogilva*, and *Actinopyga mauritiana*. Special prices of XFP 3000–3500 per kg are fetched for large individuals (20–28 cm).

2.2.4 Fisheries management: Wallis

Coastal and marine resource management does not only fall under the auspices of the governmental fisheries service but also under the environmental services that were established for Wallis and Futuna in 1997. Based on resource inventories, particularly of coral reef resources, a marine resources management plan is in preparation. This management plan also calls for strengthening and implementing public information and consciousness-raising campaigns. Additionally, a comprehensive environmental legislation has been drafted and was under approval at the time of the survey.

At present, there are two areas identified as marine reserves following customary procedures ('la coûtume'). However, final approval and establishment needs inclusion in the national marine management plan and thus a particular convention for the acceptance of marine parks and other protected areas by the communities will need to be used and applied.

In 2001, a fishers' association was founded to formally recognise professional fishers and to foster the communication between governmental authorities and the commercial fisheries sector. The government also recognised that professional fishers and the sector concerned need to be better understood. As a result, a nationwide study was launched in 2001–2002 to inventory all fishers in the country, and to assess the degree of professionalism among them. At present, one of the main objectives of the national fisheries service is to review and design effective fisheries regulations and establish the current and future status of commercial fishers in Wallis. However, one of the major problems is not the lack of rules and regulations, but their control, policy and monitoring. It should also be noted that, while the current survey was fully implemented on Wallis, only a down-scaled survey was implemented on Futuna.

From 1st July 1994, the following fisheries regulations were issued (Appendix 2.1.7):

- The use of SCUBA, night diving and hookah fishing is forbidden;
- The use of gillnets is restricted to a mesh size >45 mm, a maximum length of 250 m; the use of trawling or drag nets is forbidden inside the lagoon;
- It is forbidden to fish any lobsters ('uo') of the Panuliruidae family of <75 mm length, or carrying eggs; or any coconut crab (*Birgus latro*) in the reproduction period and if the thorax is <36 mm if they are carrying eggs or if the abdomen is coloured orange;
- The use of explosives and natural or artificial poisons is forbidden;
- FADs are not to be used to attach fishing boats or gears, and there are minimum distances for long-lining and rules for bottom fishing next to FADs;
- Trochus can only be collected if the shell diameter ranges between 9 and 12 cm; and the export of trochus requires an annual authorisation;
- Any export-intended fishery requires authorisation by the environmental service.

Non-compliance with any of the fisheries regulations may be punished with fines of XFP 10,908–54,540, or confiscation, destruction or return of the catch to the sea.

Export for trochus shells is currently limited to 34 t/year, and trochus shell size for harvesting is limited to 9–12 cm diameter. Shell sizes and quantity are controlled prior to shipment outside the country. Such limits are also considered for bêche-de-mer, if the fisheries are further developed.

In addition to governmental fisheries regulations, there are customary or traditional rules imposed by communities. For instance, the chief of Tufuone confirmed that traditionally, spear diving at night using a torch, and the use of dynamite are forbidden. Although community members are believed to be well aware of both governmental and customary rules and regulations, spear diving at night with torchlight is very common. Any non-compliance at the community level used to be sanctioned with community work; today, pigs or fish are to be given to the chief for compensation.

2.2.5 Fishing impact: Wallis

As highlighted earlier, estimation of the current fishing pressure is limited to data collected from two villages on Wallis, which represent only a small proportion (~7%) of the total population. In order to better assess the total possible impact of today's fishing activities in Wallis, average data from both surveys is extrapolated to the entire population. This model will presumably overestimate the present impact as both villages were selected for being the most active fishing communities in the northern and southern part of Wallis respectively. However, the total fisher density calculated per reef area and per total fishing ground is still very low (Table 2.11). As for the total population density, this is low when calculated in relation to the total available fishing ground and moderate when calculated in relation to just the reef surfaces. Fishing pressure remains moderate, although reaches almost 10 t/km^2 if only calculated for the available reef surface. However, this figure is presumably overestimated as the average consumption of fresh fish may actually be lower than the overall average, because most other communities on Wallis do far less fishing but buy much more fish than both the Vailala and Halalo communities. Both factors are known to reduce the consumption of fresh fish and open up opportunities to substitute other protein sources for fresh fish. For our figures, we have assumed that all fresh fish consumed is sourced from reef and lagoon habitats. In fact, the consumption also includes some catch from pelagic fisheries that is not considered by the PROCFish/C surveys.

Table 2.11: Parameters used in assessing fishing pressure on finfish resources in the whole of Wallis

Parameters	Habitat	
	Total reef area	Total fishing ground
Fishing ground area (km^2)	76.91	220.36
Density of fishers (number of fishers/km^2 fishing ground) [(1)]	37	13
Population density (people/km^2) [(2)]	127	44
Total fishing pressure of subsistence catches (t/km^2) [(3)]	9.67	3.38

[(1)] Average number of fishers/household = 1.6; total number of fishers = 2822; total number of finfish fishers = 2243 (exclusive finfish fishers and fishers targeting both fish and invertebrates); total number of invertebrate fishers = 1507 (exclusive invertebrate fishers and fishers targeting both fish and invertebrates); [(2)] total population on Wallis = 9780 people; average household size = 5.5 people; total number of households = 1778; [(3)] average per capita consumption = 63.4 kg/year; total subsistence demand of fresh fish = 744 t/year.

As far as fishing pressure on invertebrate resources is concerned, fisher density is low and so are most figures of total impact by wet weight per available surface area of habitat (Table 2.12). Highest impact (wet weight per surface area and year) occurs for soft benthos and lobster fisheries. It should be noted that the exploitation level of lobster fisheries is probably overestimated. In fact, our survey revealed that the number of commercial lobster fishers may be limited to the greater Vailala community; however, we have extrapolated the number to take into account all possible fishers on Wallis. Similarly, the potential impact of soft-benthos gleaning is presumably overestimated as not all gleaners may reach an average annual catch of 58 kg/fisher.

Table 2.12: Parameters used in assessing fishing pressure on invertebrate resources in the whole of Wallis

Parameters	Fishery					
	Reeftop gleaning (1)	Soft benthos (2)	Lobster (3)	Trochus (4)	Bêche-de-mer (5)	Other (6)
Fishing ground area (km^2)	40.40	14.37	18.5	22.14	22.81	44.95
Number of fishers (per fishery) (9)	319	968	119	40	5	60
Density of fishers (number of fishers/km^2 fishing ground)	7.9	67.4	6.4	1.8	0.2	1.3
Average annual invertebrate catch (kg/fisher/year) (10)	105.4	59.7	557.0	1133.3 (7)	1.6 (8)	238. 9
Total annual catch (t/year wet weight)	33.6	57.7	66.3	45.3	8.0	14.3
Total impact (t/km^2 habitat)	0.83	4.02	3.58	2.05	0.35	0.32

'Other' refers to giant clam and octopus fisheries; (1) reef areas include: coastal and back-reef surfaces; (2) lagoon areas that are shallow and include coral reef areas; (3) length for northern outer reef only; (4) outer reef surfaces; (5) back-reef surfaces; (6) back- and outer-reef surfaces; (7) based on a total export weight of shells of 34 t/year, shells being 75% of total wet weight; (8) based on a total export weight of 800 kg/year, dried bêche-de-mer being 10% of total wet weight; (9) extrapolated from average number of fishers per household and average percentage of fishers per fishery from Vailala und Halalo surveys; (10) extrapolated from average catch per fisher for each fishery from Vailala and Halalo surveys.

In summary, the socioeconomic survey data from Vailala and Halalo does not suggest any alarming level of fishing pressure is imposed either by the finfish or the invertebrate fisheries. This conclusion also applies if the data are extrapolated to the total population of Wallis.

The survey showed a number of characteristics that largely agree with the findings of the national fishery survey inventory that was implemented in 2001–2002. For instance, our survey results confirm that while subsistence fisheries still play an important role, a substantial share of finfish fishing and, to a smaller extent, invertebrate fishing, is done for commercial purposes. The national survey suggests that 32% of all fishing is commercial (15% is sold by fishers directly to clients, 17% is sold by fishers to commercial fish buyers).

The national inventory also explains that in each district on Wallis there is at least one characteristic fisher village. Vailala is this particular fisher community for the Hihifo district, while the Mua district has many fishers who are distributed over 11 villages, but Halalo accounts for most. In fact, the national survey indicated 42 fishers for Vailala and 36 for Halalo. Our survey found a much higher number of fishers (123 in Vailala; 201 in Halalo), because not only professional fishers were taken into account, but all fishers: both males and females, finfish and invertebrate fishers, and subsistence and commercial fishers.

At the national level, the lagoon was found to be targeted by most (37%), followed by the barrier reef (27%), the fringing reef (22%) and the external barrier reef (16%). These figures are confirmed by our survey with most fishers targeting the larger lagoon and coastal reef areas (including the back-reef) and least targeting passages and the outer reef due to sea and weather conditions.

The PROCFish/C survey also confirmed that spear diving and gillnetting are important techniques, although the frequently combined use of gillnetting, spear diving and handlining reported by respondents from Vailala and Halalo is not mentioned in the national survey. The Vailala and Halalo survey results also confirmed that finfish are the main target for most fishers and that, as far as invertebrates are concerned, octopus, trochus, crustaceans (lobsters and crabs), shellfish (giant clams, etc.) and bêche-de-mer play a minor but significant role.

At the national level, fishing trips occur about as frequently as in Vailala and Halalo; most fishers go out about twice a week, some only once a week and only a few fishers as often as three times/week. The same applies for the average duration of fishing trips; most last 2–5 hours or 6–10 hours and some even longer. What has not been explained by the national survey is the fact that the long duration of some fishing trips may be due to setting and tending gillnets and may include overnight stays on *motu*.

2.3 Finfish resource surveys: Wallis

This report aims to present a preliminary assessment of the finfish resources of the coral reefs of Halalo and Vailala in Wallis (Figure 2.36).

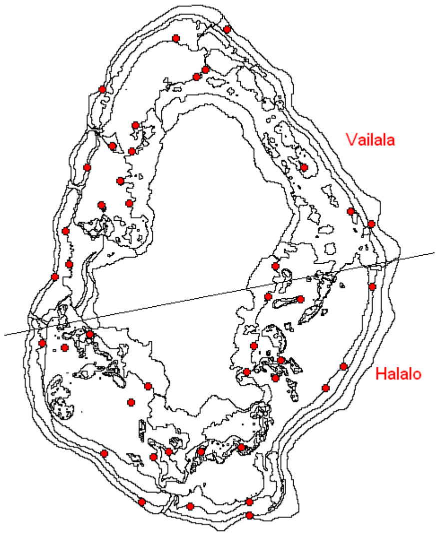

Figure 2.36: Location of the two selected sites for the PROCFish/C study in Wallis.

2.3.1 Vailala

Finfish resources and associated habitats were assessed in Vailala between 31 August and 16 September 2005, from a total of 23 transects (5 sheltered coastal, 5 intermediate, 5 back- and 8 outer-reef transects, Figure 2.37 and Appendix 3.1.1 for transect locations and coordinates respectively).

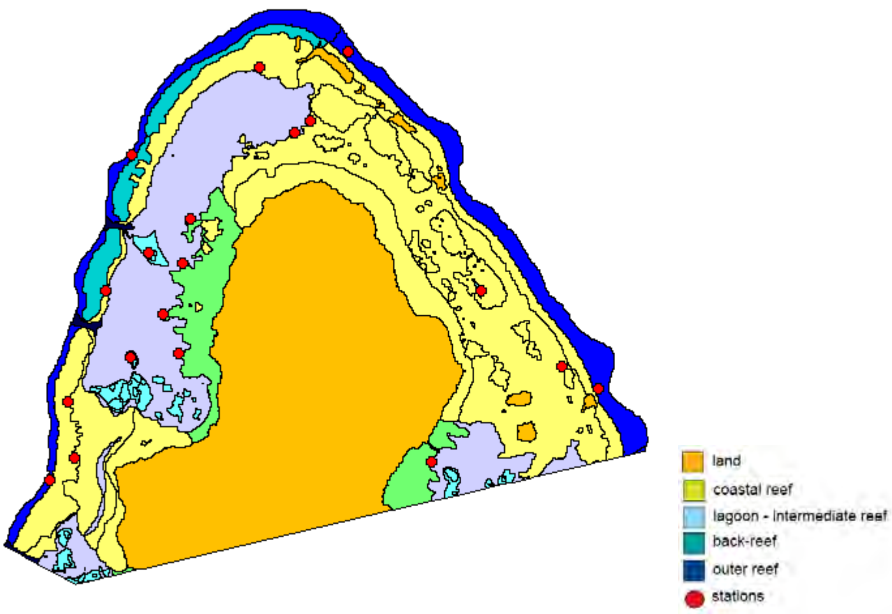

Figure 2.37: Habitat types and transect locations for finfish assessment in Vailala.

2.3.1.1 Finfish assessment results: Vailala

A total of 25 families, 59 genera, 146 species and 9901 fish were recorded in the 23 transects (See Appendix 3.1.2 for list of species.). Only data on the 15 most dominant families (See Appendix 1.2 for species selection.) are presented below, representing 46 genera, 130 species and 9591 individuals.

Finfish resources differed slightly among the four reef environments found in Vailala (Table 2.13). The intermediate reef contained the highest biomass and largest-sized fish (19 cm FL average length, 61% average size ratio), while outer reefs displayed the highest fish density, along with coastal reefs (0.7 fish/m^2) and highest biodiversity (45 species/transect). Back-reefs showed at this site the lowest values of density (0.4 fish/m^2), biomass (43 g/m^2), size (16 cm FL), size ratio (52%) and biodiversity (22 species/transect). Sheltered coastal reefs presented high density (identical to outer reefs), and second ranked biomass (109 g/m^2), size and size ratio.

Table 2.13: Primary finfish habitat and resource parameters recorded in Vailala (average values ±SE)

Parameters	Habitat				
	Sheltered coastal reef (1)	Intermediate reef (1)	Back-reef (1)	Outer reef (1)	All reefs (2)
Number of transects	5	5	5	8	23
Total habitat area (km^2)	7.9	3.0	4.0	11.2	26.0
Depth (m)	3	3	1	7	4
Soft bottom (% cover)	12 ±2	24 ±4	25 ±9	4 ±1	12
Rubble & boulders (% cover)	15 ±5	14 ±5	0 ±4	0 ±2	11
Hard bottom (% cover)	40 ±12	34 ±7	47 ±8	61 ±5	49
Live coral (% cover)	27 ±10	25 ±5	17 ±5	27 ±4	25
Soft coral (% cover)	4 ±4	1 ±0	0 ±0	0 ±0	1
Biodiversity (species/transect)	4 ±34	2 ±37	2 ±22	1 ±45	36
Density (fish/m^2)	0.7 ±0.2	0.6 ±0.1	0.4 ±0.1	0.7 ±0.2	0.6
Size (cm FL) (3)	18 ±46	19 ±38	16 ±14	17 ±18	18
Size ratio (%)	57 ±3	61 ±3	52 ±3	55 ±2	56
Biomass (g/m^2)	109.1 ±45.9	110.0 ±38.4	43.0 ±14.0	100.4 ±18.2	95.3

(1) Unweighted average; (2) weighted average that takes into account relative proportion of habitat in the study area; (3) FL = fork length.

Sheltered coastal reef environment: Vailala

The sheltered coastal reef environment of Vailala was dominated by two families of herbivorous fish: Acanthuridae and Scaridae, and by two families of carnivorous fish: Lethrinidae and Lutjanidae (Figure 2.38). These four families were represented by 32 species; particularly high abundance and biomass were recorded for *Ctenochaetus striatus, Gnathodentex aureolineatus, Lutjanus fulviflamma, Chlorurus sordidus, Scarus dimidiatus, Lutjanus kasmira, Lutjanus fulvus,* and *Acanthurus lineatus* (Table 2.14). This reef environment presented a moderately diverse habitat with a high cover of hard bottom (40%), and a relatively high cover of live corals (27%) and mobile bottom (27% for soft and rubble together) (Table 2.13 and Figure 2.38).

Table 2.14: Finfish species contributing most to main families in terms of densities and biomass in the sheltered coastal reef environment of Vailala

Family	Species	Common name	Density (fish/m^2)	Biomass (g/m^2)
Acanthuridae	*Ctenochaetus striatus*	Striated surgeonfish	0.12 ±0.06	19.4 ±10.2
	Acanthurus lineatus	Lined surgeonfish	0.01 ±0.01	4.7 ±4.6
Lethrinidae	*Gnathodentex aureolineatus*	Goldlined seabream	0.07 ±0.07	14.4 ±14.2
Lutjanidae	*Lutjanus fulviflamma*	Longspot snapper	0.02 ±0.02	7.8 ±7.7
	Lutjanus kasmira	Bluelined snapper	0.07 ±0.07	6.4 ±6.4
	Lutjanus fulvus	Flametail snapper	0.02 ±0.01	5.0 ±2.9
Scaridae	*Chlorurus sordidus*	Daisy parrotfish	0.04 ±0.02	7.1 ±4.5
	Scarus dimidiatus	Yellow-barred parrotfish	0.02 ±0.01	6.8 ±4.1

The density, size ratio, biomass and biodiversity of finfish in the sheltered coastal reefs of Vailala were higher than Halalo coastal reefs, while size was the same (18 cm FL). The trophic structure in Vailala coastal reef was equally composed of herbivorous and carnivorous species in terms of both density and biomass. The fish community was mostly represented by Acanthuridae, Lutjanidae, Lethrinidae and Scaridae in similar amounts, indicating a very diverse and healthy ecosystem. Size ratio, used as an indication of fishing stress on the fish population, was below the 50% limit for Lethrinidae, Mullidae and Scaridae indicating a certain influence from fishing targeting large-sized animals. In fact, emperor fish, goatfish and parrotfish were found to be the most frequently caught families of fish. Substrate composition was dominated by hard bottom, preferred by herbivores, such as Acanthuridae, but also had a good cover of mobile bottom, favouring carnivores[6].

[6] Soft-bottom environments are generally rich in small invertebrates, which are the main food items of carnivorous fish, while hard-bottom habitats are often covered with algae, the food of herbivorous fish.

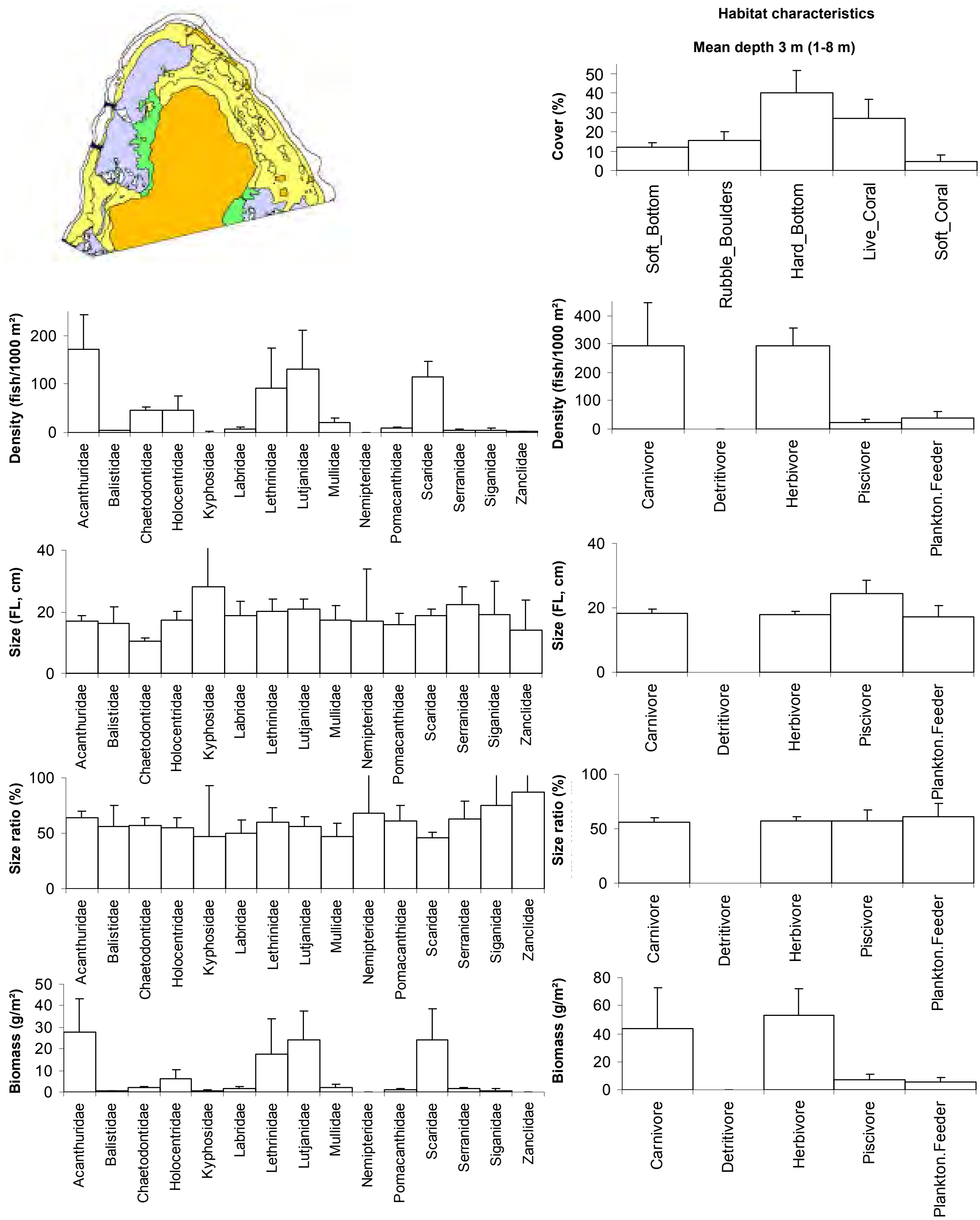

Figure 2.38: Profile of finfish resources in the sheltered coastal reef environment of Vailala.
Bars represent standard error (+SE); FL = fork length.

Intermediate-reef environment: Vailala

The intermediate-reef environment of Vailala was dominated by four families: herbivores Acanthuridae and Scaridae and carnivores Lutjanidae and Lethrinidae (Figure 2.39). These four families were represented by 35 species; particularly high abundance and biomass were recorded for *Ctenochaetus striatus*, *Lutjanus fulviflamma*, *Monotaxis grandoculis*, *Chlorurus sordidus*, *Gnathodentex aureolineatus*, *Acanthurus nigricauda* and *A. triostegus* (Table 2.15). This reef environment presented a diverse habitat slightly dominated by hard bottom (34%), with a good cover of live coral (25%), soft bottom (24%) and rubble (14%, Table 2.13).

Table 2.15: Finfish species contributing most to main families in terms of densities and biomass in the intermediate-reef environment of Vailala

Family	Species	Common name	Density (fish/m^2)	Biomass (g/m^2)
Acanthuridae	*Ctenochaetus striatus*	Striated surgeonfish	0.15 ±0.03	25.5 ±4.5
	Acanthurus nigricauda	Epaulette surgeonfish	0.01 ±0.01	4.3 ±2.3
	Acanthurus triostegus	Convict tang	0.04 ±0.04	3.2 ±3.2
Lethrinidae	*Monotaxis grandoculis*	Bigeye bream	0.03 ±0.03	11.4 ±10.9
	Gnathodentex aureolineatus	Goldlined seabream	0.04 ±0.04	5.8 ±5.8
Lutjanidae	*Lutjanus fulviflamma*	Longspot snapper	0.05 ±0.04	17.3 ±13.4
Scaridae	*Chlorurus sordidus*	Daisy parrotfish	0.05 ±0.01	6.0 ±1.2

The density, size, size ratio, biomass and biodiversity of finfish in the intermediate reefs of Vailala were all much higher than the values recorded in Halalo (Table 2.13). Herbivores were only slightly more abundant than carnivores, but the biomass of the two main trophic groups was similar. Acanthuridae were the main herbivores, while Lutjanidae and Lethrinidae were the main carnivores. Average size ratio was relatively low (<50%) only for Labridae, Lethrinidae and Scaridae.

The intermediate reefs of Vailala displayed a very diverse composition of hard and soft bottom, with a high cover of live corals, explaining the high diversity of major fish families.

Figure 2.39: Profile of finfish resources in the intermediate-reef environment of Vailala.
Bars represent standard error (+SE); FL = fork length.

Back-reef environment: Vailala

The back-reef environment of Vailala was dominated by four families: herbivorous Acanthuridae, Scaridae and Siganidae and carnivorous Lethrinidae (Figure 2.40). These four families were represented by 20 species; particularly high abundance and biomass were recorded for *Ctenochaetus striatus*, *Acanthurus triostegus*, *A. lineatus*, *Siganus argenteus*, *Monotaxis grandoculis*, *Gnathodentex aureolineatus*, *A. blochii* and *Scarus psittacus* (Table 2.16). This reef environment presented a substrate composition with strong dominance of hard bottom (47% cover) and a high cover of soft bottom (25%, Table 2.13 and Figure 2.40).

Table 2.16: Finfish species contributing most to main families in terms of densities and biomass in the back-reef environment of Vailala

Family	Species	Common name	Density (fish/m^2)	Biomass (g/m^2)
Acanthuridae	*Ctenochaetus striatus*	Striated surgeonfish	0.06 ±0.02	6.9 ±3.1
	Acanthurus triostegus	Convict tang	0.09 ±0.04	6.6 ±2.6
	Acanthurus lineatus	Lined surgeonfish	0.01 ±0.01	4.7 ±4.5
	Acanthurus blochii	Ringtail surgeonfish	0.00 ±0.00	2.1 ±2.0
Lethrinidae	*Monotaxis grandoculis*	Bigeye bream	0.01 ±0.01	2.7 ±2.6
	Gnathodentex aureolineatus	Goldlined seabream	0.03 ±0.02	2.4 ±1.5
Siganidae	*Siganus argenteus*	Forktail rabbitfish	0.03 ±0.03	3.7 ±3.7
Scaridae	*Scarus psittacus*	Common parrotfish	0.02 ±0.02	1.3 ±0.8

The density of finfish in the back-reef of Vailala was equal to the value recorded in the back-reefs of Halalo, however biomass was lower (43 versus 52 g/m^2). Trophic composition was dominated by herbivores, mostly Acanthuridae. Size ratio was below 50% of family average maximum size for Scaridae, Lethrinidae and Lutjanidae. The back-reef of Vailala displayed high cover of soft bottom (25%), favourable to Lethrinidae and Mullidae, and very high cover of hard bottom (47%), favouring herbivores, such as Acanthuridae.

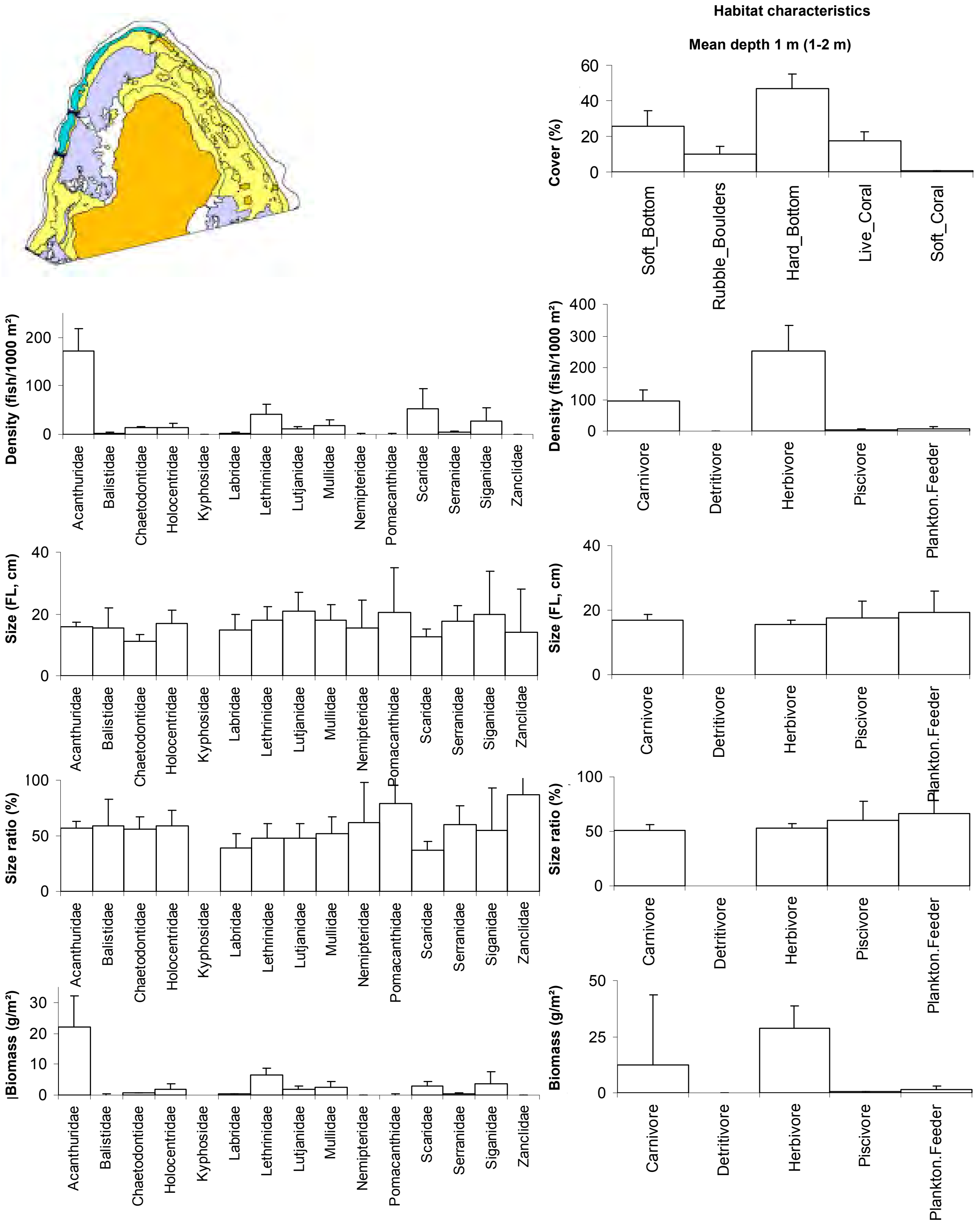

Figure 2.40: Figure 2.21: Profile of finfish resources in the back-reef environment of Vailala. Bars represent standard error (+SE); FL = fork length.

Outer-reef environment: Vailala

The outer reef of Vailala was dominated by two herbivorous families: Acanthuridae and Scaridae, and by two carnivorous families: Lutjanidae and, to a much smaller extent, Lethrinidae (Figure 2.41). These four families were represented by 40 species; particularly high abundance and biomass were recorded for *Ctenochaetus striatus, Lutjanus kasmira, Gnathodentex aureolineatus, Acanthurus lineatus, Chlorurus sordidus, L. gibbus* and *A. nigricans* (Table 2.17). Hard bottom (61% cover) largely dominated the habitat of this reef environment and live coral was also present in high cover (27%, Table 2.13 and Figure 2.41).

Table 2.17: Finfish species contributing most to main families in terms of densities and biomass in the outer-reef environment of Vailala

Family	Species	Common name	Density (fish/m^2)	Biomass (g/m^2)
Acanthuridae	*Ctenochaetus striatus*	Striated surgeonfish	0.17 ±0.03	26.8 ±3.6
	Acanthurus lineatus	Lined surgeonfish	0.03 ±0.02	6.4 ±3.2
	Acanthurus nigricans	Whitecheek surgeonfish	0.04 ±0.01	3.8 ±0.9
Lethrinidae	*Gnathodentex aureolineatus*	Goldlined seabream	0.04 ±0.02	8.4 ±4.6
Lutjanidae	*Lutjanus kasmira*	Bluelined snapper	0.19 ±0.17	12.9 ±10.6
	Lutjanus gibbus	Humpback snapper	0.01 ±0.01	4.0 ±2.6
Scaridae	*Chlorurus sordidus*	Daisy parrotfish	0.03 ±0.01	4.1 ±1.0

The density of finfish in the outer reef of Vailala was higher (0.7 fish/m^2) than the value in the same habitat at Halalo (0.6 fish/m^2), however size and biomass were lower (17 versus 18 cm FL, and 100 versus 112 g/m^2 respectively). Biodiversity was much higher in Vailala (Table 2.13). Carnivores were very high in abundance and biomass so that trophic structure was composed of equal amounts of herbivores (mostly Acanthuridae and Scaridae) and carnivores (Lutjanidae, Lethrinidae and Mullidae). Size ratios were below 50% for several families: Holocentridae, Lutjanidae, Scaridae and Siganidae. Parrotfish and snappers were among the most frequently targeted families in this habitat and their smaller average size could be a first sign of a decreasing resource. Substrate composition was strongly dominated by hard bottom (very similar to Halalo outer reefs, 68%), with a high cover of live coral (27%). Although outer reefs were targeted by the lowest number of fishers and fishing trips were less frequent compared to the other habitats, impacts from fishing have started to appear, visible in the smaller size of some major families.

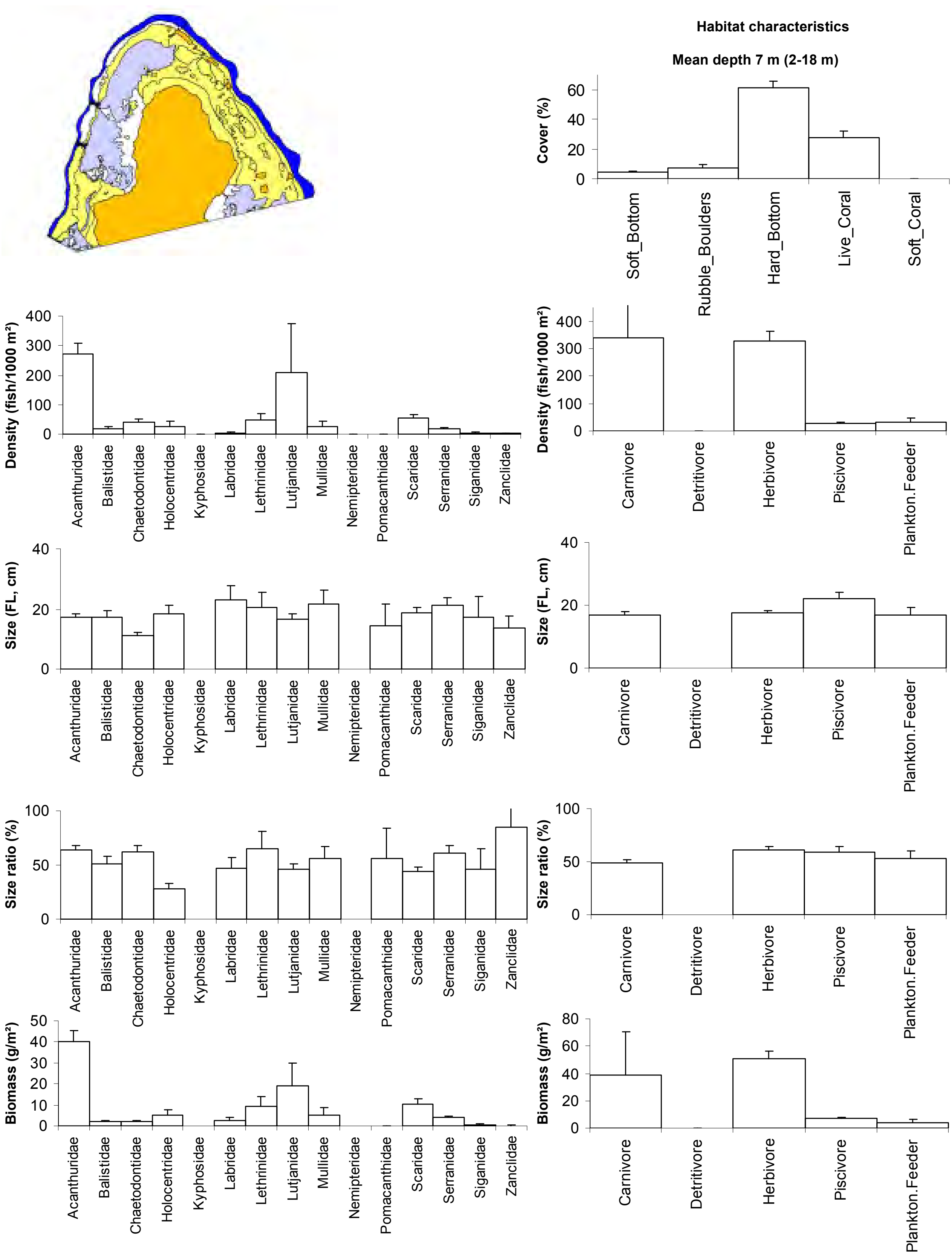

Figure 2.41: Profile of finfish resources in the outer-reef environment of Vailala.
Bars represent standard error (+SE); FL = fork length.

Overall reef environment: Vailala

Overall, the fish assemblage of Vailala was dominated by herbivorous Acanthuridae and Scaridae and carnivorous Lutjanidae and Lethrinidae (Figure 2.42). These four families were represented by a total of 50 species, dominated (in term of density and biomass) by *Ctenochaetus striatus*, *Gnathodentex aureolineatus*, *Lutjanus kasmira*, *Acanthurus lineatus*, *Chlorurus sordidus*, *L. fulviflamma* and *Monotaxis grandoculis* (Table 2.18). The average substrate was dominated by hard bottom (49%), with a good cover of live coral (25%), and of mobile bottom (23%). As expected, the overall fish assemblage in Vailala shared characteristics of outer reefs (43% of total habitat), coastal reefs (30%), and, to a lesser extent, back-reefs (15%) and intermediate reefs (11 %).

Table 2.18: Finfish species contributing most to main families in terms of densities and biomass across all reefs of Vailala (weighted average)

Family	Species	Common names	Density (fish/m^2)	Biomass (g/m^2)
Acanthuridae	*Ctenochaetus striatus*	Striated surgeonfish	0.14	21.4
	Acanthurus lineatus	Lined surgeonfish	0.02	5.0
Lethrinidae	*Gnathodentex aureolineatus*	Goldlined seabream	0.05	9.0
	Monotaxis grandoculis	Bigeye bream	0.01	3.1
Lutjanidae	*Lutjanus kasmira*	Bluelined snapper	0.10	7.5
	Lutjanus fulviflamma	Longspot snapper	0.01	4.4
Scaridae	*Chlorurus sordidus*	Daisy parrotfish	0.03	4.7

Overall, Vailala appeared to support a rather healthy finfish resource, with higher density and biomass than the ones recorded in Halalo (0.6 versus 0.4 fish/m^2 and 95 versus 66 g/m^2 respectively). Size, size ratio and biodiversity were also systematically higher in Vailala (Table 2.13). These results suggest that the finfish resource in Vailala is in average-to-good condition. Detailed assessment at the family level also revealed a good composition of herbivore and carnivore density and biomass, as well as a diverse fish community, slightly dominated by Acanthuridae, but also composed of high abundance of Scaridae and carnivorous Lutjanidae and Lethrinidae. Holocentridae, Kyphosidae and Scaridae showed average size ratios below 50%. It is possible that these families have started to suffer from spearfishing practice targeting the largest-sized fish.

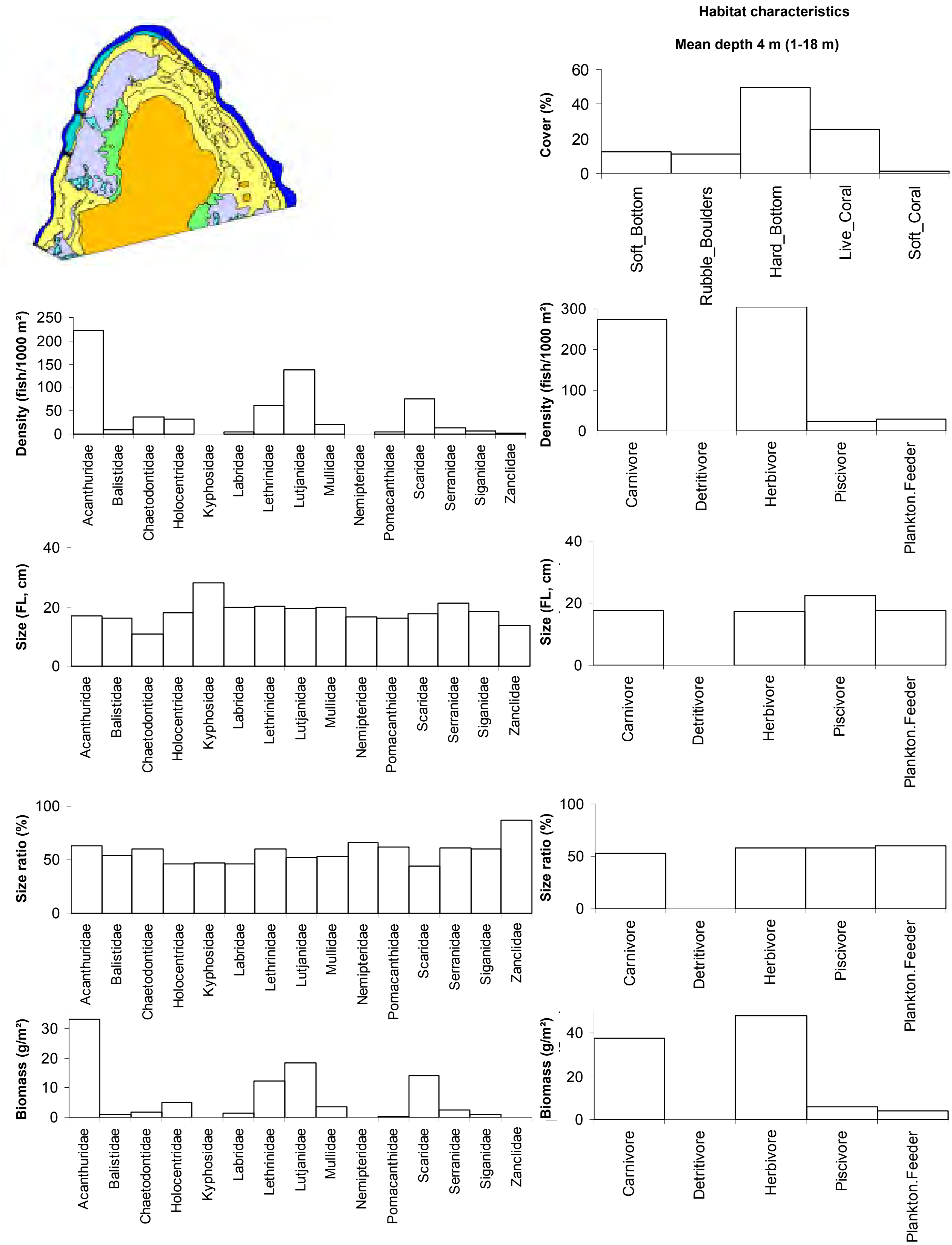

Figure 2.42: Profile of finfish resources in the combined reef habitats of Vailala (weighted average).
FL = fork length.

2.3.1.2 Discussion and conclusions: finfish resources in Vailala

The assessment indicated that the status of finfish resources in Vailala is in fairly good condition and slightly better than in Halalo (higher average density, biomass, size, size ratio and biodiversity). Detailed assessment at reef level also revealed a good composition of fish community with diversity of family and equal abundance and biomass of herbivorous and carnivorous families. Fishing in Vailala is carried out for subsistence purposes and only to a limited extent to generate income. Most catches are carried out on internal reefs (coastal, intermediate and back-reefs) but resources seem to be showing sign of decrease mainly in the back-reefs (lower density and biomass, size and size ratio as well as dominance of herbivores over carnivores).

- Overall, Vailala finfish resources appeared to be in relatively good condition. The reef habitat seemed relatively rich and the fish population diverse and abundant.

- Vailala populations of Lutjanidae, Kyphosidae, and Siganidae showed size ratios below 50%, indicating a first sign of impact from selective fishing, probably spearfishing.

2.3.2 Halalo

Finfish resources and associated habitats were assessed between 31 August and 16 September 2005, from a total of 25 transects (7 sheltered coastal, 7 intermediate, 7 back- and 4 outer-reef transects, Figure 2.43 and Appendix 3.2.1 for transect locations and coordinates respectively).

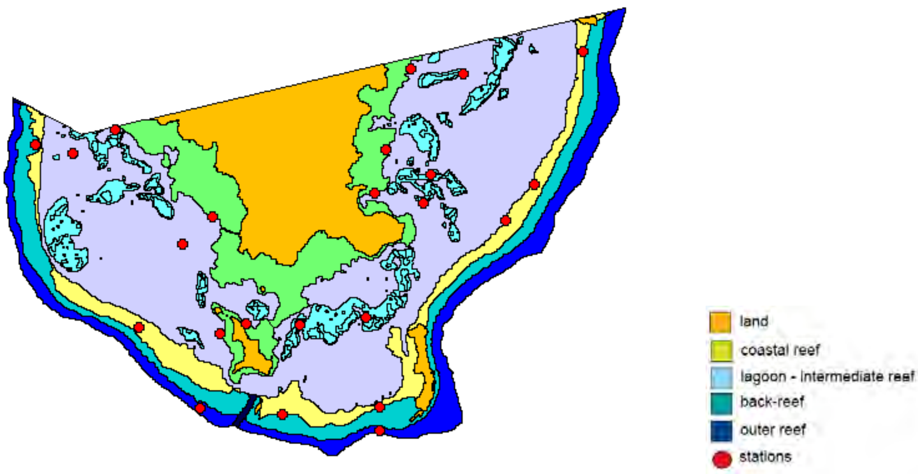

Figure 2.43: Habitat types and transect locations for finfish assessment in Halalo.

2.3.2.1 Finfish assessment results: Halalo

A total of 20 families, 52 genera, 129 species and 6931 fish were recorded in the 25 transects (See Appendix 3.2.2 for list of species.). Only data on the 15 most dominant families (See Appendix 1.2 for species selection.) are presented below, representing 45 genera, 122 species and 6881 individuals.

Finfish resources varied greatly among the four reef environments found in Halalo (Table 2.19). The outer reef contained the greatest fish density (0.6 fish/m^2), the largest average fish sizes (18 cm FL) and size ratio (61%), the largest biomass (112 g/m^2) and highest biodiversity (40 species/transect). In contrast, the intermediate reef displayed the lowest fish density (0.4 fish/m^2), although identical to coastal and back-reefs; the smallest average size and size ratios (15 cm FL and 52%); and the lowest biomass (42 g/m^2). Back-reefs displayed the lowest biodiversity (23 species/transect), and second lowest biomass (52 g/m^2). Sheltered coastal reefs showed low values of density (0.4 fish/m^2) but second-highest biomass (62 g/m^2).

Table 2.19: Primary finfish habitat and resource parameters recorded in Halalo (average values ±SE)

Parameters	Habitat				
	Sheltered coastal reef (1)	Intermediate reef (1)	Back-reef (1)	Outer reef (1)	All reefs (2)
Number of transects	7	7	7	4	25
Total habitat area (km^2)	14.8	11.4	11.2	11.0	48.3
Depth (m)	4	4	2	7	4
Soft bottom (% cover)	24 ±6	18 ±4	28 ±4	1 ±1	18
Rubble & boulders (% cover)	18 ±6	8 ±2	12 ±6	5 ±1	11
Hard bottom (% cover)	44 ±7	53 ±7	46 ±6	68 ±5	52
Live coral (% cover)	10 ±1	15 ±4	13 ±2	26 ±4	16
Soft coral (% cover)	2 ±1	5 ±5	0 ±0	0 ±0	2
Biodiversity (species/transect)	24 ±5	30 ±3	23 ±4	40 ±5	28
Density (fish/m^2)	0.4 ±0.1	0.4 ±0.1	0.4 ±0.1	0.6 ±0.1	0.4
Size (cm FL) (4)	18 ±1	15 ±1	16 ±1	18 ±1	17
Size ratio (%)	53 ±3	52 ±2	54 ±3	61 ±3	55
Biomass (g/m^2)	61.7 ±23.5	41.6 ±10.2	52.2 ±13.5	112.1 ±30.7	66.2

(1) Unweighted average; (2) weighted average that takes into account relative proportion of habitat in the study area; (3) depth range; (4) FL = fork length.

Sheltered coastal reef environment: Halalo

The sheltered coastal reef environment of Halalo was dominated by three families: herbivorous Acanthuridae and Scaridae, and carnivorous Lutjanidae (Figure 2.44, Table 2.20). These three families were represented by 28 species; particularly high abundance and biomass were recorded for *Ctenochaetus striatus, Lutjanus fulvus, L. gibbus, Chlorurus sordidus, Scarus ghobban, Acanthurus lineatus, L. kasmira* and *Zebrasoma scopas.* This reef environment was dominated by hard bottom (44%) with similar proportions of soft bottom (24%) and rubble (18%). Live-coral cover was very low (10%, Table 2.19 and Figure 2.44).

Table 2.20: Finfish species contributing most to main families in terms of densities and biomass in the sheltered coastal reef environment of Halalo

Family	Species	Common name	Density (fish/m^2)	Biomass (g/m^2)
Acanthuridae	*Ctenochaetus striatus*	Striated surgeonfish	0.09 ±0.03	10.9 ±4.4
	Acanthurus lineatus	Lined surgeonfish	0.01 ±0.01	2.8 ±2.8
	Zebrasoma scopas	Twotone tang	0.02 ±0.01	1.1 ±0.9
Lutjanidae	*Lutjanus fulvus*	Flametail snapper	0.03 ±0.02	10.0 ±5.9
	Lutjanus gibbus	Humpback snapper	0.02 ±0.01	5.8 ±5.8
	Lutjanus kasmira	Bluelined snapper	0.02 ±0.02	1.7 ±1.7
Scaridae	*Chlorurus sordidus*	Daisy parrotfish	0.03 ±0.01	3.3 ±1.6
	Scarus ghobban	Bluebarred parrotfish	0.01 ±0.01	3.1 ±3.0

The density, size, size ratio and biomass of finfish in the sheltered coastal reefs of Halalo were smaller than values recorded in the northern site, Vailala. Biodiversity was also lower (24 versus 34 species/transect). The trophic structure in Halalo coastal reefs was equally composed of herbivores and carnivores, both in terms of density and biomass. Herbivores were mainly represented by Acanthuridae and, to a smaller extent, by Scaridae. However, Scaridae, as well as Labridae, Lethrinidae and Mullidae, displayed size ratios below 50%. This might suggest the beginning of a detectable impact on such fish targets: in fact, Lethrinidae, followed by Lutjanidae, Acanthuridae and Scaridae are the most frequently fished families in sheltered coastal reefs.

The sheltered coastal reefs of Halalo displayed a dominance of hard bottom (44%) and a similar proportion of soft and rubble bottom (37% when combined). This type of substrate may explain the composite fish community: herbivorous fish are in fact generally associated with hard bottom, while carnivorous species are generally associated with soft bottom[7]. Moreover, mobile soft bottom is a type of environment that favours Lethrinidae, here represented by high numbers of *Monotaxis grandoculis*, and Mullidae (mainly *Parupeneus multifasciatus*), which feed on small invertebrates.

[7] Soft-bottom environments are generally rich in small invertebrates, which are the main food items of carnivorous fish, while hard-bottom habitats are often covered with algae, the food of herbivorous fish.

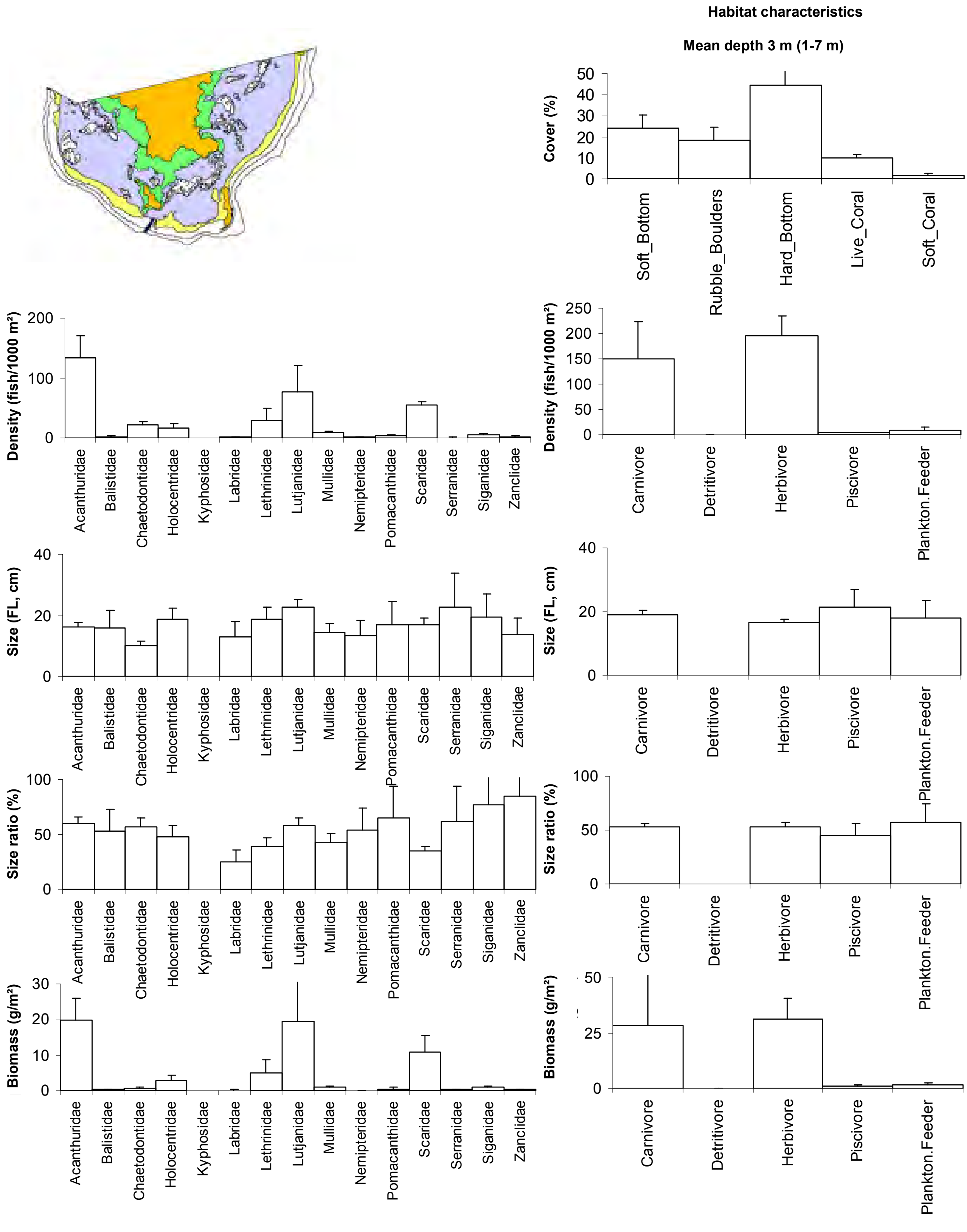

Figure 2.44: Profile of finfish resources in the sheltered coastal reef environment of Halalo.
Bars represent standard error (+SE); FL = fork length.

Intermediate-reef environment: Halalo

The intermediate-reef environment of Halalo was dominated by Acanthuridae and Lethrinidae and, to a lesser extent, Scaridae and Holocentridae. These four families were represented by 33 species; the most important in terms of biomass and density were: *Ctenochaetus striatus, Gnathodentex aureolineatus, Chlorurus sordidus, Acanthurus lineatus, Myripristis adusta* and *Monotaxis grandoculis* (Table 2.21). The substrate of this habitat was mostly covered by hard bottom (53%), a small amount of rubble (8%), a good cover of soft bottom (18%) and a slightly higher cover of live coral compared to coastal and back-reefs (15% cover) (Table 2.19 and Figure 2.45).

Table 2.21: Finfish species contributing most to main families in terms of densities and biomass in the intermediate-reef environment of Halalo

Family	Species	Common name	Density (fish/m^2)	Biomass(g/m^2)
Acanthuridae	*Ctenochaetus striatus*	Striated surgeonfish	0.10 ±0.02	12.3 ±2.6
	Acanthurus lineatus	Lined surgeonfish	0.01 ±0.01	1.7 ±1.3
Lethrinidae	*Gnathodentex aureolineatus*	Goldlined seabream	0.08 ±0.04	6.4 ±3.4
	Monotaxis grandoculis	Bigeye bream	0.01 ±0.01	1.3 ±0.8
Scaridae	*Chlorurus sordidus*	Daisy parrotfish	0.02 ±0.01	2.3 ±1.1
Holocentridae	*Myripristis adusta*	Shadowfin soldierfish	0.02 ±0.01	1.6 ±1.1

When compared to the intermediate-reef habitats of Vailala, the intermediate reefs of Halalo displayed lower fish density, size, biomass and biodiversity. When compared to the other habitats in Halalo, intermediate reefs displayed the lowest values of biomass, size and size ratio, but the second-highest value of biodiversity (30 species/transect versus 40 in the outer reefs). The trophic structure was slightly dominated by herbivores (only in terms of biomass) (Figure 2.45). Carnivorous families were well represented and composed primarily of Lethrinidae and Holocentridae. Size ratios were low for these families, as well as for the much rarer Lutjanidae and Mullidae and for the herbivorous Scaridae. Size ratios below 50% can be a first sign of impact from fishing, especially spearfishing. The intermediate reef of Halalo had a good cover of mobile substrate, composed of soft bottom and rubble (26%), which is generally favourable for Mullidae and Lethrinidae. This type of substrate may explain the particular nature of the trophic structure, which was almost equally composed of carnivores (associated with soft bottom) and of herbivores, such as Acanthuridae (associated with hard bottom).

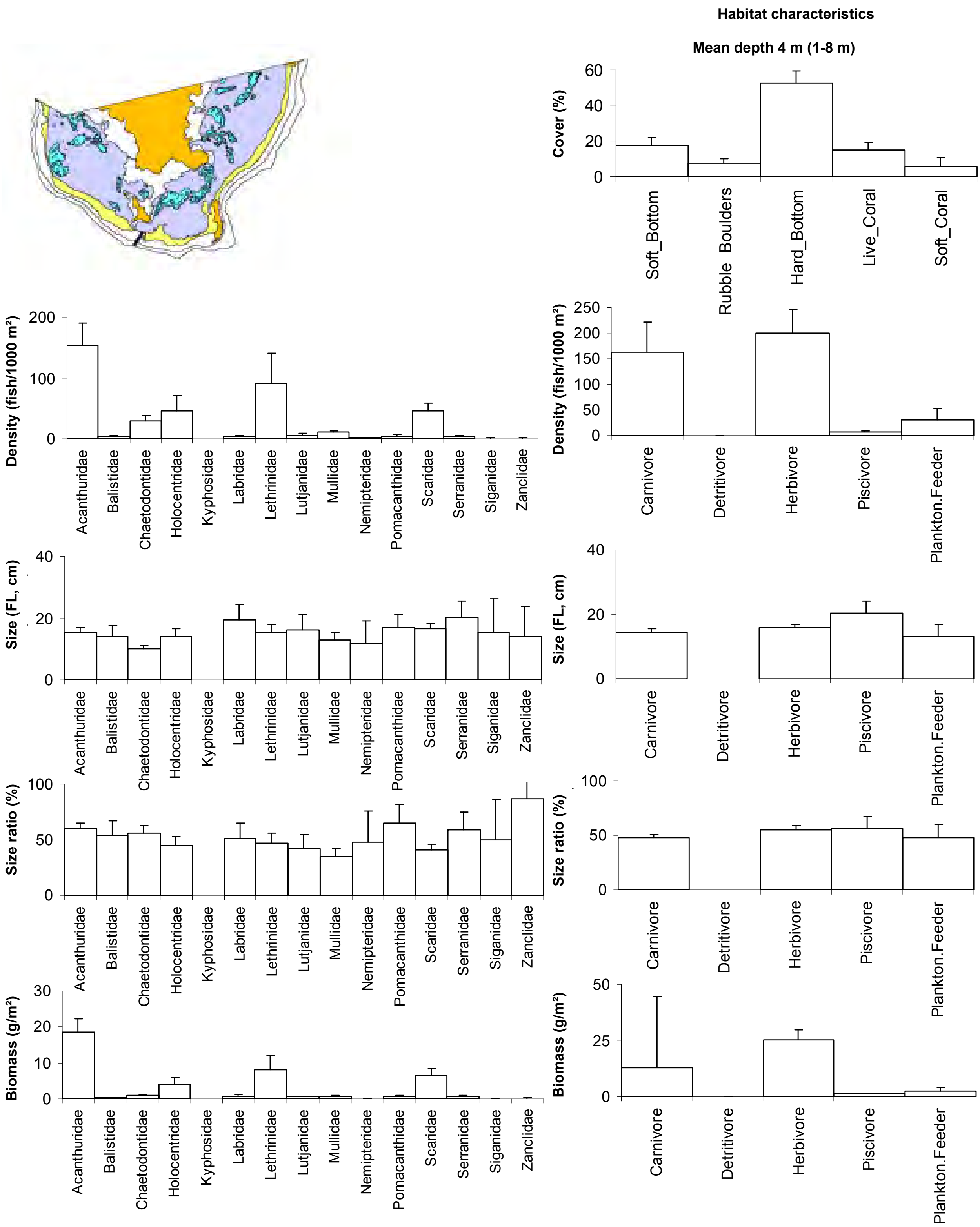

Figure 2.45: Profile of finfish resources in the intermediate-reef environment of Halalo.
Bars represent standard error (+SE); FL = fork length.

Back-reef environment: Halalo

The back-reef environment of Halalo was dominated mostly by Acanthuridae and, to a much lesser extent, Lutjanidae and Scaridae (Figure 2.46), represented overall by 26 species; particularly high abundance and biomass were recorded for *Ctenochaetus striatus, Acanthurus olivaceus, A. blochii, Lutjanus fulvus, A. triostegus, L. fulviflamma* and *Scarus psittacus* (Table 2.22). This reef environment presented a moderately diverse habitat, mostly hard bottom (46%), with a good cover of soft bottom (28%) and slightly more live-coral cover than coastal reefs (13%) (Table 2.19 and Figure 2.46).

Table 2.22: Finfish species contributing most to main families in terms of densities and biomass in the back-reef environment of Halalo

Family	Species	Common name	Density (fish/m^2)	Biomass (g/m^2)
Acanthuridae	*Ctenochaetus striatus*	Striated surgeonfish	0.107 ±0.038	12.4 ±4.5
	Acanthurus olivaceus	Orangeband surgeonfish	0.045 ±0.030	10.0 ±6.4
	Acanthurus blochii	Ringtail surgeonfish	0.018 ±0.016	5.7 ±5.4
	Acanthurus triostegus	Convict tang	0.052 ±0.021	3.4 ±1.5
Lutjanidae	*Lutjanus fulvus*	Flametail snapper	0.019 ±0.015	4.8 ±3.6
	Lutjanus fulviflamma	Longspot snapper	0.005 ±0.004	1.3 ±1.0
Scaridae	*Scarus psittacus*	Common parrotfish	0.005 ±0.002	1.0 ±0.6

The size ratio, biomass and biodiversity of fish in the back-reef of Halalo were all higher than the values in Vailala back-reefs. Fish density and size were equal to those in Vailala back-reefs. Size and biomass were the second-lowest values among the four habitats in Halalo, while density was the same at coastal, back- and intermediate reefs. The trophic structure in Halalo back-reefs was strongly dominated by herbivores in both density and biomass. Size ratios of Labridae, Lethrinidae, Mullidae and Scaridae were well below the 50% limit. The back-reefs of Halalo had a rather high percentage of hard bottom (46%) and a good cover of mobile bottom (30% of soft bottom and rubble). This type of environment may explain why herbivorous fish are particularly abundant, since they are generally associated with hard bottom.

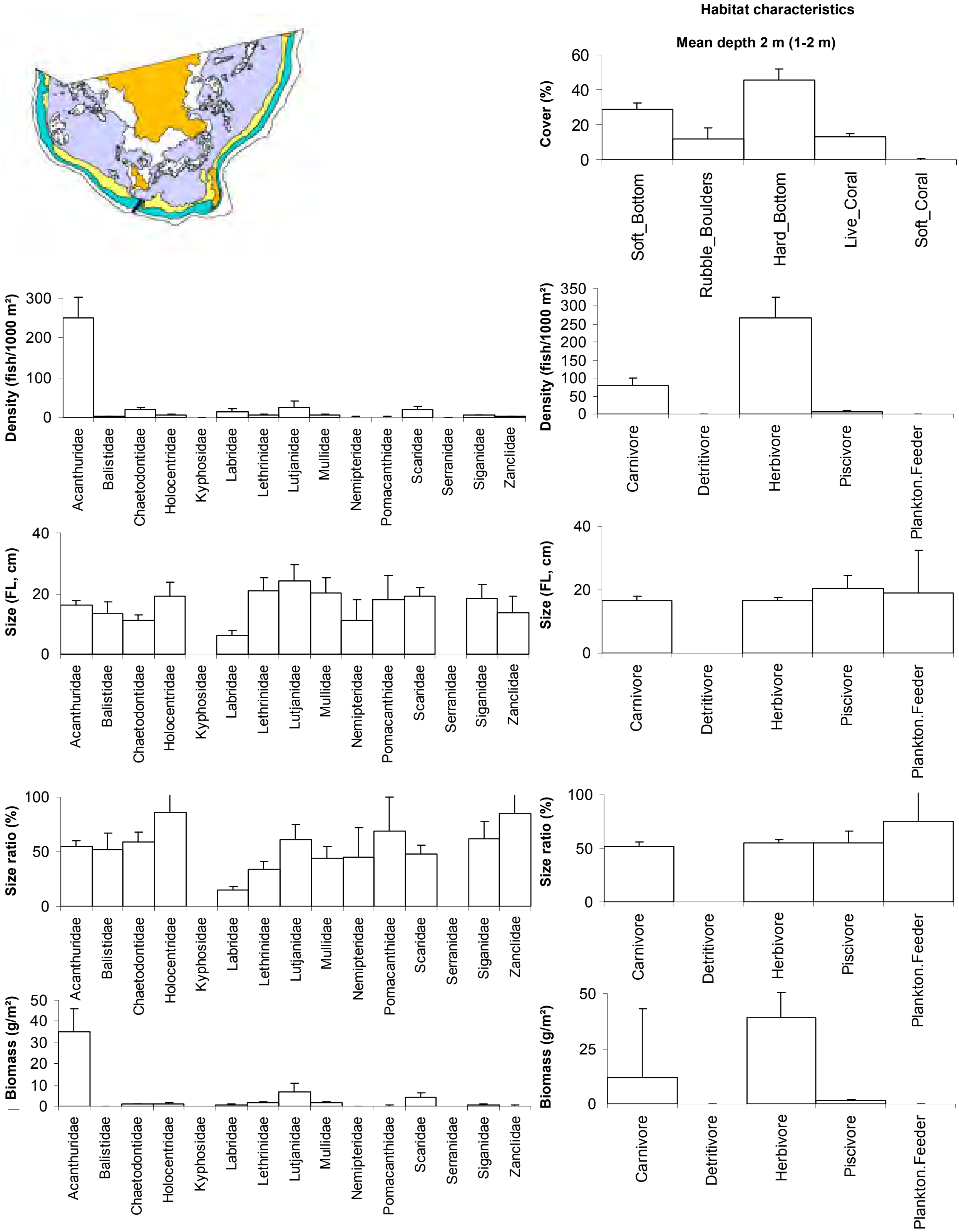

Figure 2.46: Profile of finfish resources in the back-reef environment of Halalo.
Bars represent standard error (+SE); FL = fork length.

Outer-reef environment: Halalo

The outer reef of Halalo was dominated, both in terms of density and biomass, by herbivorous Acanthuridae and carnivorous Lethrinidae, Lutjanidae and Mullidae (Figure 2.47), as well as by the family Kyphosidae only for biomass. These five families were present with 21 species: *Ctenochaetus striatus*, *Acanthurus lineatus*, *Mulloidichthys vanicolensis*, *Kyphosus cinerascens*, *Gnathodentex aureolineatus*, *Lutjanus monostigma*, *A. nigricans*, *Monotaxis grandoculis* and *L. biguttatus* (Table 2.23). Hard bottom covered most of the habitat (68%), with a good amount of live coral (26%), but almost no mobile substrate.

Table 2.23: Finfish species contributing most to main families in terms of densities and biomass in the outer-reef environment of Halalo

Family	Species	Common name	Density (fish/m^2)	Biomass (g/m^2)
Acanthuridae	*Ctenochaetus striatus*	Striated surgeonfish	0.22 ±0.03	30.0 ±3.6
	Acanthurus lineatus	Lined surgeonfish	0.08 ±0.03	21.1 ±9.2
	Acanthurus nigricans	Whitecheek surgeonfish	0.05 ±0.02	4.0 ±1.6
Mullidae	*Mulloidichthys vanicolensis*	Yellowfin goatfish	0.03 ±0.03	9.4 ±9.4
Kyphosidae	*Kyphosus cinerascens*	Topsail drummer	0.02 ±0.02	8.7 ±8.7
Lethrinidae	*Gnathodentex aureolineatus*	Goldlined seabream	0.04 ±0.03	7.1 ±5.3
	Monotaxis grandoculis	Bigeye bream	0.01 ±0.00	3.2 ±2.6
Lutjanidae	*Lutjanus monostigma*	Onespot snapper	0.01 ±0.01	5.0 ±5.0
	Lutjanus biguttatus	Two-spot snapper	0.02 ±0.02	2.5 ±2.5

The size, size ratio and biomass of finfish in the outer reef of Halalo were higher than those recorded in Vailala (Table 2.19). However, density was lower (0.6 versus 0.7 fish/m^2). When compared to the other Halalo habitats, the outer-reef resources displayed the highest biological values. The trophic composition was dominated by herbivores and overall the fish community was rather complex with many families occuring. Among these, Acanthuridae were the main herbivores and Lethrinidae, Lutjanidae, Mullidae and Kyphosidae represented the bulk of the carnivore community. Substrate composition showed a strong dominance of hard bottom and live coral (94% together) explaining the high abundance of Acanthuridae.

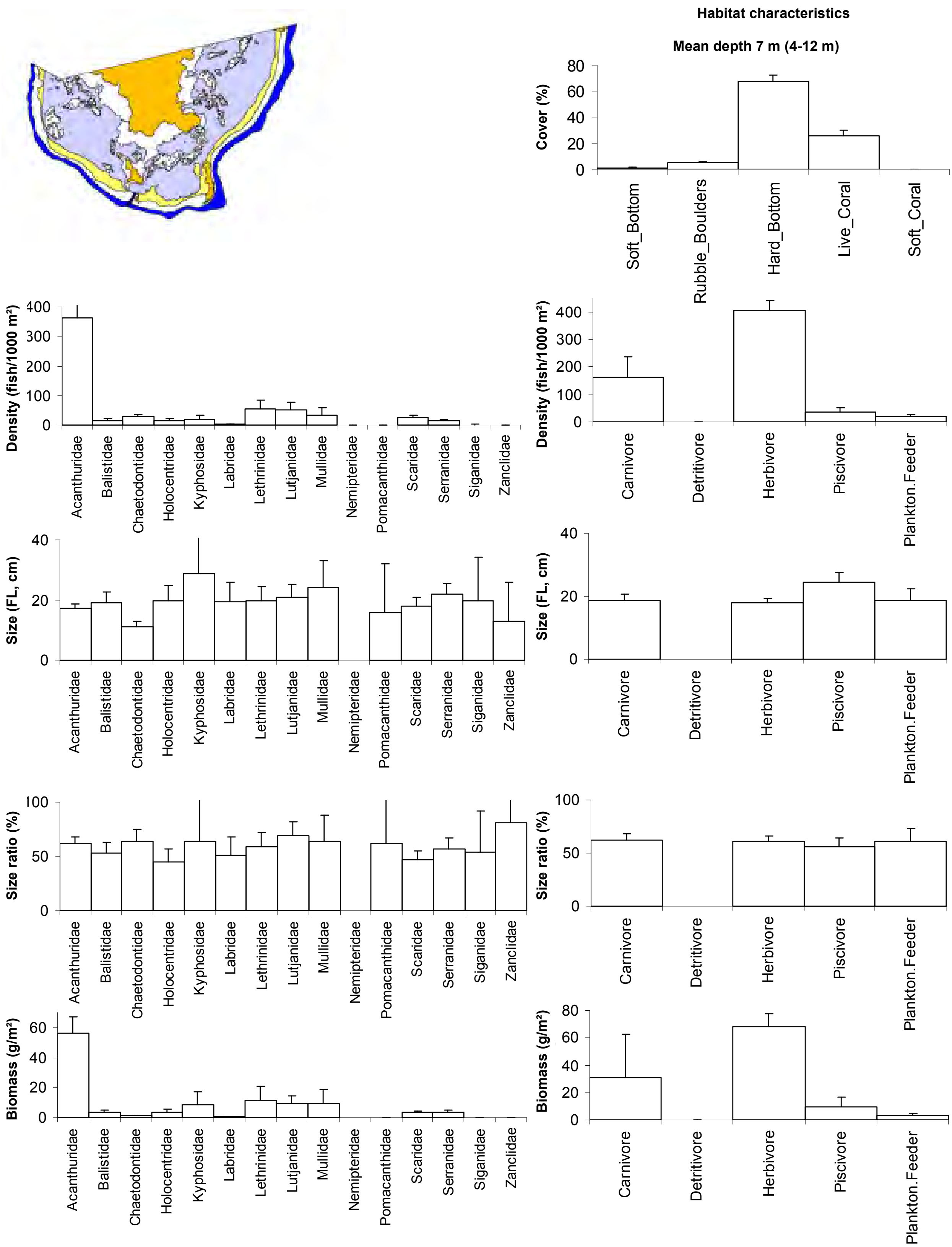

Figure 2.47: Profile of finfish resources in the outer-reef environment of Halalo.
Bars represent standard error (+SE); FL = fork length.

Overall reef environment: Halalo

Overall, the fish assemblage of Halalo was dominated, in terms of density and biomass, and to a large extent, by herbivores Acanthuridae, and to a lesser extent, Scaridae; other important families were carnivores Lethrinidae and Lutjanidae (Figure 2.48). These four families were represented by a total of 47 species, dominated by *Ctenochaetus striatus*, *Acanthurus lineatus*, *Lutjanus fulvus*, *Gnathodentex aureolineatus*, *A. olivaceus*, *A. blochii*, *Chlorurus sordidus* and *Monotaxis grandoculis* (Table 2.24). Hard bottom covered a good proportion of the habitat (52%); cover of live coral was rather low (16%, Table 2.13 and Figure 2.48), and lower than in the overall reef environment in the northern part of Wallis (25%). As expected, the overall fish assemblage in Halalo shared characteristics primarily of coastal reefs (30% of total habitat), and, to similar extent, intermediate reefs (24%), back-reefs (23%) and outer reefs (23 %).

Table 2.24: Finfish species contributing most to main families in terms of densities and biomass across all reefs of Halalo (weighted average)

Family	Species	Common name	Density (fish/m^2)	Biomass (g/m^2)
Acanthuridae	*Ctenochaetus striatus*	Striated surgeonfish	0.13	15.9
	Acanthurus lineatus	Lined surgeonfish	0.02	6.1
	Acanthurus olivaceus	Orangeband surgeonfish	0.01	2.3
	Acanthurus blochii	Ringtail surgeonfish	0.01	2.2
Lutjanidae	*Lutjanus fulvus*	Flametail snapper	0.01	4.2
Lethrinidae	*Gnathodentex aureolineatus*	Goldlined seabream	0.03	3.4
	Monotaxis grandoculis	Bigeye bream	0.01	2.1
Scaridae	*Chlorurus sordidus*	Daisy parrotfish	0.02	2.2

Overall, Halalo showed lower biological values than Vailala. The trophic structure was dominated by herbivores, mainly represented by a very high abundance of Acanthuridae. Cover of hard and soft bottom was higher than in Vailala, but live-coral cover was lower. Since carnivores are in general associated with soft bottoms, their high abundance could be explained by natural habitat composition. Size ratios were below the 50% limit for Labridae, Lethrinidae, Acanthuridae and Scaridae, perhaps an early warning of fishing impact.

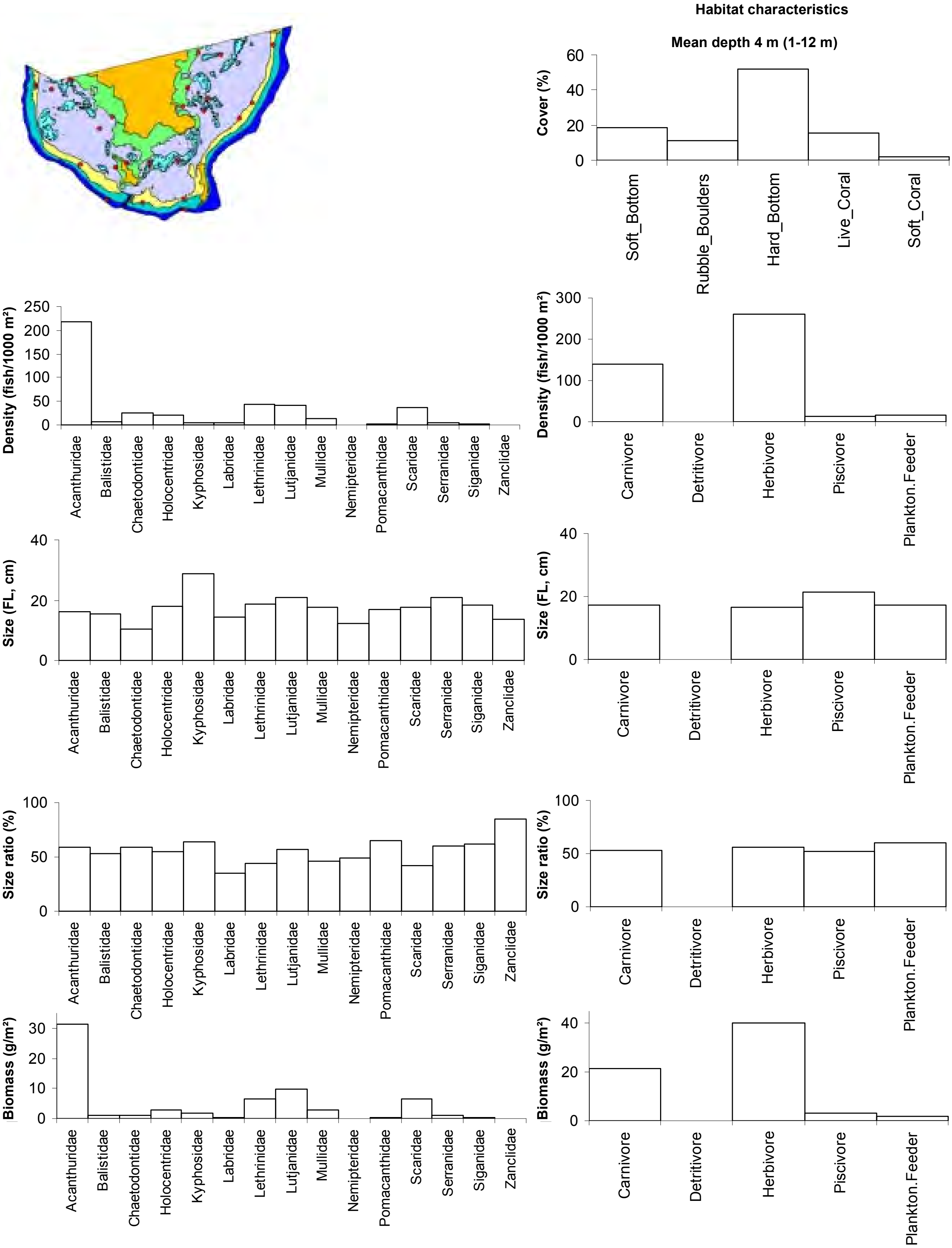

Figure 2.48: Profile of finfish resources in the combined reef habitats of Halalo (weighted average).
FL = fork length.

2.3.2.2 Discussion and conclusions: finfish resources in Halalo

The assessment indicated that the status of finfish resources in this site at the time of surveys was average. The Halalo community is only slightly dependent on fishing for income generation (Less than 40% of the people rely on fisheries as their first source of income, although this proportion is higher than the 18% of Vailala) and, although the community consumes a large quantity of fresh fish, the density of the population per reef-habitat area and per fishing ground does not impose a very high pressure on the overall resources. However, more impact is inflicted on the lagoon habitat due to the higher density of fishers and frequency of trips to this habitat compared to the other areas (mainly passages). The underwater methodology does not allow diving in the passages (which are normally fished), but comparisons can be made between the lagoon and the outer reefs. Outer reefs displayed the highest density, size, biomass and diversity of fish of all the habitats analysed, suggesting healthy stocks and little exploitation on this environment. Instead, lagoon reefs showed the lowest values of biological indicators. Here, fish size and size ratio, which are used to indicate the level of impact from catches, were particularly low. The fishing methods (mostly gillnets and spearfishing), rather than the frequency of catches, are mainly responsible for the impact recorded on average fish size. Gillnetting and spearfishing are harmful practices for fish communities.

- Overall, Halalo finfish resources appeared to be in average condition. However, at the reef-habitat level, strong differences were found, especially between the rich outer reefs and the very poor lagoon and sheltered coastal reefs. Both the composition of the substrate and the density and biomass of fish were much poorer than in the northern part of the island.

- First signs of fishing impact were revealed by the low abundance and biomass in the lagoon and coastal reefs. Biodiversity was also lower than at Vailala.

- The higher fishing pressure put on the fisheries in the lagoon and coastal reefs is also shown by the smaller fish sizes, a first signal of high exploitation.

2.4 Invertebrate resource surveys: Wallis

The diversity and abundance of invertebrate species at Halalo and Vailala on Uvea at Wallis were independently determined using a range of survey techniques (Table 2.25): broad-scale assessment (using the 'manta tow' technique; locations shown in Figure 2.49) and finer-scale assessment of specific reef and benthic habitats (Figures 2.50 and 2.51).

The broad-scale assessment was conducted by manta tow, the main objective being to describe the distribution pattern of invertebrates (rareness/commonness, patchiness) at large scale and, importantly, to identify target areas for further, fine-scale assessment. Then fine-scale assessment was conducted in target areas to specifically describe the status of resource in those areas of naturally higher abundance and/or most suitable habitat.

Table 2.25: Number of stations and replicates completed at Vailala, Halalo and all Wallis

All Wallis (survey totals)

Survey method	Stations	Replicate measures
Broad-scale transects (B-S)	25	150 transects
Reef-benthos transects (RBt)	35	210 transects
Soft-benthos transects (SBt)	0	0 transect
Soft-benthos infaunal quadrats (SBq)	23	184 quadrat groups
Mother-of-pearl transects (MOPt)	10	60 transects
Mother-of-pearl searches (MOPs)	5	30 search periods
Reef-front searches	11 RFs 11 RFs_w	132 search periods
Sea cucumber night searches (Ns)	4	30 search periods
Sea cucumber day searches (Ds)	7	44 search periods

RFS = reef-front search; RFs_w = reef-front search by walking.

Vailala

Survey method	Stations	Replicate measures
Broad-scale transects (B-S)	12	72 transects
Reef-benthos transects (RBt)	17	102 transects
Soft-benthos transects (SBt)	0	0 transect
Soft-benthos infaunal quadrats (SBq)	23	184 quadrat groups
Mother-of-pearl transects (MOPt)	6	36 transects
Mother-of-pearl searches (MOPs)	2	12 search periods
Reef-front searches	6 RFs 2 RFs_w	48 search periods
Sea cucumber night searches (Ns)	2	18 search periods
Sea cucumber day searches (Ds)	3	20 search periods

RFS = reef-front search; RFs_w = reef-front search by walking.

Halalo

Survey method	Stations	Replicate measures
Broad-scale transects (B-S)	13	78 transects
Reef-benthos transects (RBt)	18	108 transects
Soft-benthos transects (SBt)	0	0 transect
Soft-benthos infaunal quadrats (SBq)	0	0 quadrat group
Mother-of-pearl transects (MOPt)	4	24 transects
Mother-of-pearl searches (MOPs)	3	18 search periods
Reef-front searches	5 RFs 9 RFs_w	84 search periods
Sea cucumber night searches (Ns)	2	12 search periods
Sea cucumber day searches (Ds)	4	24 search periods

RFS = reef-front search; RFs_w = reef-front search by walking.

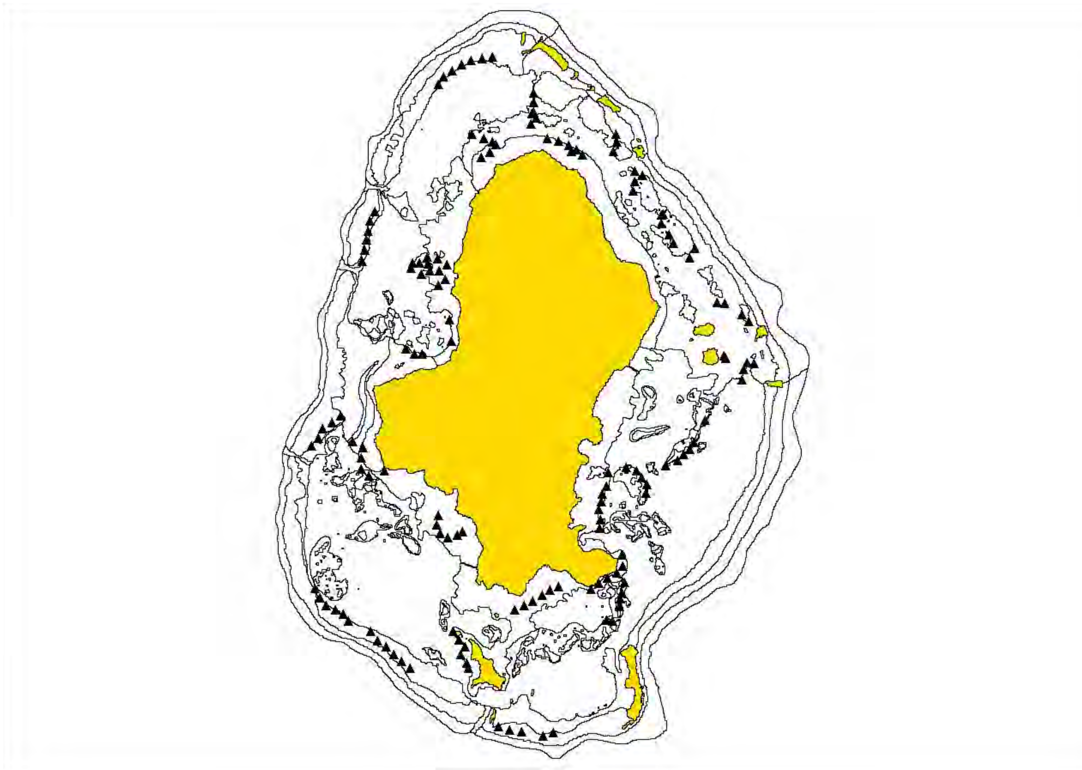

Figure 2.49: Broad-scale survey stations for invertebrates in Wallis.
Data from broad-scale surveys conducted using 'manta-tow' board;
black triangles: transect start waypoints.

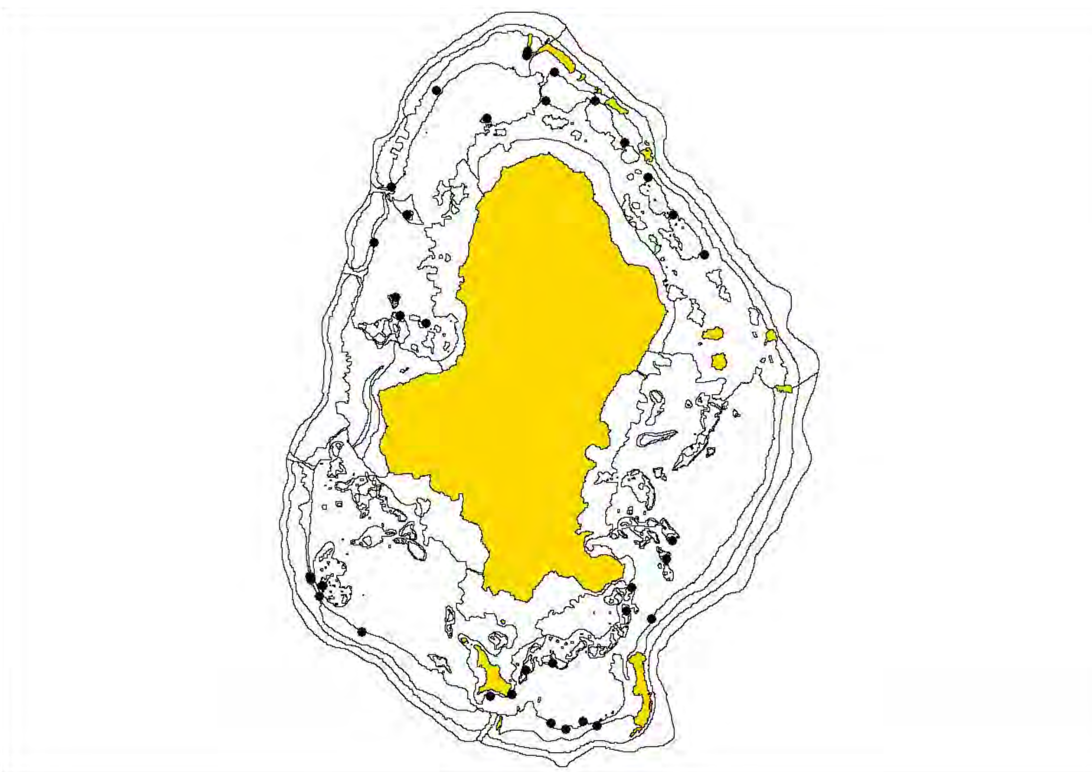

Figure 2.50: Fine-scale reef-benthos transect survey stations for invertebrates in Wallis.
Black circles: reef-benthos transect stations (RBt).

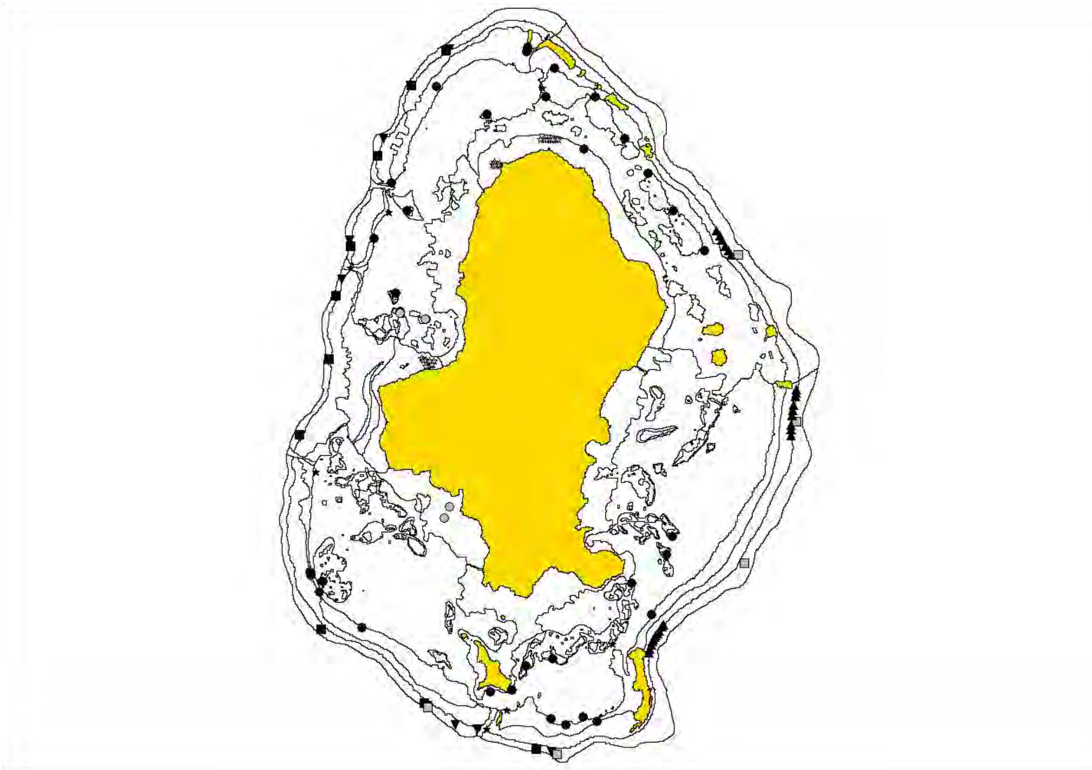

Figure 2.51: Fine-scale survey stations for invertebrates in Wallis.
Black triangles inverted: reef-front search stations (RFs);
black triangles: reef-front search stations by walking (RFs_w);
grey stars: soft-benthos infaunal quadrat stations (SBq);
grey squares: mother-of-pearl search stations (MOPs);
black squares: mother-of-pearl transect stations (MOPt);
black stars: sea cucumber day search stations (Ds);
grey circles: sea cucumber night search stations (Ns).

Sixty-three species or species groupings (groups of species within a genus) were recorded during the Wallis (Vailala/Halalo) invertebrate surveys; 15 (Vailala: 14/ Halalo: 5) bivalves, 60 (48/44) gastropods, 16 (16/14) sea cucumbers, 5 (3/4) crustaceans, 4 (3/3) starfish and 6 (6/4) urchins, 1 cnidarian (1/1) (Appendix 4.1.1 and Appendices for each site: 4.2 and 4.3). Information on key families and species is detailed below.

2.4.1 Giant clams: Vailala, Halalo and all Wallis

Broad-scale sampling provided an overview of giant clam distribution around Wallis. A total of 75.3 km^2 of shallow-reef habitat suitable for giant clams was found within the lagoon (42.1 km^2) and at the barrier (33.2 km^2). Outside the barrier, the reef slope was generally acute but some shallow-water shoals existed, especially in the northwest (lee) of the island. Shallow-water reef flats and benthos near the shoreline of Wallis tended to be shallow or dry at low tides, and was generally not very suitable for many clam species.

Generally, water flow within the lagoon was only dynamic near passages in the barrier reef and 'false' passes within the lagoon (false passe south of I Nukuloa in Vailala and passe Faioa in Halalo). Water movement in the lagoon was influenced by run-off from the land, and by open ocean.

During the broad-scale assessment of Wallis, only the elongate clam, *Tridacna maxima*, was recorded (present in 6 stations, 10 transects). The average density of these clams was 1.9 per ha ±0.9. Halalo (3.2 per ha ±1.6) had a higher mean density of *T. maxima* than that recorded at Vailala (0.5 per ha ±0.3).

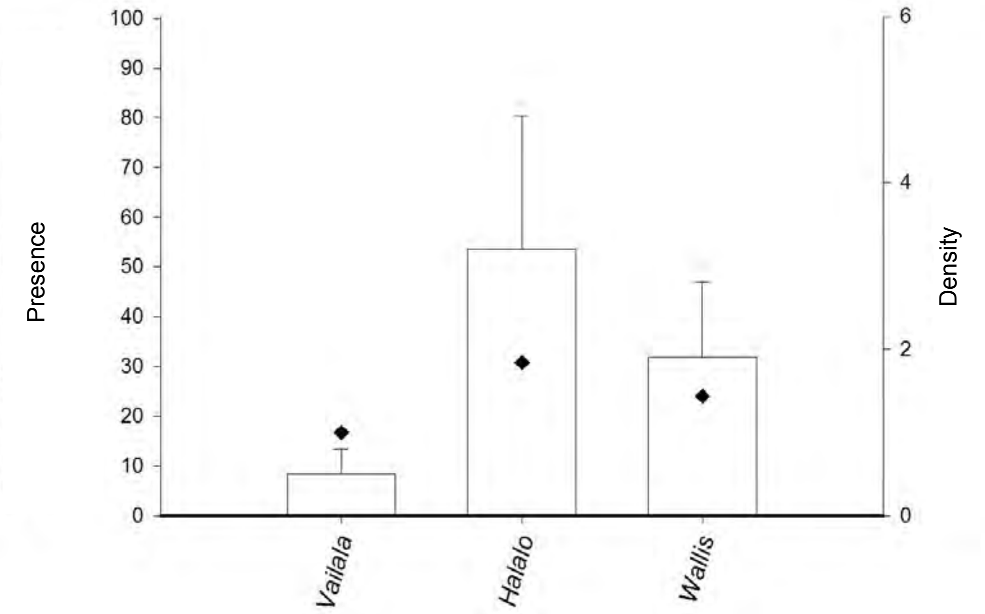

Figure 2.52: Presence and mean density of *Tridacna maxima* clams at Vailala, Halalo and all Wallis based on broad-scale survey.
Presence is measured as % of stations surveyed where clams were present and denoted by black diamonds; density is measured in numbers per hectare and is represented by bars (+SE).

Based on the findings of the broad-scale survey, finer-scale surveys targeted specific areas of shallow-water reef (clam habitat). In these reef-benthos assessments (RBt), *T. maxima* was present within 47% of stations in Vailala and 39% of stations in Halalo (Figure 2.53). RBt stations in Wallis had an overall mean density of 33.3 per ha ±9.8 (Vailala stations: 31.9 per ha ±9.0; Halalo stations: 34.7 per ha ±9.6). *T. maxima* were well dispersed across the lagoon in Wallis. When density was calculated from the 15 RBt stations where clams were noted, *T. maxima* had a mean density of 77.8 per ha ±17.2. The highest-density station was on the northwest point of Nukuloa Island, Vailala, and on the back-reef west of Faioa island in the Halalo section of the lagoon.

Despite earlier reports of the fluted clam, *Tridacna squamosa*, being recorded on Wallis (Wells 1997), no larger species of giant clam (neither the smooth clam *Tridacna derasa* nor the true giant clam *Tridacna gigas*) were recorded in surveys. These species are characteristically found at lower density than the smaller species, but generally always show up in PROCFish assessments where they occur.

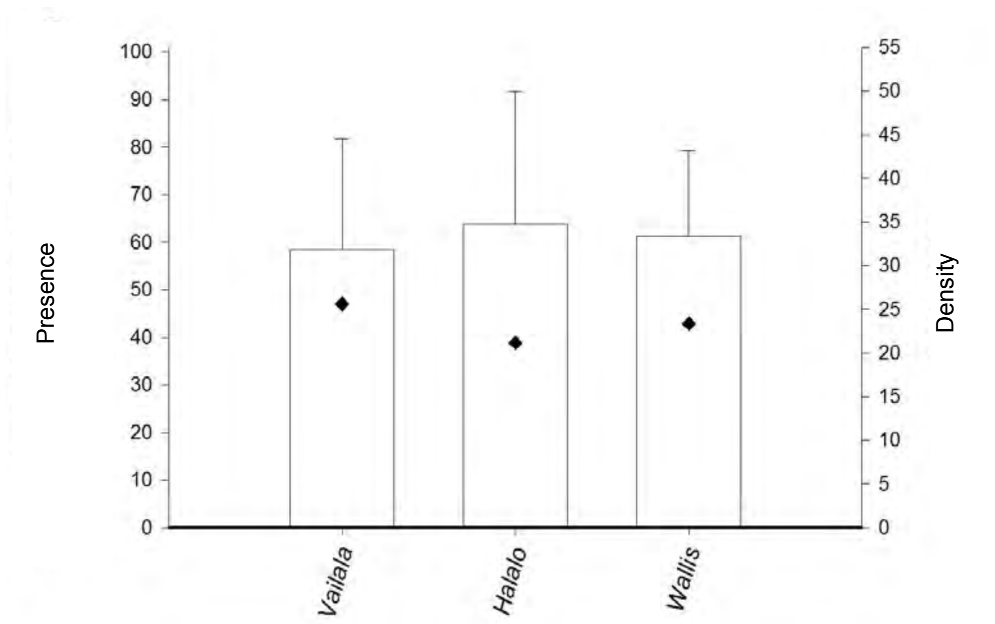

Figure 2.53: Presence and mean density of *Tridacna maxima* clams at Vailala, Halalo and all Wallis based on fine-scale reef-benthos survey.
Presence is measured as % of stations surveyed where clams were present and denoted by black diamonds; density is measured in numbers per hectare and is represented by bars (+SE).

Despite the moderate densities noted in survey, a full range of clam (*T. maxima*) sizes were recorded, with an average length of 21.0 cm ±2.2. Clams from reef-benthos transects alone had a smaller mean length of 18.9 cm ±3.8. As can be seen from the length frequency graphs (Figure 2.54), clams of all lengths, including clams around the asymptotic length of approximately 30 cm, were recorded in survey. Larger clams were usually found outside the barrier reefs in low density, and clams within the lagoon were sparse and smaller in size (Unfished stocks usually have a predominance of larger clam sizes.).

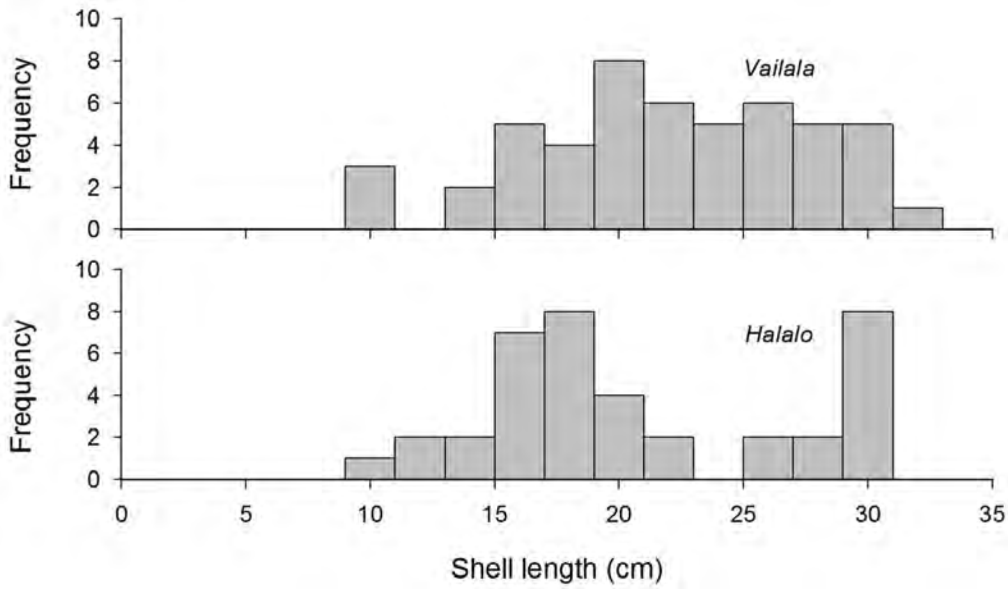

Figure 2.54: Size frequency histograms of giant clam shell length (cm) for Vailala and Halalo.

2.4.2 Mother-of-pearl species (MOP) – trochus and pearl oysters: Vailala, Halalo and all Wallis

Exposed reef-front was extensive at Wallis (66.7 km total lineal distance; approximately 30.3 km for Vailala and 36.4 km for Halalo. At the barrier reef there was a wide reef flat (mostly in the southeast) and, in some areas, shallow-reef slopes with offshore shoals were found (mostly in the northwest). These environments provided a very suitable, complex habitat covered by hard bottom and boulders, which connected to extensive areas of back-reef. In combination, these habitats provided a very suitable environment for both the juvenile and adult life stages of the commercial topshell, *Trochus niloticus*.

Reef systems at Wallis (and Futuna) are at the extreme easterly range of the natural distribution of trochus (Adams *et al*. 1992). However, trochus was studied here in 2004–2006 (Chauvet *et al.* 2006), and this PROCFish survey adds to the understanding of the resource and medium-term changes in its status. In the current work, *T. niloticus* were recorded from broad-scale surveys, on reef slopes in mother-of-pearl transect stations (MOPt and MOPs), reef-benthos transects and reef-front search assessments (n = 260 recorded in survey, see Table 2.26.).

Table 2.26: Presence and mean density of *Trochus niloticus* and *Trochus pyramis* in Wallis
Based on various assessment techniques; mean density measured in numbers/ha (±SE).

	Density	SE	% of stations with species	% of transects or search periods with species
Trochus niloticus				
B-S	0.2	0.2	2/25 = 8	2/151 = 1
RBt	4.8	2.8	3/35 = 9	3/210 = 1
RFs	13.9	4.5	7/11 = 64	19/66 = 29
MOPs	22.7	13.8	4/5 = 80	9/30 = 30
MOPt	185.4	60.5	10/10 = 100	39/60 = 65
Trochus pyramis				
B-S	0.2	0.2	2/25 = 8	2/151 = 1
RBt	0.0	0.0	0/35 = 0	0/210 = 0
RFs	0.4	0.4	1/11 = 20	1/66 = 1
MOPs	3.0	3.0	1/5 = 20	1/30 = 3
MOPt	10.4	3.5	5/10 = 50	5/60 = 8

B-S = broad-scale; RBt = reef-benthos transect; RFs = reef-front search; MOPs = mother-of-pearl search; MOPt = mother-of-pearl transect.

The mother-of-pearl transects (MOPt) yielded a good density of trochus within some of the better areas for trochus at Wallis. Presence of trochus within these stations was high, with 63% of transects holding shells. At the station with the highest density (NW outer-reef slope) *T. niloticus* was recorded at a density of 667 trochus/ha. This equates to 32 shells per station, with the greatest number of trochus per 80 m^2 transect being 17 individuals.

Reeftops on the barrier in the southeast and east (Halalo) also commonly yielded shells (76% of search periods) at reasonable density for reeftop habitat that partially dries out at low tide (density range 28–167 per ha).

These numbers differed slightly from those observed by Chauvet *et al.* (2006). They record an overall average density of 217 ±65 specimens/ha, while we only reach 185 ±60 per ha.

Data on distribution and density suggest that trochus are well targeted at both Halalo and Vailala and, although not at a stage where fishing is heavily affecting spawning and recruitment of trochus, abundance is lower than could be expected for a well-managed fishery. Although these open-reef systems are not markedly depleted, the lack of significant juvenile habitat (more so in Vailala) and the open and isolated nature of the system make trochus more vulnerable to fishing in Wallis than would be the case in other reef systems. As such, trochus aggregations should be rested for as long as possible, until the main trochus areas have densities reaching an average of at least 500–600 per ha before there is any future major harvest of shell (Appendices 4.1.5 to 4.1.8 and Appendices for each site 4.2 and 4.3). At the present time, only a very small number of stations (15% of MOPt stations) are at this level (Figure 2.55).

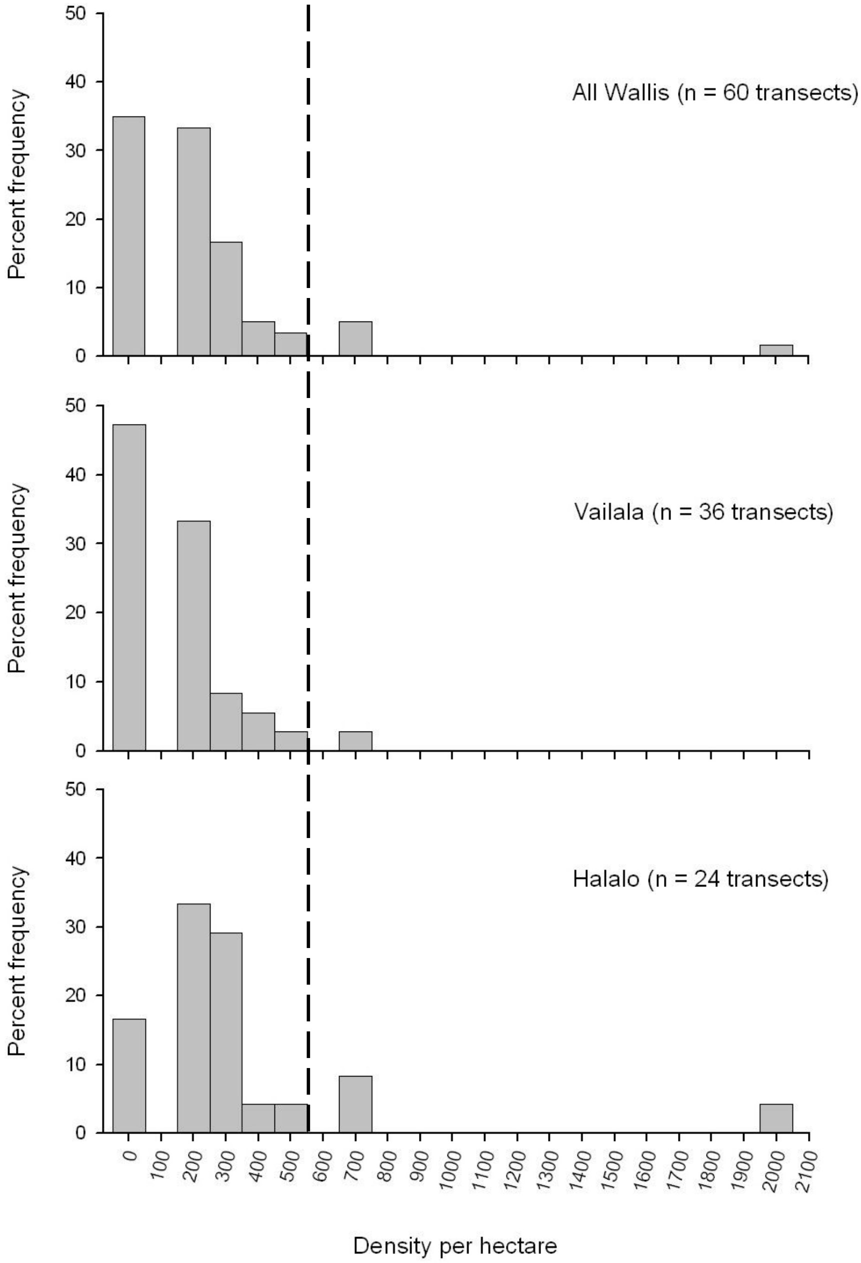

Figure 2.55: Percentage frequency plot of *Trochus niloticus* density (per ha) for mother-of-pearl 80 m^2 transects conducted at Vailala, Halalo and all Wallis.
Dotted line indicates the threshold density (500–600 trochus/ha) below which commercial harvesting is not recommended.

The mean size (basal width) of *T. niloticus* recorded in this study was 9.4 cm ±0.1 (n = 259, Figure 2.56). This is similar to the sizes recorded by Chauvet *et al.* (2006): 9.1 cm in 2004 and 9.9 cm in 2006. Unfortunately, although fishing was conducted during our mission, we were unable to get a sample of trochus sizes from harvested shells. Such information would have been helpful to understand the target size classes and to get a length–weight measure which would allow some estimation of the growth rate of *T. niloticus* in Wallis.

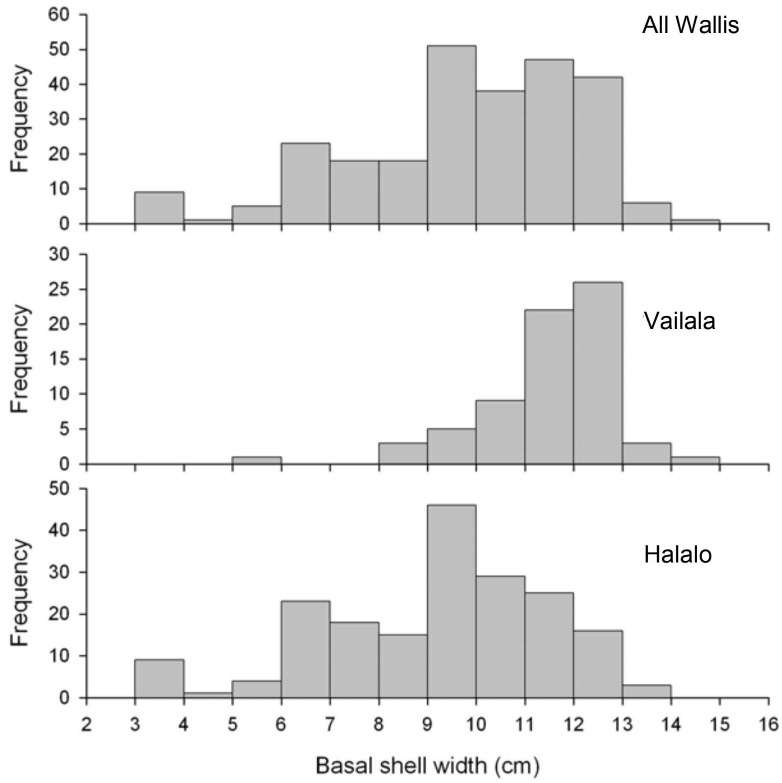

Figure 2.56: Size frequency histograms of trochus shell length (cm) for Vailala, Halalo and all Wallis.

Data on shell size suggest that broodstock is present, although older large shells do not make up a very large proportion of the stock (25% of shells were over 11 cm basal width, Figure 2.56). In some other trochus fisheries, where stock has not been fished for an extended period or there is a maximum basal width for commercial sale of >11 cm, this portion of the stock makes up to 50% of the population. The result from Wallis can be interpreted as an indication of the high level of fishing.

Shell size also gives an important indication of the status of stocks by highlighting new recruitment into the fishery (Figure 2.57), or signalling a lack of recruitment, which could have bad implications for the numbers of trochus entering the capture-size classes in the next few years. The length-frequency graph reveals that the bulk of stock at Wallis is within the capture size classes (First maturity of trochus is at 7–8 cm, or three years of age.). For this cryptic species, younger shells are normally only picked up in surveys from the size of about 5.5 cm, when small trochus are emerging from a cryptic style of life and joining the main stock. As can be seen from the length-frequency graph, stronger recruitment is in the south (Halalo) than in the north. Younger trochus are evident from size records collected during searches, especially on the southwest barrier reeftop (Figure 2.57).

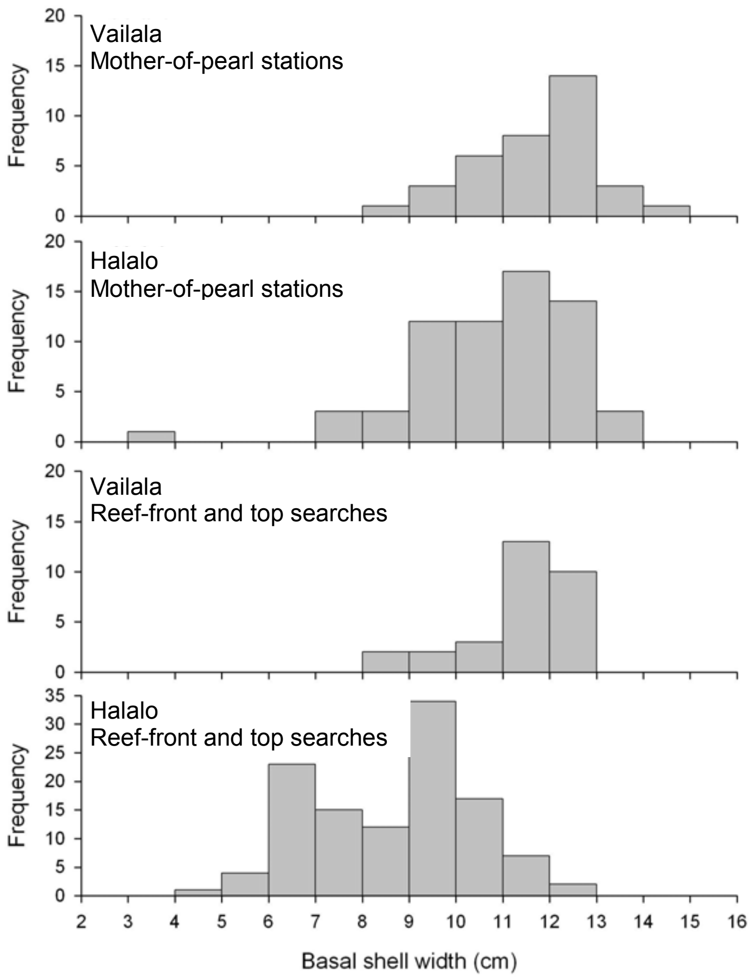

Figure 2.57: Frequency plot of trochus shell size (mm) for Vailala and Halalo from MOP stations on SCUBA and reef front and reeftops on snorkel or walking.

Green topshell, *Tectus pyramis* (of low commercial value), a species closely related to trochus, with similar distribution and life-history characteristics, was far less common than *Trochus niloticus* (Table 2.26). Reef-benthos transect stations held no *T. pyramis*, and MOPt stations on SCUBA recorded them in 50% of stations at low density (10.4 per ha ±3.5). Although the density of *T. pyramis* was low, a full range of size classes was recorded (mean 6.5 cm ±0.2, n = 7).

Pinctada margaritifera, a normally cryptic and sparsely distributed pearl oyster species, was not recorded in either Vailala or Halalo surveys. Taking into account the cryptic nature of *P. margaritifera*, one would expect recordings to be low (<20 individuals); however, this finding suggests that fishing of blacklip pearl oyster has been significant in the past.

2.4.3 Infaunal species and groups: Vailala

Areas of soft benthos, seagrass and in-ground shell resource beds were surveyed in Vailala. Shells such as arc (*Anadara* spp.), Venus (*Gafrarium* spp.) and mussel shells (*Modiolus* spp.) are the typical species of choice for gleaners, being larger and often at high density in such 'digging' fisheries. In Vailala, arc shells were not common (recorded in 7% of quadrat groups), and recorded at low-to-moderate average station density (1.1 per m^2 ±0.4). Even at the station with the highest density of arc shells, the average was not high (8 per m^2). Other species, such as Venus shells (*G. pectinatum* and *G. tumidum*), were recorded at slightly higher densities than arc shells (in 19% of quadrat groups) and had a higher average station density (2.8 m^2 ±1.1). Other bivalve and gastropod species of possible interest recorded in infaunal surveys were *Cerithium* spp. (39% of stations), *Fragum* spp. (13% of stations), and *Modiolus* spp. (30% of stations).

2.4.4 Other gastropods and bivalves: Wallis

The larger Seba spider conchs, *Lambis truncata*, were noted in broad-scale, reef-benthos transect stations and in deeper-water sea cucumber assessments, but only at low density. No smaller spider conchs (*Lambis lambis*, *L. crocata*, *L. chiragra* or *L. scorpius*) were recorded, although *Strombus luhuanus* and *Strombus gibberulus* were locally abundant (Appendices 4.1.1 to 4.1.10 and Appendices for each site 4.2 and 4.3). Although only present in 17% of reef-benthos stations, *S. luhuanus* had an average density of 732.1 per ha ±601.4.

Two species of *Turbo* were noted (*Turbo argyrostomus* and *T. setosus*) but both were uncommon and occurred at low density in survey. These commonly collected gastropods are normally found along exposed reef fronts in the Pacific although, in some areas, the swell limited access to the reef front during our study.

The tiger cowry, *Cypraea tigris*, locally harvested for food, was quite common (in 60% of the RBt stations) with a moderately high density (59.5 per ha ±15.2). Other resource species targeted by fishers in the Pacific (e.g. *Astralium*, *Bursa*, *Cassis*, *Cerithium*, *Chicoreus*, *Conus*, *Cymatium*, *Cypraea*, *Latirolagena*, *Pleuroploca*, *Rhinoclavis*, *Thais* and *Vasum*) were also recorded during independent survey (See lists in Appendices 4.1.1 to 4.1.7 and Appendices for each site 4.2 and 4.3.). Data on other bivalves in broad-scale and fine-scale benthos surveys, such as *Anadara*, *Chama*, *Codakia*, *Fragum*, *Gafrarium*, *Hyotissa*, *Spondylus*, *Pinna*, *Spondylus* and *Tellina* are also in Appendices 4.1.1 to 4.1.7 (and Appendices for each site 4.2 and 4.3). No creel survey was conducted in Wallis, although we did meet with sea cucumber fishers and examined their catches during night work in Vailala.

2.4.5 Lobsters: Wallis

There was no dedicated night reef-front assessment of lobsters (See Methods.). However, occasional records occur during our assessment, mostly of species living inside the lagoon, although night searches for sea cucumbers also provided a useful opportunity to record lobsters.

The painted coral lobster, *Panulirus versicolor* (more commonly found in coral gardens of lagoon systems), was noted on six occasions in survey, and was noted in broad-scale, MOP stations and at night. No slipper lobsters were recorded, although a moulted carapace was seen. *Lysiosquillina maculata* (the 'sand lobster', banded shrimp killer or *varo*) was recorded sporadically all around Wallis (n = 4), and is not generally targeted by local fishers. Good inshore habitat for this species exists all around Wallis.

2.4.6 Sea cucumbers[8]: Wallis

Presence and density of sea cucumber species were determined through broad-scale and fine-scale survey methods (Table 2.27, Appendices 4.1.1 to 4.1.7 and Appendices for each site 4.2 and 4.3, also see Methods). The large extent and wide range of habitats in Wallis was part of the reason that as many as 15 species of commercial sea cucumbers (plus one indicator species) were recorded during in-water assessments (Table 2.27).

Sea cucumber species associated with reef, such as the medium-value leopardfish (*Bohadschia argus*), were common (recorded in 39% of broad-scale transects and 71% of RBt) and at high density (140.5 per ha ±32.0 in RBt stations). The higher-value species greenfish (*Stichopus chloronotus*) was recorded in most assessments and, although not always common in shallow reef, was recorded in high-density patches across the lagoon (mean 278 per ha ±190.7 in broad-scale stations). Black teatfish (*Holothuria nobilis*), a premium-value species, was moderately well represented (8–9% of broad-scale and RBt surveys), and at moderate density (RBt mean density 7.1 per ha ±5.0) in all the shallow-reef assessments. This species is generally found at low density on back-reefs in the Pacific, but is also found in deeper water. In deeper-water assessments during this survey, *H. nobilis* was recorded at a mean density of <7 per ha (BdM Ds and MOP surveys).

Parts of the more oceanic-influenced sectors of Wallis had habitat suited to surf redfish, *Actinopyga mauritiana*, but, despite this species being relatively common in reef-front assessments (27% of RFs, and 55% barrier RFs_w), they were only at low density (<10 per ha). In other locations in the Pacific, this species is recorded in densities above 400–500 per ha. Local fishers, M Susenio Likafia and his son-in-law M Ikauno Sipalo and a Vanuatu fisher, reported that this stock had previously been targeted in Wallis.

More protected soft-benthos areas with patches of reef were common at Wallis, with rich reef-flat sediments, seagrass and mangrove stands present. Curryfish (*Stichopus hermanni*) were recorded in 16% of broad-scale assessments at moderately low density (7.2 per ha). Blackfish (*Actinopyga miliaris*) and stonefish (*A. lecanora*) were rarely recorded, but elephant trunkfish (*Holothuria fuscopunctata*) and brown sandfish (*Bohadschia vitiensis*) were more common. Brown sandfish were especially common (in 40% of broad-scale transects) with two stations on the northwest coastline holding average densities 2000–6000 per ha. Lower-value lollyfish (*H. atra*) were both common and numerous (Table 2.27).

The high-value sandfish *H. scabra* was found in 1% of broad-scale stations (n = 10 individuals) and this species occurs in critically low numbers on the northwestern side of Uvea. Although mangrove and seagrass shoreline areas were common along this shoreline, the habitat was quite hard and compacted and not always optimal for sandfish. On one evening we went out to see if we could locate the species, and talk to the fishers. They were using torches and were getting a very low catch rate (<1–3 pieces/hour of undersized animals). We did receive later reports that other small pockets of sandfish can be found around the shorelines of Wallis. Catches should be halted to allow recovery of this important commercial species, as it is on the eastern edge of its distribution range and thus, once it is fished out, is not likely to recover.

[8]There has been a recent change to sea cucumber taxonomy that has changed the name of the black teatfish in the Pacific from *Holothuria* (*Microthele*) *nobilis* to *H. whitmaei*. It is possible that the scientific name for white teatfish may also change in the future. This should be noted when comparing texts, as in this report the 'original' taxonomic names are used.

Deep dives on SCUBA (sea cucumber day searches, depth range 10–45 m) were used to obtain a preliminary assessment of deep-water stocks, such as the high-value white teatfish (*Holothuria fuscogilva*), prickly redfish (*Thelenota ananas*) and the lower-value amberfish (*T. anax*). In these surveys, thirteen white teatfish were found at reasonable coverage but low density (71% of sea cucumber day stations at 11.4 per ha ±5.3). Fishers interviewed on site (while processing curryfish) reported that they had already targeted teatfish in the lagoon. Both prickly redfish and amberfish were moderately common but at low density (Table 2.27).

2.4.7 Other echinoderms: Wallis

Edible collector urchins, *Tripneustes gratilla*, were not recorded at Wallis, and slate urchins, *Heterocentrotus mammillatus*, were rare. Urchins, such as *Diadema* spp. and *Echinothrix* spp., which can be used to indicate habitat condition, were also recorded. *Diadema* spp. was not common inside the lagoon (present in 8% of broad-scale stations), however the numbers of *Echinothrix* spp. were moderately high in some areas (present in 91% of the RFs_w stations, reaching station densities of >490 per ha). The smaller *Echinometra mathaei* was not particularly common or at high density.

The blue starfish, *Linckia laevigata*, was common in survey (in 52% of broad-scale transects, 86% of reef-benthos stations) and at a quite high density (>490 per ha in RBt areas and >84 per ha in broad-scale surveys). Two coralivore (coral eating) starfish species were recorded: the cushion star, *Culcita novaeguineae*, which was common (in 84% of broad-scale transects, 66% of reef-benthos stations), with medium-to-high density, and the crown of thorns starfish, *Acanthaster planci*, which was rare. Crown of thorns were only noticed in one area, around the passage and back-reef on the west barrier-reef passage near Halalo (Appendices 4.1.1 to 4.1.7 and Appendices for each site 4.2 and 4.3).

Table 2.27: Sea cucumber species records for all Wallis

Species	Common name	Commercial value [5]	B-S transects n = 151			Reef benthos stations n = 35			Other stations RFs = 11 RFs_w = 11			Other stations MOPt = 10 MOPs = 5			Other stations SBq = 23; Ds = 7; Ns = 4		
			D [1]	DwP [2]	PP [3]	D	DwP	PP	D	DwP	PP	D	DwP	PP	D	DwP	PP
Actinopyga mauritiana	Surf redfish	M/H				1.2	41.7	3	2.1 7.6	7.8 13.9	27 RFs 55 RFs_w	14.6 1.5	29.2 7.6	50 MOPt 20 MOPs			
Actinopyga miliaris	Blackfish	M/H	0.2	16.7	1	1.2	41.7	3							0.9	2.2	43 Ds
Bohadschia argus	Leopardfish	M	29.6	75.7	39	140.5	196.5	71				10.4	34.7	30 MOPt	2.3 30.4	5.4 40.5	43 Ds 75 Ns
Bohadschia graeffei	Flowerfish	L	0.1	16.7	1							2.1	20.8	10 MOPt			
Bohadschia vitiensis	Brown sandfish	L	654.2	1619.5	40	6	69.4	9							0.3 0.3 371.1	2.0 2.4 371.1	13 SBq 14 Ds 100 Ns
Holothuria atra	Lollyfish	L	1450.3	2670.7	54	3659.5	5822	63	30.3	37.0	82 RFs_w	2.1	20.8	10 MOPt	11.1 272.6	25.6 363.5	43 SBq 75 Ns
Holothuria coluber	Snakefish	L															
Holothuria fuscogilva [4]	White teatfish	H													11.4	16	71 Ds
Holothuria fuscopunctata	Elephant trunkfish	M	4.5	48.7	9	1.2	41.7	3							4.4 3	15.5 11.9	29 Ds 25 Ns
Holothuria nobilis [4]	Black teatfish	H	1.6	20.7	8	7.1	83.3	9	0.7	7.8	9 RFs	6.3	31.3	20 MOPt	0.3	1.8	14 Ds
Holothuria scabra	Sandfish	H	1.1	83.3	1												
Stichopus chloronotus	Greenfish	H/M	277	1162	24	148.8	372	4	5.3	58.8	9 RFs	4.2	41.7	10 MOPt	2.3 0.8 123	54.0 5.4 164	4 SBq 14 Ds 75 Ns
Stichopus hermanni	Curryfish	H/M	7.9	49.8	16	2.4	41.7	6							0.3 27.4	2.4 27.4	14 Ds 100 Ns

[1] D = mean density (numbers/ha); [2] DwP = mean density (numbers/ha) for transects or stations where the species was present; [3] PP = percentage presence (units where the species was found); [4] the scientific name of the black teatfish has recently changed from *Holothuria* (*Microthele*) *nobilis* to *H. whitmaei* and the white teatfish (*H. fuscogilva*) may have also changed name before this report is published. [5] L = low value; M = medium value; H= high value; H/M is higher in value than M/H; B-S transects= broad-scale transects; SBt = soft-benthos transect; RFs = reef-front search; RFs_w = reef-front search by walking; MOPs = mother-of-pearl search; MOPt = mother-of-pearl transect; SBq = soft-benthos infaunal quadrat; Ds = day search; Ns = night search.

Table 2.27: Sea cucumber species records for all Wallis (continued)

Species	Common name	Commercial value [5]	B-S transects n = 151			Reef benthos stations n = 35			Other stations RFs = 11 RFs_w = 11			Other stations MOPt = 10 MOPs = 5			Other stations SBq = 23; Ds = 7; Ns = 4		
			D [1]	DwP [2]	PP [3]	D	DwP	PP	D	DwP	PP	D	DwP	PP	D	DwP	PP
Stichopus horrens	Peanutfish	H/M	340.4	6425	5										65.2 3.0	187.5 11.9	35 SBq 25 Ns
Thelenota ananas	Prickly redfish	H	0.6	20.8	3	1.2	41.7	3							1	7.1	14 Ds
Thelenota anax	Amberfish	M													7.7	27.1	28 Ds

[1] D = mean density (numbers/ha); [2] DwP = mean density (numbers/ha) for transects or stations where the species was present; [3] PP = percentage presence (units where the species was found); [4] the scientific name of the black teatfish has recently changed from *Holothuria* (*Microthele*) *nobilis* to *H. whitmaei* and the white teatfish (*H. fuscogilva*) may have also changed name before this report is published. [5] L = low value; M = medium value; H= high value; H/M is higher in value than M/H; B-S transects= broad-scale transects; SBt = soft-benthos transect; RFs = reef-front search; RFs_w = reef-front search by walking; MOPs = mother-of-pearl search; MOPt = mother-of-pearl transect; SBq = soft-benthos infaunal quadrat; Ds = day search; Ns = night search.

2.4.8 Discussion and conclusions: invertebrate resources in Wallis

A summary of environmental, stock status and management factors for the main fisheries is given below. Please note that information on other, smaller fisheries and the status of less prominent species groups can be found within the body of the invertebrate chapter.

- There is a wide range of shallow-water reef habitats suitable for giant clams. Inshore, midshore and barrier reef was extensive around Wallis and water movement away from the shore was generally dynamic.

- The density of elongate clams, *Tridacna maxima*, was low, and to a point where the sparse distribution could negatively affect spawning and fertilisation success, and therefore the sustainability of this resource.

- Size-frequency distributions revealed that the full range of *T. maxima* size classes was still present at Wallis, but larger clams, which make up an important part of the spawning biomass, were mostly absent from easily accessible inshore reef (Clams are protandrous hermaphrodites and only become female, and therefore only produce eggs, at larger size classes.).

- Giant clams at Wallis were markedly impacted by fishing pressure, especially at easily accessed fishing locations.

- Despite the fluted clam, *Tridacna squamosa*, being previously recorded as present in Wallis, none were noted in this survey, and therefore we consider this species to be 'commercially extinct'[9] in Wallis. This is an unexpected result, as islands with a similar lagoon and offshore environment to Wallis have usually managed to retain stocks of this species.

- Trochus habitat at Wallis was extensive, with all the major components to support a commercial fishery. The only limiting factors were the sandy nature of the back-reef in some areas (rather than rubble and hard benthos), and the isolated nature of Wallis, which limits cross fertilisation and therefore potential recruitment.

- The low density of trochus in the main fishing areas suggests that stocks are moderately impacted by fishing. Given the conditions within the remote, semi-open reef system, care should be taken, as stocks may be more susceptible to the effects of fishing here than in more extensive, contiguous reef systems.

- The size profile of trochus shells recorded in Wallis suggests that large broodstock are present in the population and recruitment is ongoing. Size controls that limit the sale of shells above 12 cm should continue to be enforced to ensure the protection of the most productive-sized specimens (over 11–12 cm basal width). The current size profile of the stock suggests that this measure is only partially successful in protecting larger shells at present (Appendix 4.7).

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[9] 'Commercially extinct' refers to scarcity such that collection is not possible to service commercial or subsistence fishing, but species is or may still be present at very low densities.

- Trochus under 9 cm (new recruits) were noticeable in survey, especially in the southeast of Wallis (on the reeftop). These young trochus need to continue to be protected until they have had at least one season of spawning before they enter the capture size classes.

- There is potential to move some trochus from areas of high-density recruitment in the southwest to adult habitat around Wallis (including the northwest).

- Major harvests should be postponed until stocks build up to 500–600 per ha in the major aggregations. This advice is more conservative than the advice of previous researchers (Chauvet 2006), who suggested that fishing is at an appropriate level and catches have the capacity to increase.

- The blacklip pearl oyster, *Pinctada margaritifera*, was absent from survey records, although other mother-of-pearl stocks, such as the green topshell, *Tectus pyramis* (of low commercial value), were recorded at low density.

- Wallis has a diverse range of environments and depths suitable for sea cucumbers, with large sheltered embayments of protected lagoon in the northwest, in contrast with the more oceanic-influenced reefs and passage in the southeast.

- The range of sea cucumber species recorded at Wallis was large considering its eastern position in the Pacific, distant from the more species-rich areas close to the centre of biodiversity. This partially reflects the varied environment that was present, but also the fact that only a few commercial fishers were targeting the export fishery at the time of the survey.

- The presence and density data collected in the survey suggest that sea cucumbers are impacted by fishing pressure, but commercial fishing is only having a critical effect on some species. Careful management of fishing is required if Wallis wants to ensure this fishery is sustainable.

- Sandfish (*Holothuria scabra*) fishing should be halted as soon as possible to allow the limited stocks to recover from critical levels of overfishing. Present levels of stock are extremely low for a species that can support aggregations at high density, and this resource is in danger of being lost to Wallis.

- Sea cucumbers play an important role in ‘cleaning’ benthic substrates of organic matter, and mixing (‘bioturbating’) sands and muds. When these species are removed, there is the potential for detritus to build up, and for substrates to become more compacted, creating conditions that can promote the development of non-palatable algal mats (blue–green algae) and anoxic conditions (lacking in oxygen), which are unsuitable for life.

2.5 Overall recommendations for Wallis

Based on the survey work undertaken and the assessments made, the following recommendations are made for Wallis:

- Given the importance of fisheries to people in Wallis both for food and income, the fact that most people fish in one way or another, and that the country enjoys an open-access system, MPAs be established, which represent the country's most important habitats, in order to secure biodiversity and reproduction for the future.

- The ongoing efforts of the Fisheries Service to establish a better link and cooperation with the fishermen's association, be continued, with a focus on: increasing registration of commercially oriented, small-scale fishers and their motorised boats; adopting a minimum mesh size for gillnetting; and controlling leisure or lifestyle fishing.

- The national Fisheries Service continue with their control of export fishery produce, mainly beche-de-mer and trochus, and possibly include other species, such as lobsters. Monitoring should accompany annual quotas provided by species and size, and compliance with existing regulations should be enforced.

- The use of gillnetting and spear diving, especially in the lagoon, be regulated and spear diving at night be banned.

- There are still reports of dynamite fishing continuing in Wallis. This, together with bleach fishing, which are very destructive practices for both fish resources and habitat, be immediately stopped and fines imposed on any fishers practising them.

- Major harvests of trochus be postponed until stocks build up to 500–600 per ha in the major aggregations. To do this, size controls that limit the sale of shell above 12 cm should continue to be enforced to ensure the protection of the most productive-sized specimens (over 11–12 cm basal width). Also, trochus under 9 cm (new recruits) continue to be protected until they have had at least one season of spawning before they enter the capture size classes. There is also potential to move some trochus from areas of high-density recruitment in the southwest to adult habitat around Wallis (including the northwest).

- Careful management of sea cucumber fishing is required if Wallis wants to ensure this fishery is sustainable. Fishing for sandfish *Holothuria scabra* should be halted as soon as possible to allow the limited stocks to recover from critical levels of overfishing.

3. PROFILE AND RESULTS FOR FUTUNA

3.1 Site characteristics

Futuna is a volcanic island with a relatively large land mass (approximately 64 km^2), which rises steeply from a narrow coastal plain to an elevation of 875 m (401 m on Alofi Islet). Streams were noticeable and rainfall is reportedly high on Futuna (over 2500 mm). In general, the environment on reefs was generally dynamic, with little protection from wind and ocean swells. Reef margins of mixed hard and soft benthos, with areas of benthos suitable for commercial deposit feeders were not common (Sea cucumbers eat organic matter in the upper few mm of bottom substrates.) although, immediately beyond the coastal reef flats, there is a second terrace (shoal) at 5–10 m depth, where a network of sloping terraced pavements, interspersed with spur-and-groove habitat and sandy areas predominates. This system extends a further 200–400 m from the coast, to a depth of 40 m before the depth gradient increases sharply. During BdM search dives it was observed that there were good coral growths in the reef system. In some areas, coral cover was estimated to range from 30–50%. In some areas the nearby island of Alofi acts as a protective barrier from windward surges.

Unlike Wallis, Futuna has no lagoon, and shallow-water reef in the form of fringing reef is of varying width. Most reef flat lies near the water surface or is exposed during low tide. At the reef edge, most areas were subject to a high degree of wave action and in some areas the reef slope fell off quickly into deep water.

3.2 Socioeconomic surveys: Futuna

Socioeconomic fieldwork was carried out on Futuna during September and October 2005. The survey first targeted the two communities of Vele and Leava only, but was then extended to also cover Fina, Poi, Tamana and Toloke. In total 76 households were surveyed, which included 470 people, representing 8% of the total number of households (831) and population (4873) on the island. These 76 households are distributed as follows: Fina (3), Leava (24), Poi (5), Tamana (15), Toloke (4) and Vele (25). The villages selected for survey are representative of the two kingdoms that govern Futuna: Sigave and Alo. The customary structure is provided in Appendix 2.2.1. Due to the assumption that the lifestyle of people on Futuna is similar among all communities, data from all survey sites are summarised and presented as one site called 'Futuna'.

Household interviews aimed to collect general demographic, socioeconomic and consumption parameters. A total of 58 individual interviews of finfish fishers (24 males, 34 females) and 40 invertebrate fishers (12 males, 28 females) were conducted. These fishers belonged to one of the 76 households surveyed. Sometimes, the same person was interviewed for both finfish fishing and invertebrate harvesting.

3.2.1 The role of fisheries in the Futuna community: fishery demographics, income and seafood consumption patterns

Our survey results (Table 3.1) suggest an average of 1.3 fishers per household. If we apply this average to the total number of households, we arrive at a total of 1233 fishers on Futuna. Applying our household survey data concerning the type of fisher (finfish fisher, invertebrate fisher) by gender, we can project a total of 554 fishers who fish exclusively for finfish (340 males, 214 females), a total of 176 fishers who fish exclusively for invertebrates (25 males, 151 females) and 176 male and 327 female fishers who fish for both finfish and invertebrates.

Only 12% of all households on Futuna own a boat, but most of these are motorised (80%) and a few are non-motorised (20%).

Ranked income sources (Figure 3.1) suggest that fisheries are not an important sector but salaries and other sources are. In fact, almost 45% of all households depend on salaries as first income, and another 43% receive their first income from social fees. Only 7% of all households claimed fisheries as their first source of income, and another 13% quoted fisheries as a second income source. Agriculture plays a similar role; while it is not important as a primary income source (4% of all households) it does represent an option for 22% of all households to gain some additional cash income. The average annual household expenditure level is low (USD 11,000 per year) suggesting that people on Futuna still enjoy a more traditional lifestyle. This argument is further supported by the fact that commercial goods are much more expensive than on Wallis due to the additional transport cost and the smaller market scale.

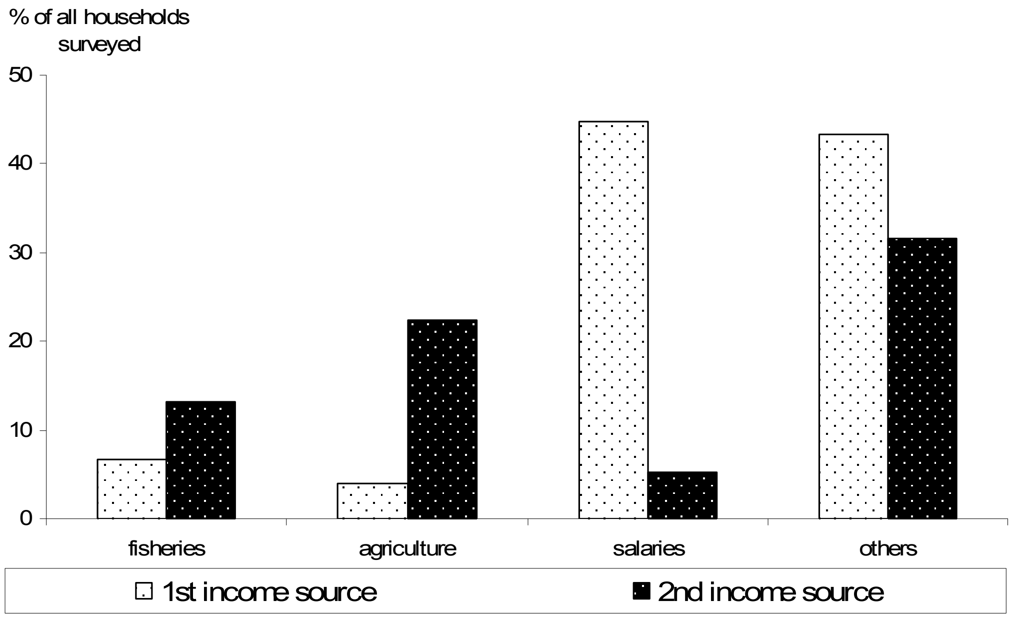

Figure 3.1: Ranked sources of income (%) in Futuna.
Total number of households = 76 = 100%. Some households have more than one income source and those may be of equal importance; thus double quotations for 1st and 2nd incomes are possible.
'Others' are mostly home-based small business.

The importance of fisheries, however, shows in the fact that all households reported eating fresh fish, and over 40% also eat invertebrates. The fish that is consumed is mostly caught by a member of the household (78%), but also often bought (41%) and received as a gift (76%). The proportion of invertebrates caught by a member of the household where it is eaten is lower (37%). However invertebrates are rarely ever bought on Futuna (~1%) but may at times be given on a non-monetary basis (8%). These results suggest that finfish is a potential source of income while invertebrates are more an item for subsistence purposes. Figures also suggest that a considerable share of finfish catches may be marketed within the Futuna community.

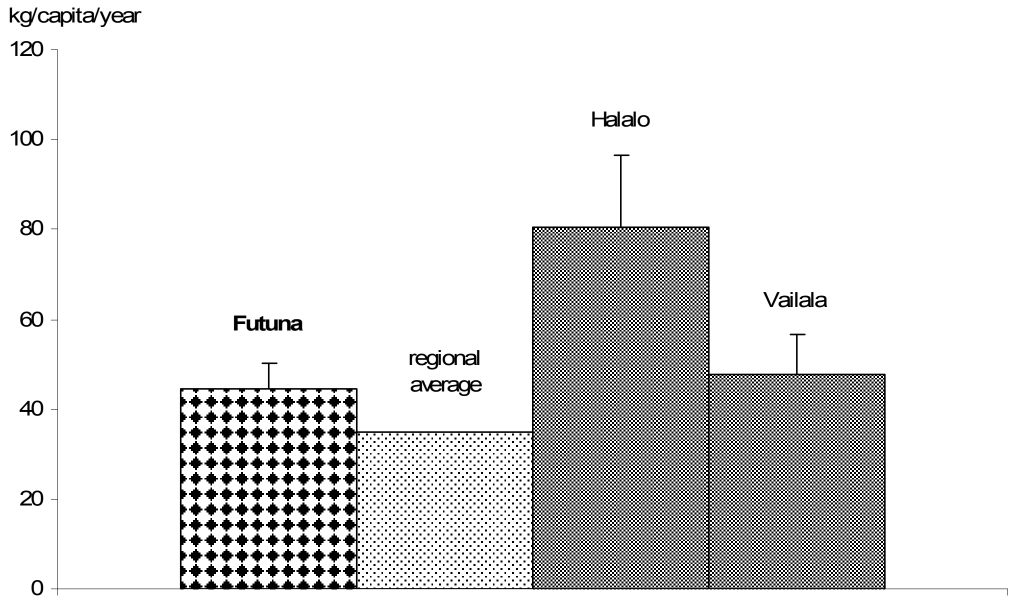

Figure 3.2: Per capita consumption (kg/year) of fresh fish in Futuna (n = 76) compared to the regional average (FAO 2008) and the other two PROCFish/C sites in Wallis.
Figures are averages from all households interviewed, and take into account age, gender and non-edible parts of fish. Bars represent standard error (+SE).

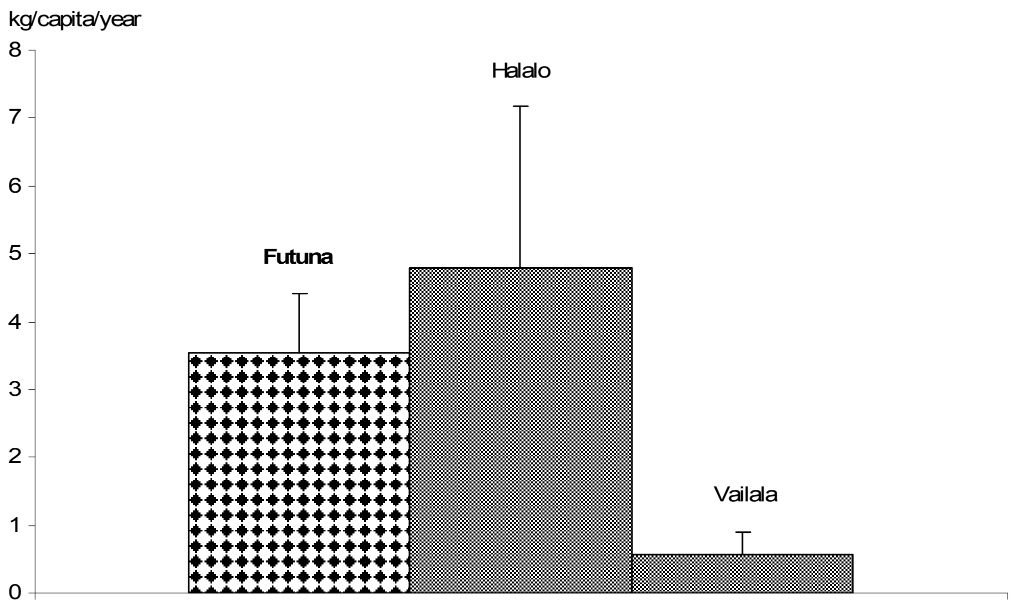

Figure 3.3: Per capita consumption (kg/year) of invertebrates (meat only) in Futuna (n = 76) compared to the other the two PROCFish/C sites in Wallis.
Figures are averages from all households interviewed, and take into account age, gender and non-edible parts of invertebrates. Bars represent standard error (+SE).

The per capita consumption of fresh fish (~45 kg/year ±5.6) on Futuna is above the regional average (FAO 2008) (Figure 3.2), but lower than the average for Wallis and Futuna combined, i.e. including the two sites surveyed on Wallis. The per capita consumption of invertebrates (meat only) is ~4 kg/year (Figure 3.3) and significantly lower compared to finfish but about the same as the average calculated for all sites on Wallis and Futuna. Although most people reported eating canned fish on average at least once a week, the amount eaten is extremely low. This trend seems to apply for all sites surveyed. In fact, data collected suggest that people on Wallis and Futuna prefer other alternatives, probably meat, rather than canned fish (Table 3.1).

Comparing results among all sites investigated on Wallis and Futuna (Table 3.1), people on Futuna are less dependent on fisheries for income generation and eat less fresh fish in a year. Nevertheless, there is no difference between Futuna and the average of all sites concerning the number of fishers per household and access to boat transport. Also, people on Futuna do not spend more on basic living expenditure, but they do receive less from remittances.

Table 3.1: Fishery demography, income and seafood consumption patterns in Futuna

Survey coverage	Site (n = 76 HH)	Average across sites (n = 137 HH)
Demography		
HH involved in reef fisheries (%)	82.9	87.6
Number of fishers per HH	1.29 (±0.10)	1.47 (±0.09)
Male finfish fishers per HH (%)	27.6	40.6
Female finfish fishers per HH (%)	17.3	8.4
Male invertebrate fishers per HH (%)	2.0	1.5
Female invertebrate fishers per HH (%)	12.2	16.3
Male finfish and invertebrate fishers per HH (%)	14.3	13.4
Female finfish and invertebrate fishers per HH (%)	26.5	19.8
Income		
HH with fisheries as 1st income (%)	6.6	16.1
HH with fisheries as 2nd income (%)	13.2	19.7
HH with agriculture as 1st income (%)	3.9	5.8
HH with agriculture as 2nd income (%)	22.4	18.2
HH with salary as 1st income (%)	44.7	46.7
HH with salary as 2nd income (%)	5.3	4.4
HH with other source as 1st income (%)	43.4	32.1
HH with other source as 2nd income (%)	31.6	32.8
Expenditure (USD/year/HH)	11,023.31 (±1,196.09)	10,991.98 (±847.25)
Remittance (USD/year/HH) (1)	1560.92 (±362.23)	1738.04 (±330.62)
Consumption		
Quantity fresh fish consumed (kg/capita/year)	44.66 (±5.58)	52.99 (±5.13)
Frequency fresh fish consumed (times/week)	3.13 (±0.22)	3.44 (±0.16)
Quantity fresh invertebrate consumed (kg/capita/year)	3.53 (±0.89)	3.11 (±5.13)
Frequency fresh invertebrate consumed (times/week)	0.40 (±0.09)	0.45 (±0.07)
Quantity canned fish consumed (kg/capita/year)	0.00 (±0.00)	1.68 (±0.39)
Frequency canned fish consumed (times/week)	1.65 (±0.15)	1.19 (±0.10)
HH eat fresh fish (%)	100.0	99.3
HH eat invertebrates (%)	42.1	48.9
HH eat canned fish (%)	94.7	79.6
HH eat fresh fish they catch (%)	77.6	77.6
HH eat fresh fish they buy (%)	40.8	40.8
HH eat fresh fish they are given (%)	76.3	76.3
HH eat fresh invertebrates they catch (%)	36.8	36.8
HH eat fresh invertebrates they buy (%)	1.3	1.3
HH eat fresh invertebrates they are given (%)	7.9	7.9

HH = household; (1) average sum for households that receive remittances; numbers in brackets are standard error.

3.2.2 Fishing strategies and gear: Futuna

Degree of specialisation in fishing

Fishing on Futuna is performed by both gender groups (Figure 3.4). However, from the 45% of all fishers who exclusively target finfish, most are males (28%) and fewer are females (17%). There are more female fishers who exclusively target invertebrates (12% of all fishers interviewed), and there are hardly any males who exclusively fish for invertebrates (~2%). Another 41% of all fishers (27% females, 14% males) target both finfish and invertebrates, although not necessarily at the same time.

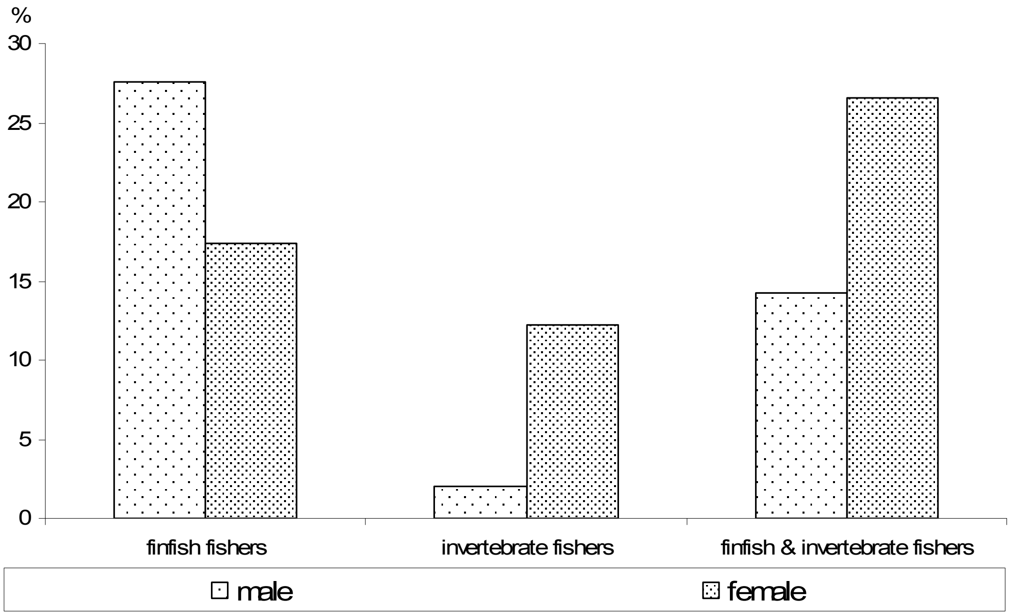

Figure 3.4: Proportion (%) of fishers who target finfish or invertebrates exclusively, and those who target both finfish and invertebrates in Futuna.
All fishers = 100%.

'Atule' (*Selar crumenophthalmus*) is a special and traditional fishery that is exclusively practised by female fishers on Futuna. Although, during the survey, changes in the seasonality and amount of 'atule' occurring along the usual shorelines were reported, females on Futuna continue to practise this traditional fishery between January and July each year. Usually at least two to three, but often all females (20–30) of a community fish about 3–4 times a week during the 'atule' peak season. A gillnet of about 2 m x 200 m is set in shallow water and a traditional wooden canoe is used for transporting the net and for catching. Each trip takes no longer than about two hours and no ice is used. An average catch is about 50–100 'atule' of 24–32 cm fork length. Fishers reported that, in former times, catches were much better, averaging 500–1000 'atule' of 24–32 cm fork length. Tradition does not permit the 'atule' catch to be sold, but it is distributed among the participating fishers and other community members.

Targeted stocks/habitat

Most fishers on Futuna use the sheltered coastal reef that borders the island for catching reef fish. At low tide, this reef terrace is mostly exposed and offers a platform from which to cast rods or nets at the outer slope. Very few males, usually spear divers, target reef fish at the outer reef by canoe or motorised boat. Male invertebrate fishers mainly target lobsters, giant clams, octopus and trochus, while females only collect on the reeftop or on the attached sandy beach patch (Tables 3.2 and 3.3).

Table 3.2: Proportion (%) of interviewed male and female fishers harvesting finfish and invertebrate stocks across a range of habitats (reported catch) in Futuna

Resource	Habitat / Fishery	% of male fishers interviewed	% of female fishers interviewed
Finfish	Coastal sheltered reef	91.7	100.0
	Outer reef	8.3	0.0
Invertebrates	Lobster	50.0	0.0
	Other	33.3	0.0
	Reeftop	8.3	100.0
	Trochus	16.7	0.0
	Trochus & lobster	8.3	0.0
	Trochus & lobster & other	8.3	0.0

'Other' refers to the octopus, lobster and giant clam fisheries.
Finfish fisher interviews, males: n = 24; females: n = 36. Invertebrate fisher interviews, males: n = 15; females: n = 35.

Fishing patterns and strategies

The combined information on the number of fishers, the frequency of fishing trips and the average catch per fishing trip are the basic factors used to estimate the fishing pressure imposed by people from Futuna on their fishing grounds (Table 3.2).

Our survey sample suggests that fishers in Futuna have little choice of fishing area and the sheltered coastal reef is the main habitat for reef fisheries. The reef substrate is also the main habitat that supports invertebrate fisheries on Futuna (lobsters, trochus, giant clams, octopus and shells). If data on fisheries are disaggregated and data on all invertebrate fishers are combined regardless of gender, we find that most fishers target the reeftop to collect shells for artisanal or subsistence food purposes, and fewer fishers target lobsters, giant clams, octopus or trochus (Figure 3.5). Females dominate the fishery but only engage in reeftop gleaning, and never in any of the dive fisheries (Figure 3.6).

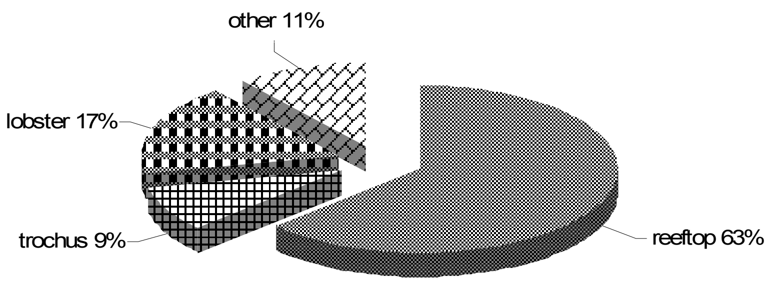

Figure 3.5: Proportion (%) of fishers targeting the four primary invertebrate habitats found in Futuna.
Data based on individual fisher surveys; data for combined fisheries are disaggregated; 'other' refers to the octopus, lobster and giant clam fisheries.

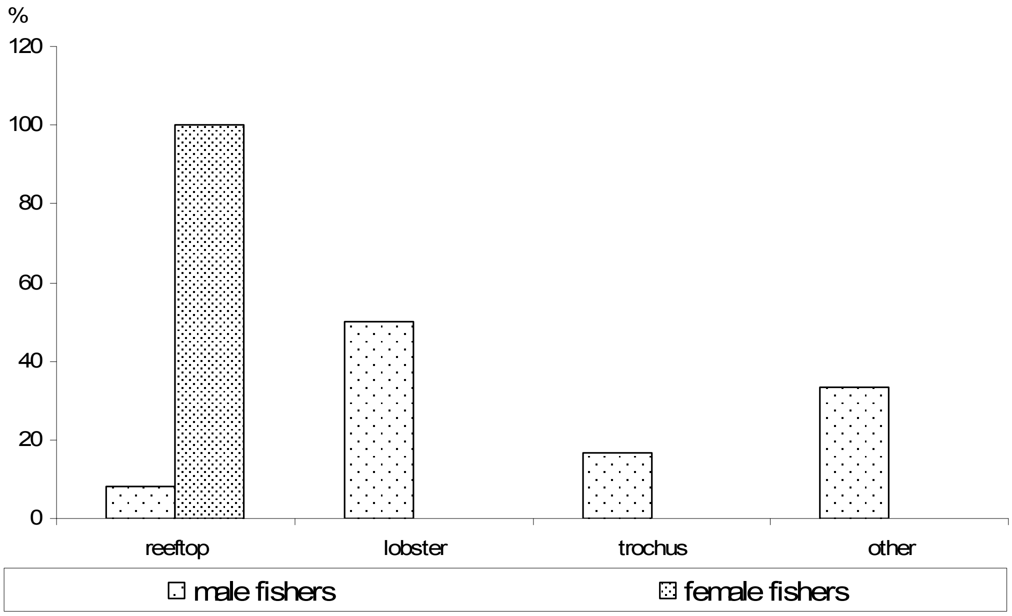

Figure 3.6: Proportion (%) of male and female fishers targeting various invertebrate habitats in Futuna.
Data based on individual fisher surveys; data for combined fisheries are disaggregated; fishers commonly target more than one habitat; figures refer to the proportion of all fishers that target each habitat: n = 15 for males, n = 35 for females; 'other' refers to the octopus, lobster and giant clam fisheries.

Gear

Figure 3.7 shows that fishers on Futuna use a wide range of techniques to catch fish at the sheltered coastal reef. About 10–20% of all fishers reported using castnets in combination with other techniques during one trip, or only handlines, gillnets or castnets, or handheld spears in combination with other techniques. Scoop nets are popular for catching small fish on an *ad hoc* basis for the next meal and these were used by about 10% of all fishers interviewed. Spear diving, handheld spears alone or fish poisoning are less popular. The few male fishers who venture out to the outer reef either use gillnets or spear dive. While finfish fishing at the sheltered coastal reef is usually done by walking (91% of respondents never use boat transport), about half of all fishing trips to the outer reef involve non-motorised or motorised boats.

Gleaning and free-diving for invertebrates are done using only very simple tools. Reeftop gleaning is usually done by walking during the day to pick up shells for artisanal work or during the night with torches, baskets and knives to collect edible gastropods or others. Lobsters and giant clams are picked up by hand; mask, snorkel and fins are used for apnoea diving, and sometimes a knife or a speargun are used to catch giant clams, octopus or lobsters. Mostly, diving for lobsters and trochus is done by walking to the edge of the reef and free-diving from there. However, in all cases when trochus, lobsters, octopus and giant clams are targeted in one fishing trip, mainly for commercial purposes, motorised boats are used to reach better fishing grounds.

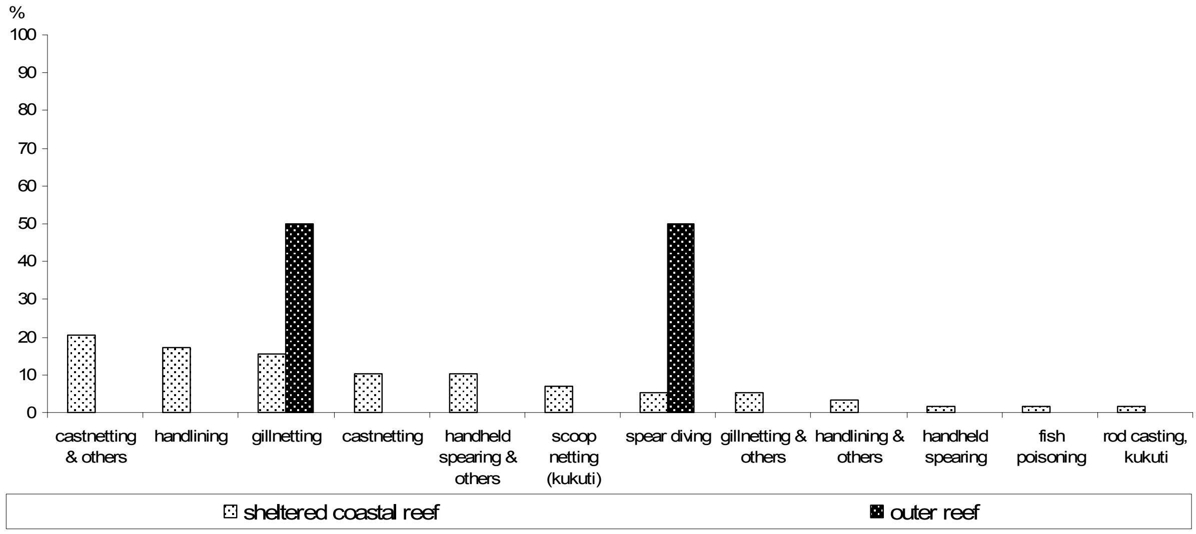

Figure 3.7: Fishing methods commonly used in different habitat types in Futuna.
Proportions are expressed in % of total number of trips to each habitat. One fisher may use more than one technique per habitat and target more than one habitat in one trip.

Frequency and duration of fishing trips

As shown in Table 3.3, the frequency of fishing trips is similar between male and female fishers. On average, fishers go out once or twice a week, and the few who target the outer reef may do so at least twice a week. Trips take about four hours each for both female and male fishers, while trips to the outer reef are twice as long, on average eight hours. This difference is because fishers targeting the outer reef are often the more commercial fishers, who use boats so that thay can go further and target a larger area. Invertebrate collection is done much less frequently. Males may dive once a week for lobsters or trochus but once a fortnight or once a month only if targeting octopus, giant clams, or trochus and lobsters in one joint trip. Females only target the reeftops and they do so 1–1.5 times/week and for about 2.5 hours on average. Invertebrate collection trips take 3–4 hours usually; however, the commercially-oriented fishing trips for lobsters and trochus may take a whole night, i.e. six hours on average.

Finfish is caught according to the tides, as fishers wait for the sheltered coastal reef to be accessible during low tide. This explains why most respondents reported fishing at night or day. The same applies for fishers targeting the outer reef. Invertebrates are mostly collected during the day; however, 25% of all trips targeting octopus, giant clams and lobsters and 31% of trips to the reeftop may also be done at night. Lobsters, trochus and lobsters are fished at night. Almost all finfish fishers and absolutely all invertebrate fishers reported fishing throughout the year.

Table 3.3: Average frequency and duration of fishing trips reported by male and female fishers in Futuna

Resource	Habitat / Fishery	Trip frequency (trips/week)		Trip duration (hours/trip)	
		Male fishers	Female fishers	Male fishers	Female fishers
Finfish	Sheltered coastal reef	1.70 (±0.24)	1.57 (±0.26)	4.25 (±0.63)	3.29 (±0.28)
	Outer reef	2.25 (±0.25)	0	8.00 (±4.00)	0
Invertebrates	Lobster	1.37 (±0.27)	0	3.00 (±0.73)	0
	Other	0.48 (±0.18)	0	3.00 (±1.08)	0
	Reeftop	2.00 (n/a)	1.44 (±0.20)	3.00 (n/a)	2.37 (±0.19)
	Trochus	1.00 (±0.00)	0	4.00 (±2.00)	0
	Trochus & lobster	0.23 (n/a)	0	6.00 (n/a)	0
	Trochus & lobster & other	1.50 (n/a)	0	2.50 (n/a)	0

Figures in brackets denote standard error; ‘other’ refers to the octopus, lobster and giant clam fisheries.
Finfish fisher interviews, males: n = 24; females: n = 15. Invertebrate fisher interviews, males: n = 15; females: n = 35.

3.2.3 Catch composition and volume – finfish: Futuna

Catches from the sheltered coastal reef include a great variety of different fish species and species groups, with Mugilidae (‘kanae’, *Crenimugil crenilabis, Liza vaigiensis*) and Acanthuridae (‘ume’, *Naso unicornis*) determining each about 10% of the reported catch. Others, including *Sargocentron spiniferum* (‘malau’), *Acanthurus triostegus* (‘manini’), *Kyphosus vaigiensis* (‘nue’), *Selar crumenophthalmus* (‘atule’) and *Acanthurus xanthopterus* (‘palangi’) each determine 4–6% of the total reported catch. In total, about 60 different species were reported by respondents targeting the sheltered coastal reef only. For catches from the outer reef, fewer species were reported, with *Caranx ignobilis* alone determining 30% of the reported catch. The remaining 70% are shared by 7–8 other species, mainly *Sargocentron spiniferum,* Serranidae and Lethrinidae (Detailed data are provided in Appendix 2.2.2.).

Our survey sample of finfish fishers interviewed represents about 5.5% of the projected total number of finfish fishers on Futuna. The survey included, to a great extent, fishers who have a commercial interest but also those who fish regularly mainly for subsistence purposes. Hence we have extrapolated our results to estimate the total annual fishing pressure imposed by the people of Futuna on their fishing ground. However, due to the fact that our sample includes a great number of commercial fishers, the percentage of exported finfish is overestimated. In fact, the survey showed that very little reef fish is exported from Futuna to Wallis or elsewhere. On the other side, the figure extrapolated for subsistence purposes may reflect, within acceptable margin errors, the impact that is imposed on Futuna reef resources due to the demand and consumption pattern of the local communities.

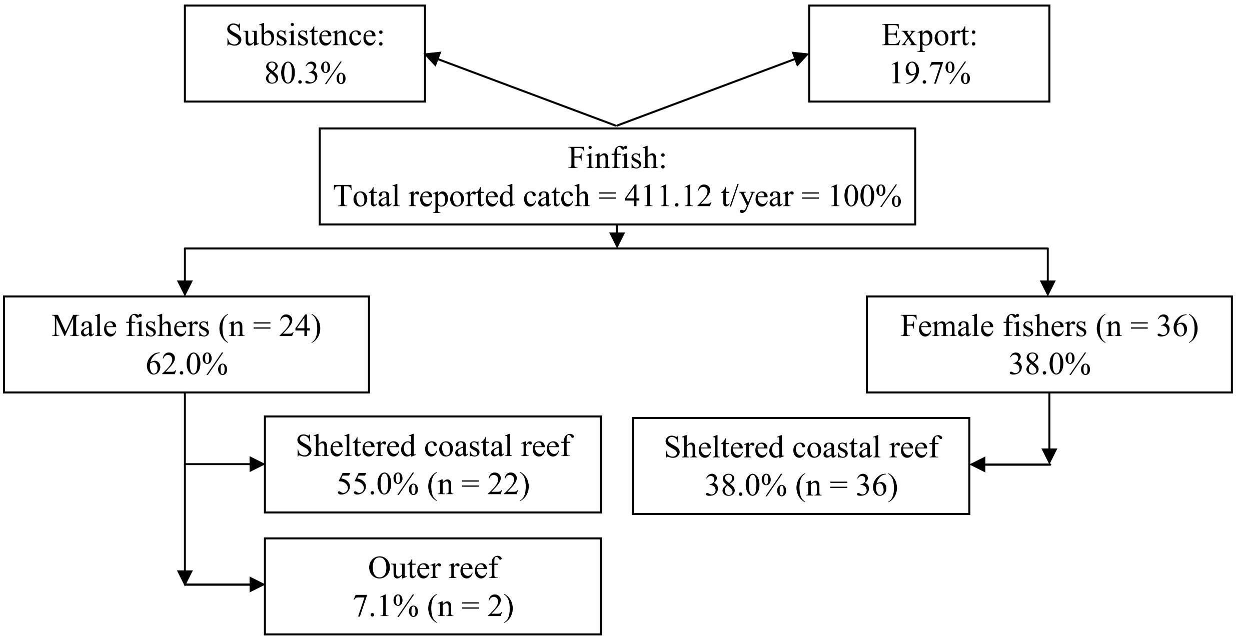

Figure 3.8: Total annual finfish catch (tonnes) and proportion (%) by fishery and gender (reported catch) in Futuna.
n is the total number of interviews conducted per each fishery; total number of interviews may exceed total number of fishers surveyed as one fisher may target more than one fishery and thus respond to more than one fishery survey.

As shown in Figure 3.8, the major share (>80%) of fishing impact is due to the demand imposed by the population of Futuna on its reef resources. In fact, other survey observations suggest that the total impact is slightly overestimated, as there is no significant export to Wallis or elsewhere. The shop owner of Amigos on Futuna confirmed that 5–6 t/year of pelagic fish (tuna) only, were exported to Wallis. It can therefore be concluded that the total annual impact on the island's reef resources may account for 80% of the extrapolated 411.12 t/year, i.e. ~329 t/year. Almost all impact is on the sheltered coastal reef (93% of the total catch) and very little is sourced from the outer reef (~7% of the total catch).

The high impact on the sheltered coastal reef is a function of the number of fishers targeting this habitat rather than the average annual catch rate. As shown in Figure 3.9, average catches range from 200 kg/fisher/year for females to 500 kg/fisher/year for males. Due to the small sample size and also the relatively low importance of fishing at the outer reef, the higher annual catches of finfish reported for outer-reef fishing should not be given too much emphasis here.

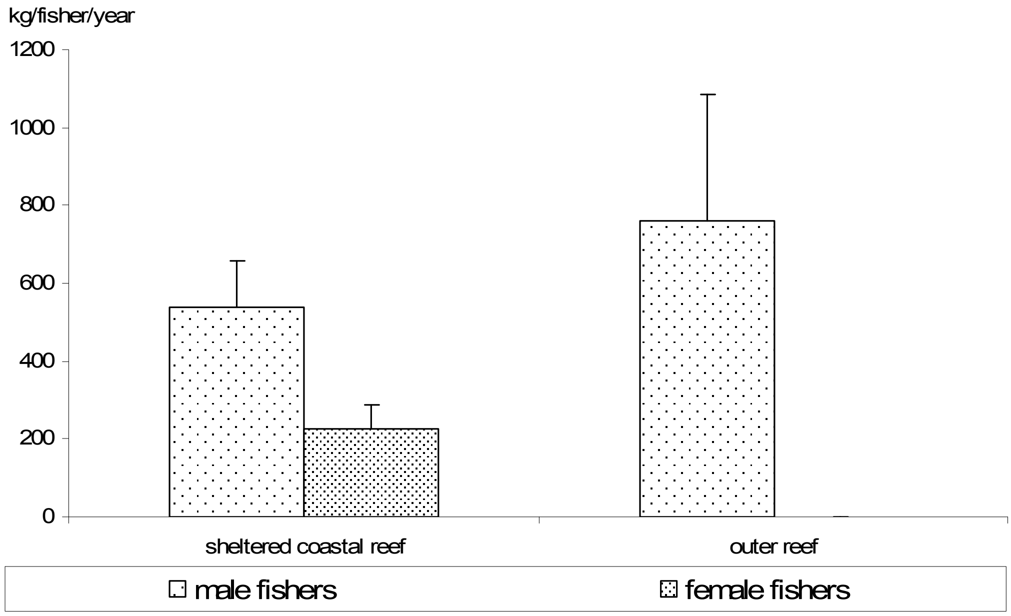

Figure 3.9: Average annual catch (kg/year, +SE) per fisher by gender and habitat in Futuna (based on reported catch only).

CPUE data, as shown in Figure 3.10, reveal no real differences between the productivity of fishers targeting the sheltered coastal reef and the outer reef, if we take into account the variations expressed by the standard error. Also, the difference of productivity between male and female fishers targeting finfish in the sheltered coastal reef is not that pronounced (1.3 kg/hour fished for females and 1.9 kg/hour fished for male fishers). Overall, productivity is relatively low and reflects the fact that most fishers pursue subsistence rather than commercial interests.

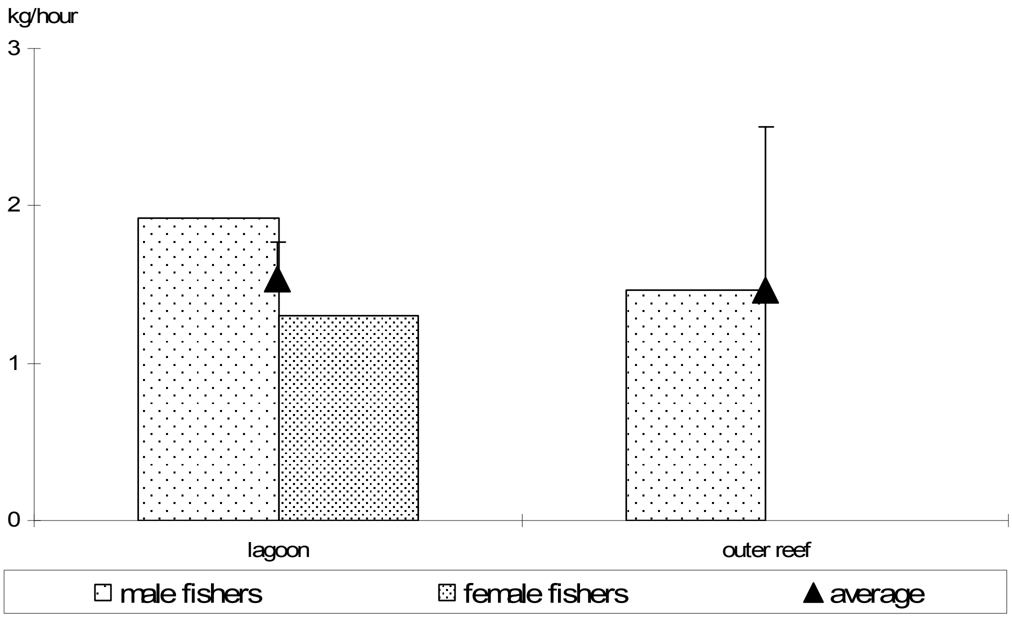

Figure 3.10: Catch per unit effort (kg/hour of total fishing trip) for male and female fishers by habitat type in Futuna.

Effort includes time spent transporting, fishing and landing catch. Bars represent standard error (+SE).

The low interest in commercial fishing also shows when we compare data on the objectives of fishing trips provided by respondents. Most fishing is done to satisfy the household's needs for fish as well as for social needs, i.e. non-monetary sharing of catch among family and community members. Only a very small proportion (~20%) of fishing is done in order to generate income (Figure 3.11). The fact that reef fishing at the outer reef is mainly for subsistence rather than commercial purposes is also clearly shown in Figure 3.11. However, these fishing trips may be combined with pelagic fishing or with diving for trochus and lobsters, which are often for local sale.

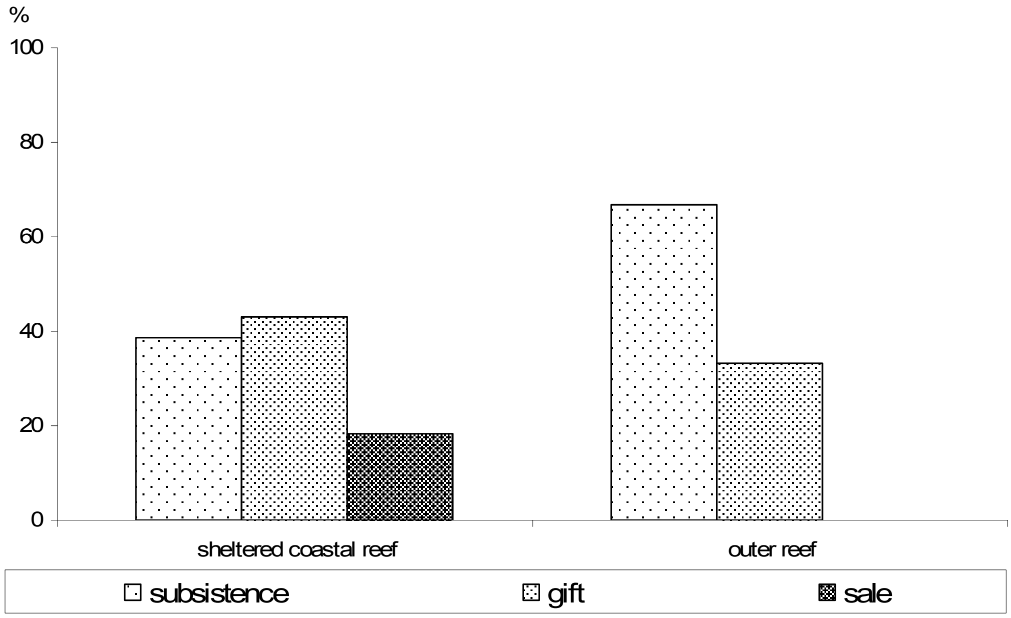

Figure 3.11: The use of finfish catches for subsistence, gifts and sale, by habitat in Futuna.
Proportions are expressed in % of the total number of trips per habitat.

Data on the average reported finfish sizes by family and habitat as shown in Figure 3.12 show a great variability in fish sizes by family. In general, average fish sizes are small, ranging from 15 to 25 cm. Mullidae, Acanthuridae and Priacanthidae are among the smaller fish, Lutjanidae and Carangidae about 20 cm in length on average, and Mugilidae, Holocentridae and Scaridae represent the largest average fish sizes around 25 cm. The overall small length and the high variability may be explained by two combined factors. Firstly, most fishing is done by walking to the edge of the sheltered coastal reef and by frequently using scoop nets and castnets. The use of handlines and gillnets are less frequent, and so is spear diving. The latter three techniques are likely to catch bigger fish than are caught with scoop nets and castnets.

By comparison, and as expected, the reported fish sizes from catches at the outer reef are larger and range around 30 cm and above. The data shown in Figure 3.12 for the average length of Carangidae caught at the outer reef seems to be an exception and should not be paid too much attention, due to the small sample size.

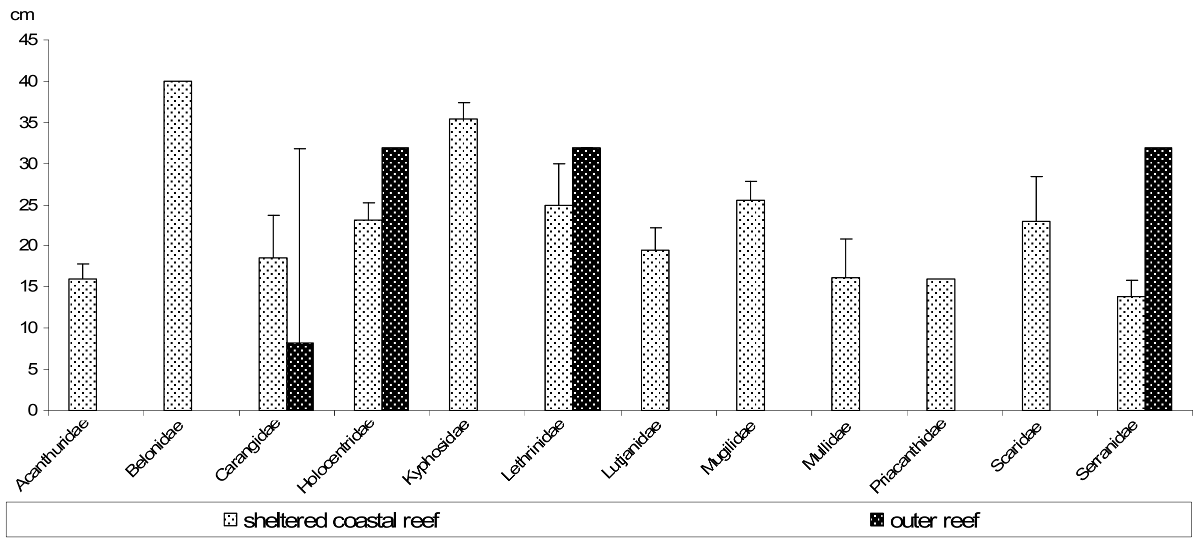

Figure 3.12: Average sizes (cm fork length) of fish caught by family and habitat in Futuna.
Bars represent standard error (+SE).

Some parameters selected to assess the current fishing pressure on Futuna's living reef resources are shown in Table 3.4. Fishing pressure on reef resources only applies to the coastal reef, which is at the same time an outer reef, due to the fact that there is no lagoon habitat. The difference between fishers targeting either the coastal or the outer reef is mainly due to the use of boats (motorised and non-motorised) at the outer reef, which allow fishers to access reef areas that are deeper and further away from the coral flats that dry during low tide. Consequently, in the case of Futuna, there is no difference between the total coastal reef, the total reef and the total fishing ground area. Fishing pressure is estimated using total fisher and population densities as well as the total subsistence demand of the island, as there is hardly any export of reef finfish from Futuna.

Overall, the available reef area is not extensive, resulting in a relatively high fisher density (>90 fishers/km^2), a high population density (435 people/km^2) and consequently, due to the relatively high consumption of fresh fish also, a very high fishing pressure per reef area. To what extent the total catch of ~24 t/km^2 available coastal reef area has a detrimental effect on the reef fish populations remains questionable. It must be borne in mind that the coastal reef is directly connected to the open ocean, and hence that reef and pelagic species groups intermingle. This is reflected in the families reported for the average catch composition. Thus, fishers do not only target reef fish but also pelagic fish. Taking into account the most common fishing techniques used, it seems that impact may be more selective concerning the size of fish caught rather than the particular fish species. However, these assumptions and interpretations need further confirmation with the results of the underwater finfish resource survey.

Table 3.4: Parameters used in assessing fishing pressure on finfish resources in Futuna

Parameters	Habitat				
	Sheltered coastal reef	Lagoon	Outer reef	Total reef area	Total fishing ground
Fishing ground area (km^2)	9.64	0.29	13.51	23.19	23.49
Density of fishers (number of fishers/km^2 fishing ground)	12			5	5
Population density (people/km^2)		0		255	252
Average annual finfish catch (kg/fisher/year)	346.13 (±60.29)	0	762.17 (±323.54)		
Total fishing pressure of subsistence catches (t/km^2)	24.30			14.23	14.05

The outer-reef area is part of the sheltered coastal reef, hence not regarded separately; catch figures are based on recorded data from survey respondents only; total number of fishers is extrapolated from household surveys; figures in brackets denote standard error; n/a: no size information available; total population = 5912; total number of fishers = 1233 (surveyed sites: 119); total subsistence demand = 330.1 t/year.

Commercialisation

The field survey revealed that there is a recent but increasing development of local fish sales on Futuna. Traditionally, fish was a non-monetary commodity and this tradition is still very strong among Futuna people. However, due to the increased living costs and changes in lifestyle, cash income is needed and fish is a potential source of revenue. However, the recent and future plans call for the commercialisation of pelagic fish rather than reef fish. This is due to the fact that pelagic fishing requires motorised boats and specific investment costs for trolling. These financial requirements are socially acknowledged to be accounted and paid for. At present there are about 3–5 small shops dealing with fish sales. The shop at Vele, for example, buys pelagic fish from five regular Vele fishers at XFP 700 per kg and sells it for XFP 900 per kg frozen. The total volume of exclusively pelagic or deep-bottom fish amounts to about 50 kg/month. Similarly, the shop at Alo buys from 10 regular local fishers. The local price is the same (buying price XFP 700 per kg; selling price XFP 900 per kg for fish either sold on ice or deep frozen). The current volume is about 100–150 kg/month. Plans call for the development of a fish shop supported by project funding from OGAF (Organisation des Agriculteurs Futuniens) in order to purchase a motorised boat with a 30 HP outboard engine. A second shop in Alo also buys and sells pelagic and deep-bottom fish only.

3.2.4 Catch composition and volume – invertebrates: Futuna

Calculations of the reported annual catch rates per species group are shown in Figure 3.13. The graph shows that the major impact by wet weight is mainly due to catches of three species groups: giant clams (*Tridacna maxima*), lobsters (*Panulirus* spp.) and trochus (*Trochus niloticus*). By comparison, catches reported for all other 12 species or species groups are of minor if not insignificant importance (Detailed data are provided in Appendices 2.2.3 and 2.2.4.). Results shown here are extrapolated figures based on our sample size. In the case of Futuna, the sample represents only about 8% of the total population. Major focus was given to capturing the invertebrate fishers who target lobsters, trochus and giant clams. Fishers interviewed were asked to estimate the total number of local fishers involved in any of these three fisheries, and their estimates are at least 50% if not 65% lower than our extrapolated figures. While the relationship of relative importance among these three major species (giant clams, lobsters and trochus) compared with the other invertebrates collected is accurate, the absolute amounts for the three species are overestimated. Due to the estimation of the total number of local fishers involved, it can be assumed that the total annual impact by wet weight of giant clams is 2.4–3.5 t/year, of lobsters 1.6–2.3 t/year, and of trochus 1.3–1.9 t/year.

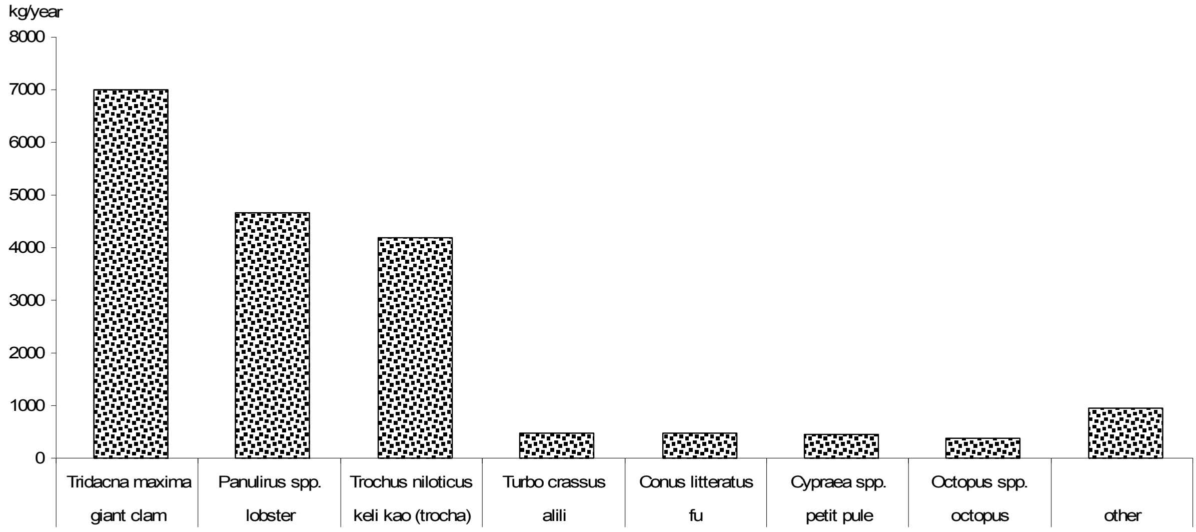

Figure 3.13: Total annual invertebrate catch (t wet weight /year) by species (reported catch) in Futuna.
'Other' refers to the octopus, lobster and giant clam fisheries.

This argument is supported by lobster export data collected from Amigos shop on Futuna. In 2004 the owner of the shop exported 1 t of lobster by air to Wallis and Noumea. Clients based in New Caledonia include the Phare Amédée and the Park Royal Hotel. He deals with five regular fishers from Vele, three from Leava and another 10 occasional fishers from Futuna. He buys for XFP 1000 per kg if speared and XFP 1200 per kg if still alive. About 60% of the catch he buys includes specimens of 24–28 cm in length, while 40% are smaller, 16–18 cm in length (*Lysiosquillina* spp.). The shop owner also confirmed that the local commercialisation and catch of reef crabs (*Carpilius maculatus*) is small, and may have reached about 100 kg in 2004. Specimens, rarely offered, are about 16 cm in size and cost XFP 1200 per kg.

Survey results revealed a total of about 10 commercial lobster fishers based at Toloke village, which is part of the Vele community, and a total of three trochus fishers who mostly sell the meat locally. Trochus is usually caught on request from clients. The actual price at the time of the survey was XFP 1500 for 40 trochus boiled and prepared in coconut milk. Lobster is sold locally to shops or restaurants, upon request to a private client in Futuna or, at times, to Wallis. The current lobster prices were XFP 1100 per kg fresh weight.

As already stated, invertebrate fisheries are limited and not of great importance for Futuna. Accordingly, the limited biodiversity reported for catches is not surprising. In fact there is only one habitat, i.e. reeftop, and reeftop gleaning prompted the greatest number of species distinguished by different vernacular names. Some of these species, such as lobsters, giant clams, octopus and trochus, may also be particularly targeted and thus assessed as a specialised fishery. Because of the degree of specialisation, the number of species is low, ranging from one vernacular name for trochus fisheries to three vernacular names from combined fishing trips for trochus, lobsters and giant clams and/or octopus (Figure 3.14).

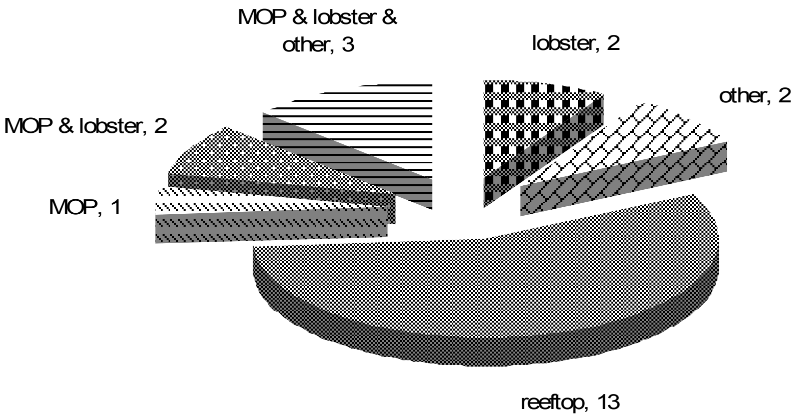

Figure 3.14: Number of vernacular names recorded for each invertebrate fishery in Futuna.
'Other' refers to the octopus, lobster and giant clam fisheries.

Females from Futuna only participate in reeftop gleaning. Thus, Figure 3.15 shows mainly data for male fishers. Average annual catches reported by male fishers on Futuna targeting the different fisheries (Figure 3.15) are highly variable and range from 300 to >1000 kg/fisher/year. However, taking into account data that is supported by a sample size large enough to permit calculation of an SE, highest average annual catches by wet weight occur for trochus and lobster fishers. Female reeftop gleaners only reach relatively low catches of 300–350 kg/fisher/year. As mentioned earlier, the sample sizes for males who do reeftop gleaning or combined trochus, lobster and other fishing in one trip are too small to allow interpretation.

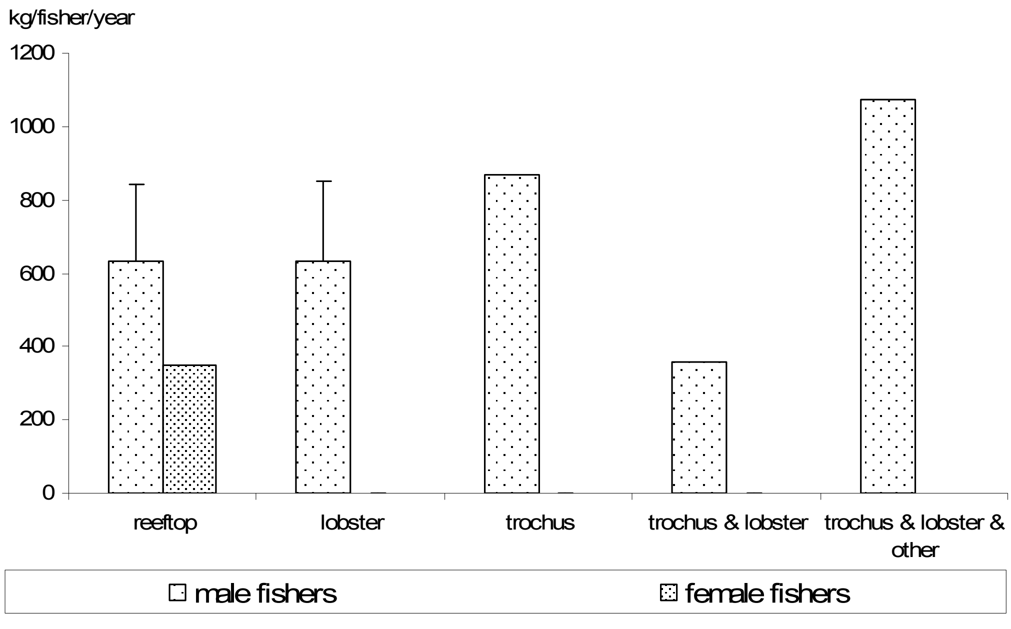

Figure 3.15: Average annual invertebrate catch (kg wet weight/year) by fisher, gender and fishery in Futuna.
Data based on individual fisher surveys. Figures refer to the proportion of all fishers that target each habitat (n = 15 for males, n = 35 for females). Bars represent standard error (+SE).'Other' refers to the octopus, lobster and giant clam fisheries.

In contrast to finfish fishing, invertebrate fishing is mainly done for subsistence purposes, and the share sold within or outside the Futuna community amounts to a maximum of 40% if we assume that half of all catches in the category 'consumption & sale combined' are sold (Figure 3.16). Considering that lobsters are the main, if not the only export species group, it is concluded that, if lobsters are excluded, the current impact of fishing on Futuna invertebrate resources is determined by the subsistence needs of the community. It may also be of interest that trochus used to be harvested in small amounts for export, but that this fishery is no longer operational.

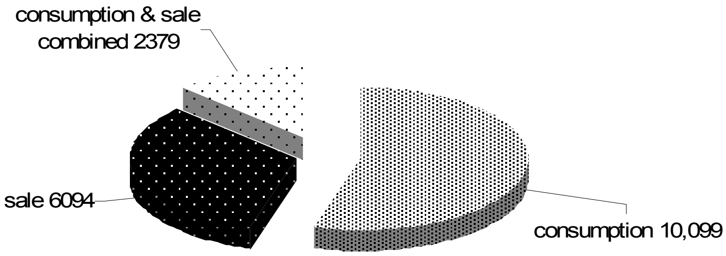

Figure 3.16: Total annual invertebrate biomass (kg wet weight/year) used for consumption, sale, and consumption and sale combined (reported catch) in Futuna.

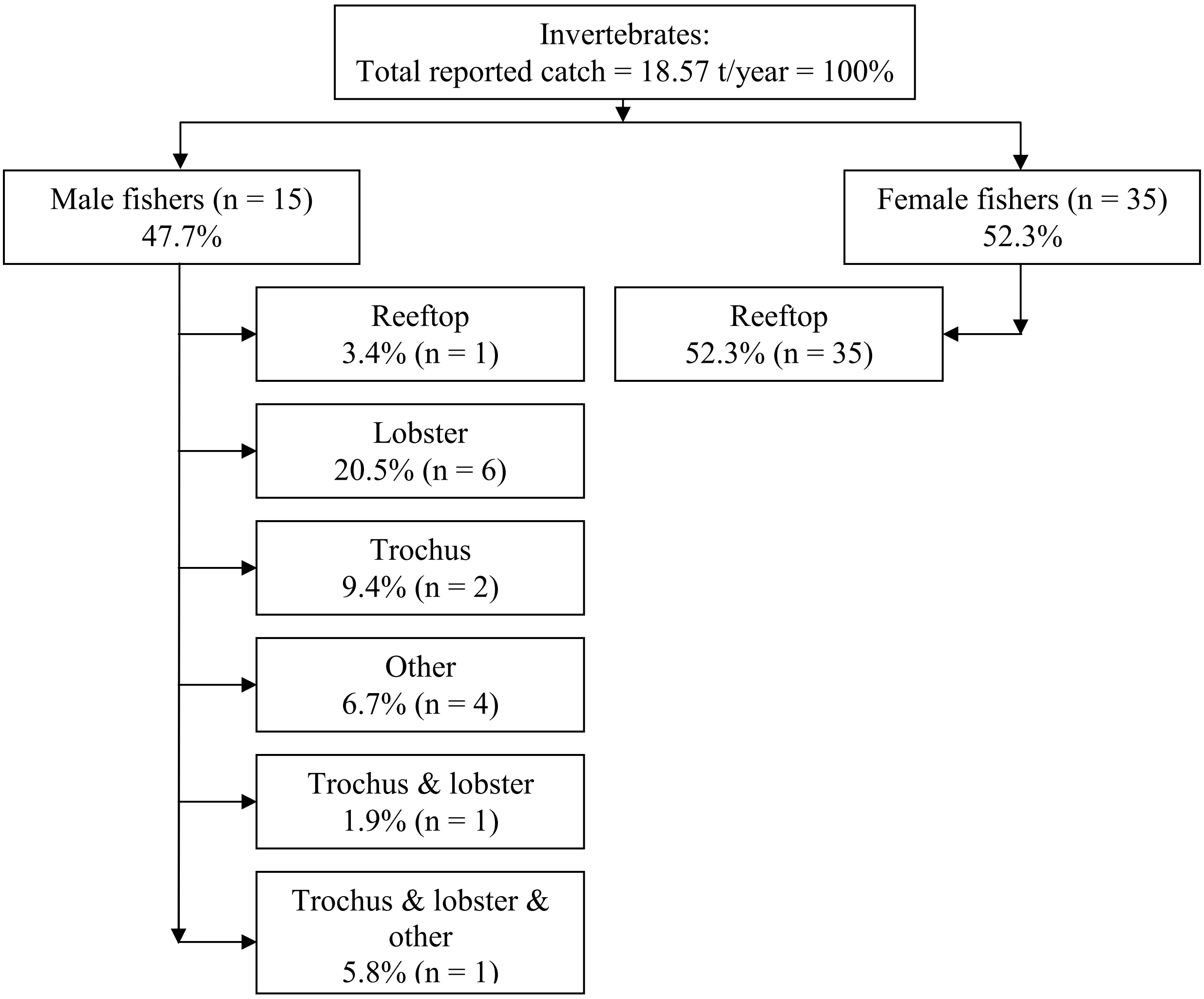

Figure 3.17: Total annual invertebrate catch (tonnes) and proportion (%) by fishery and gender (reported catch) in Futuna.
n is the total number of interviews conducted per each fishery; total number of interviews may exceed total number of fishers surveyed as one fisher may target more than one fishery and thus respond to more than one fishery survey. 'Other' refers to the octopus, lobster and giant clam fishery.

The total annual catch volume (expressed in wet weight based on recorded data from all respondents interviewed) amounts to 18.57 t/year (Figure 3.17). Catches from reeftop gleaning determine over half of all reported annual impacts (55.7%) followed by lobster fisheries (>20%) and trochus (~10%). Concerning the wet weight caught by year, gender participation is similar, with females collecting slightly more than males.

Table 3.5: Parameters used in assessing fishing pressure on invertebrate resources in Futuna

Parameters	Fishery					
	Lobster [3]	Other	Reeftop	Trochus	Trochus & lobster	Trochus & lobster & other
Fishing ground area (km^2)	18.5	13.59	13.59	13.59	n/a	n/a
Number of fishers (per fishery) [1]	101	67	614	34	17	17
Density of fishers (number of fishers/km^2 fishing ground)	5	5	45	3	n/a	n/a
Average annual invertebrate catch (kg/fisher/year) [2]	633 (±207.21)	312 (±221.91)	357 (±62.28)	869 (±217.14)	360 (n/a)	1075 (n/a)

[1] Number of fishers extrapolated from household surveys; [2] catch figures are based on recorded data from survey respondents only; [3] reef length on Western side of Futuna's main island only considered here; 'other' refers to the octopus, lobster and giant clam fisheries; n/a = no size information available or standard error not calculated.

The parameters presented in Table 3.5 show no variability in the size of the available fishing grounds for the various fisheries as all species collected are associated with reefs or reef habitats that are lined by sandy beaches. The only difference concerns lobster collection, which is mainly done along the slope of the western reef edge. Therefore we have only considered the length of this reef area. However, generally speaking, the number of fishers per fishery is low, and so is the density of fishers expressed either in km reef length as in the case of the lobster fishery or fishers per km^2 of reef area as for the other fisheries. Highest fisher density – and data reported earlier suggests these are mainly female fishers – exists for reeftop gleaning. However, here average annual catches are low and thus balance potential fishing pressure. Highest impact per fisher and year (expressed in wet weight) exists where the fisher density is lowest (i.e. the lobster and trochus fishery).

Commercialisation

There are two major women's associations on Futuna, one in the Kingdom of Sigave, the other one in the Kingdom of Alo (Appendix 2.2.5). The Federation of Artisanal Women of Sigave includes 11 different associations and has a total of 50 women members. Almost every member collects shells for artisanal purposes, with about 20 very active and commercially oriented women artisans. The Federation sells on average about 100 shell necklaces per month, each worth between XFP 600 and 5000. Sales are mainly made locally to supply families with necklaces to be given to departing family members or to take to family members and relatives when visiting overseas. Part of the Federation's funding comes from local sales of fish caught during joint gillnetting trips. These fund-raising fishing trips are made regularly, about twice per month and may take 4–6 hours, depending whether done at night or during the day. The smaller fish caught are distributed among the participating women and the larger ones (usually about 80 fish at ~40 cm fork length) are sold locally for XFP 1500 per fish.

The Women's Federation of Alo comprises 10 associations and 30 members. About 10 of these women are artisans who collect shells and make necklaces and other decorative shell items for sale. The Federation sells about 50 necklaces per month, each worth XFP 500–3000, and another 20–50 shell strings and shell hairbands.

3.2.5 Fisheries management: Futuna

Futuna is divided into two kingdoms and peacefully governed: the Kingdom of Alo and the Kingdom of Sigave. Both kingdoms maintain a system that is strongly determined by traditional values. Respect for and compliance with rules and values among Futunese people are high. This observation was supported by information given by the chiefs of the major villages, whom we interviewed.

However, apart from the government fisheries regulations (restrictions on the use of SCUBA gear, gillnets, crustacean collection, FADs, bans on explosives, poisons etc., and trochus size regulations), there were no traditional or customary rules in place (Appendix 2.2.6). Tradition demands that reef fish is mainly distributed on a non-commercial basis; however, due to modern lifestyle changes, a local commercial system has slowly been introduced, at least for pelagic fish. The harvest of commercial species, such as trochus, lobsters and perhaps others, is mainly limited by market access rather than rules or regulations, be they governmental or traditional. It was mentioned that there is one place only where fishing is limited or forbidden and which is located close to a FAD. Fishing is mainly done using gillnets, castnets, handlines and spears, and the average mesh size of gillnets is 4.5 cm.

3.2.6 Discussion and conclusions: socioeconomics in Futuna

- Fisheries are not an important sector for income generation on Futuna. Only 7% of all households reported fisheries as their first income source, and another 13% reported fisheries as their second income source. In contrast, salaries are of highest importance, complemented by income from agriculture and from other sources, such as small business, retirement pensions and other social fees.

- All households consume fresh fish but less than half consume invertebrates regularly. The per capita consumption of fresh fish is above the regional average but below the average estimated across all PROCFish/C sites investigated on Futuna and Wallis. Invertebrate consumption is low, about 3.5 kg/person/year.

- The average household expenditure level is not of particular note, except to mention that people on Futuna spend slightly more than people on Wallis. This may be explained by the even more isolated geographical location of Futuna, combined with a much smaller market than Wallis. Some receive remittances, but on average these do not cover more than 9–10% of the mean annual household expenditure.

- Both males and females fish for finfish, but fewer females fish for finfish and more collect invertebrates. Invertebrate harvesting that requires free-diving is exclusively performed by males. Most fishing targets the coastal reef, which drops steeply down with no lagoon system. Most fishers, males and females, walk to the edge at low tide where they use castnets or lines. Only a few men fish the outer-reef slope, using motorised or non-motorised boats. Invertebrate collection focuses on reeftops, and some fishers (males) free-dive for lobsters, trochus and giant clams. From a commercial point of view, shell collection for handicrafts, lobsters for export and trochus for local demand are important.

- Various fishing gears are used to catch finfish, mainly castnets, gillnets, handlines and spears, but invertebrate fisheries mainly involve the use of simple tools. Most fishing is done without any boat transport, except when the outer reef is fished.

- Fishing pressure is highest on the coastal reef and is high considering fisher density, population density and total catch for subsistence purposes per km^2 reef area. However, taking into account that the coastal reef is directly linked to the open ocean, and that pelagic species intermingle with reef fish, the actual impact of fishing on Futuna reef resources may be rather low.

- Invertebrate fisheries mainly serve the subsistence needs of the Futuna community, except for the lobster that is exported. Overall, fishing pressure is low in terms of fisher density and average recorded catch per fisher and year. Limited market access and lack of market infrastructure limit the future exploitation level.

Survey results suggest two major conclusions. Firstly, current present pressure on finfish resources on Futuna is only moderate or even low when we consider that the coastal reef is the only habitat targeted and that this habitat is directly linked to the open ocean. Any impact on reef resources is determined by the island community's own demand for fresh fish as only small amounts are exported. Finfish export is mainly of pelagic fish. While Futuna's population density is increasing (A 5.5% increase in population is reported.), the local fish consumption is lower than the average of all sites investigated, including Wallis. If the current development of local and perhaps export-oriented fish sale increases, future impacts will be on pelagic rather than on reef-fish resources.

These conclusions are supported by a Fisheries Service survey that was carried out on Futuna in February 2002. The survey covered only 46 fishers in both kingdoms and only 10 of these were considered to fish sufficiently and frequently enough to be classified as artisanal fishers. In other words, the survey suggests, although indirectly as no catch data was collected, that fishing pressure on Futuna further to the subsistence needs of its population is very limited. This also showed in the figures provided on the income situation of all 46 fishers interviewed. Only 20% of all fishers gained all their income from fisheries, while 24% received salaries from the public sector, 9% were retired, 26% were married to a partner with salary income, and 47% were also involved in agriculture.

Considering invertebrate fisheries, fisher densities appear low. This observation also applies for all of the three species groups that make up most of the reported and extrapolated catch volume by wet weight, i.e. giant clams, lobsters and trochus. The volume by wet weight collected from reeftops is insignificant, even though some specimens sustain the local subsistence demand for shellfish, and others provide income from handicrafts made by local women. There is no reason to assume that fishing pressure on invertebrate resources has reached an alarming level. However, historical trends (e.g. previous trochus harvesting activities and quantities) and the natural potential of the available habitats need to be taken into account before final conclusions are drawn.

Futuna is governed by two kings in accordance with traditional and customary values and rules. Consequently, the fact that there was no report on any customary or local regulation to control fishing pressure, or to regulate fisheries in any way, may be an indication that the status of fisheries resources on Futuna has not dramatically changed and that they are still considered to be healthy and able to sustain the current level of demand.

3.3 Finfish resource surveys: Futuna

Finfish resources and associated habitats were assessed between 2 and 19 November 2005, from a total of 45 transects (all in the outer reef, see Figure 3.18 and Appendix 3.3.1 for transect locations and coordinates respectively.).

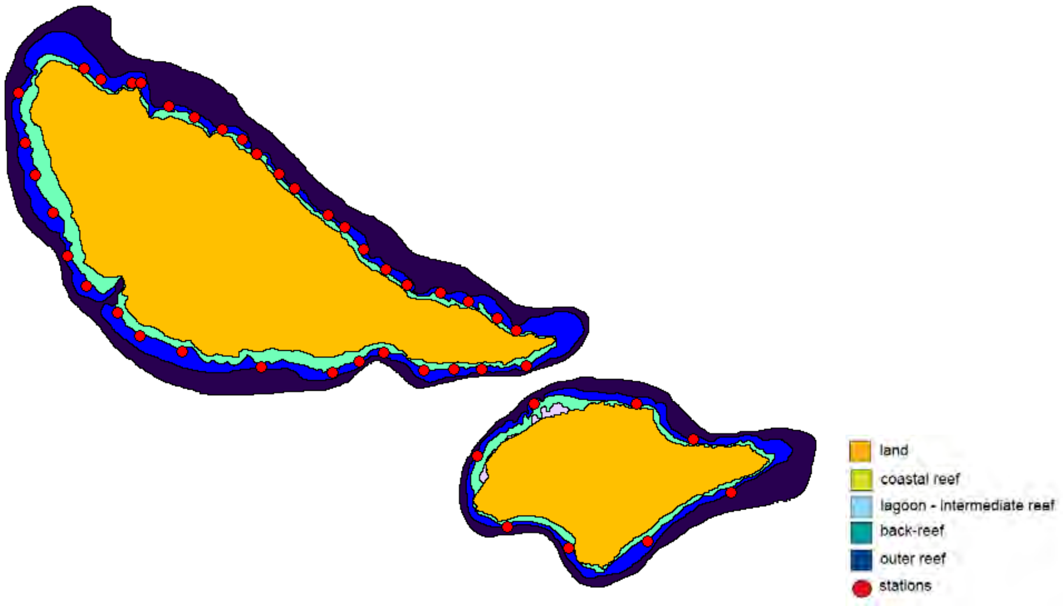

Figure 3.18: Habitat types and transect locations for finfish assessment in Futuna.

3.3.1 Finfish assessment results: Futuna

A total of 21 families, 51 genera, 137 species and 11,197 fish were recorded in the 45 transects (See Appendix 3.3.2 for list of species.). Only data on the 14 most dominant families are presented below (See Appendix 1.2 for species selection.), representing 43 genera, 126 species and 11,169 individuals.

The outer reef was the only habitat present in Futuna. Compared to the outer reef habitats of Vailala and Halalo, Futuna displayed much poorer fish resources, with very low values of density and biomass, as well as biodiversity (Table 3.6).

Table 3.6: Primary finfish habitat and resource parameters recorded in Futuna (average values ±SE)

Parameters	Outer reef
Number of transects	45
Total habitat area (km^2)	13.6
Depth (m)	7 (1-15) [(1)]
Soft bottom (% cover)	3 ±3
Rubble & boulders (% cover)	3 ±1
Hard bottom (% cover)	76 ±2
Live coral (% cover)	16 ±1
Soft coral (% cover)	2 ±0
Biodiversity (species/transect)	30 ±1
Density (fish/m^2)	0.3 ±0.0
Size (cm FL) [(2)]	17 ±0
Size ratio (%)	59 ±1
Biomass (g/m^2)	46.9 ±4.5

[(1)] Depth range; [(2)] FL = fork length.

The outer-reef environment of Futuna was dominated by one herbivorous family, Acanthuridae and, to a much smaller extent and only for biomass, by Scaridae (Figure 3.19, Table 3.7). These two families were represented by 34 species; particularly high abundance and biomass were recorded for *Ctenochaetus striatus*, *Acanthurus lineatus*, *A. nigricans*, *Chlorurus frontalis*, *Naso lituratus* and *Scarus psittacus*. This reef environment was mostly covered by hard bottom (76%), with very little live-coral cover (16%, Table 3.6, Figure 3.19).

Table 3.7: Finfish species contributing most to main families in terms of densities and biomass in the outer-reef environment of Futuna

Family	Species	Common name	Density (fish/m^2)	Biomass (g/m^2)
Acanthuridae	*Ctenochaetus striatus*	Striated surgeonfish	0.099 ±0.016	12.1 ±2.0
	Acanthurus lineatus	Lined surgeonfish	0.039 ±0.006	11.8 ±1.8
	Acanthurus nigricans	Whitecheek surgeonfish	0.030 ±0.008	2.4 ±0.6
	Naso lituratus	Orangespine unicornfish	0.004 ±0.001	1.0 ±0.2
Scaridae	*Chlorurus frontalis*	Tan-faced parrotfish	0.004 ±0.002	1.1 ±0.6
	Scarus psittacus	Common parrotfish	0.003 ±0.001	0.6 ±0.2

The density and biomass of finfish in the outer reefs of Futuna were smaller than values recorded in Vailala and Halalo. Biodiversity was also lower (30 versus 45 and 40 species/transect respectively). Size and size ratios were similar to those in the other two sites (17 cm FL and 59% for Futuna versus 17–18 cm FL and 55–61% for Wallis sites). The trophic structure in Futuna outer reefs was strongly dominated by herbivores, mainly represented by Acanthuridae. Scaridae were only relatively important in terms of biomass (6 g/m^2 versus 30 g/m^2 of Acanthuridae).

The reefs were mostly covered by hard bottom (76%). This may explain the prevalence of Acanthuridae and especially of *Ctenochaetus striatus* and *Acanthurus lineatus*, both of which are always associated with hard bottom. Fish from the family Acanthuridae are the most targeted by fishers.

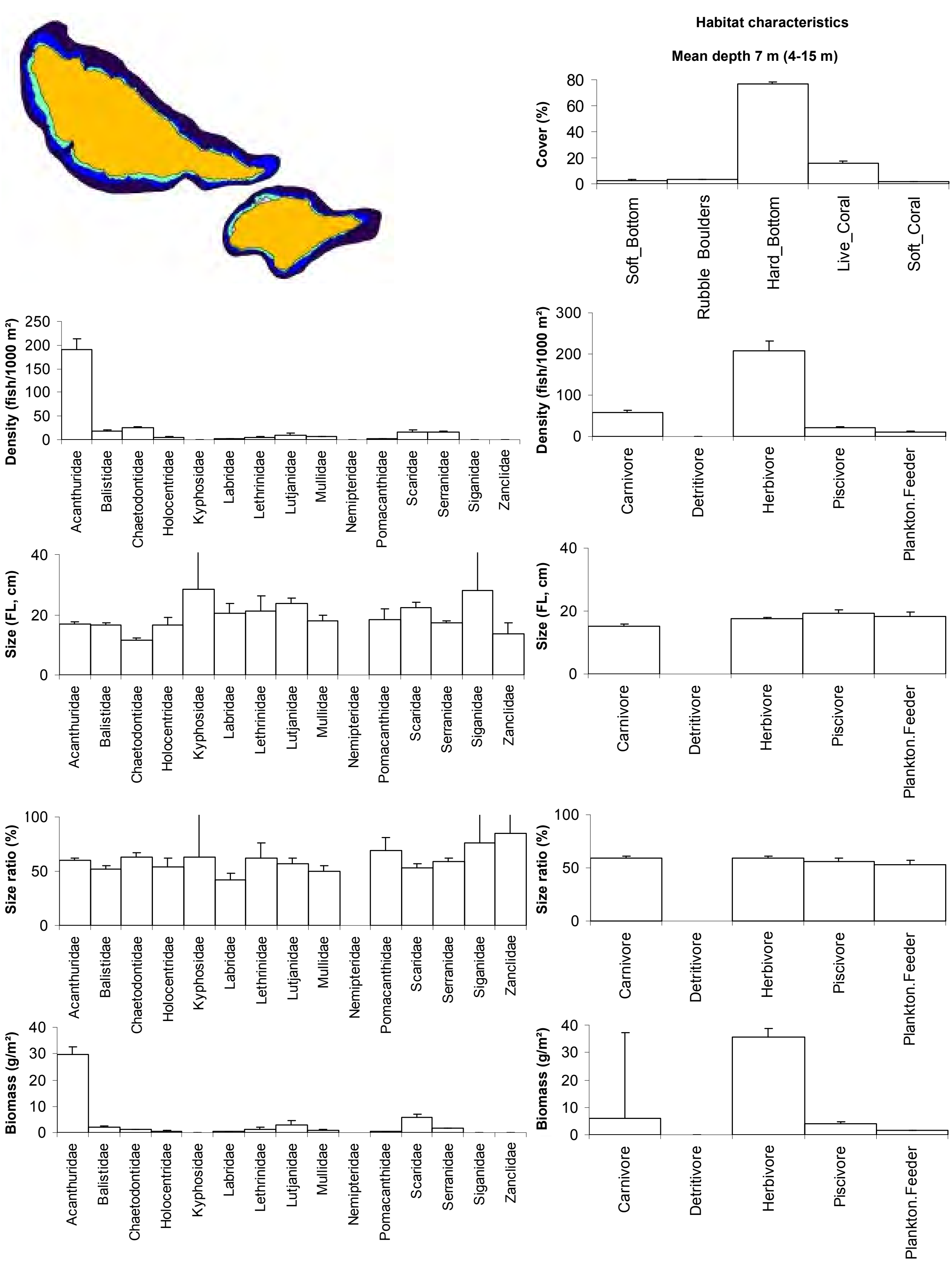

Figure 3.19: Profile of finfish resources in the outer-reef environment of Futuna.
Bars represent standard error (+SE); FL = fork length.

3.3.2 Discussion and conclusions: finfish resources in Futuna

The assessment indicated that the status of finfish resources in this site is relatively poor. This is probably a consequence of Futuna being naturally poor in terms of availability of reef habitats and productivity of outer reefs. Biomass and density of fish are in fact the lowest in the country (Wallis and Futuna). Most fishing is done for subsistence and mainly from the reef crest surrounding the island (mostly using handlines for deep-water fish). Fishing on the outer reefs is mainly done off the west (leeward) coast. The community is less dependent on fishing for income generation compared to at the other sites. However, considering that people here consume quite a large quantity of fresh fish, and that the densities of the population and of the sustenance fishers per reef habitat areas are fairly high due to the reduced fishing ground, quite a high pressure is imposed on the only habitat present.

- Overall, Futuna finfish resources appeared to be in relatively poor condition. The reef habitat is naturally poor (coral slab with very little live coral) and the finfish resources scarce.

- The dominance of herbivore fish may be explained by the type of habitat, mainly composed of hard bottom with very little live coral.

- Fishing mainly targets outer, deep-water fish. Species normally assessed in the shallower 10 m were not reported by the underwater surveys but were caught by line fishing. The fact that these species were found at deeper depths than normal might indicate a first impact on some carnivorous families, such as Lethrinidae.

3.4 Invertebrate resource surveys: Futuna

The diversity and abundance of invertebrate species at Leava, in the west of the main Island of Futuna, and at Vele, on the west side of Alofi islet, were independently determined using a range of survey techniques (Table 3.8): broad-scale assessment (using the 'manta tow' technique; locations shown in Figure 3.20) and fine-scale assessment of specific reef and benthic habitats (Figures 3.21 and 3.22).

Table 3.8: Number of stations and replicates completed at Leava, Vele and all Futuna

All Futuna (survey totals)

Survey method	Stations	Replicate measures
Broad-scale transects (B-S)	20	119 transects
Reef-benthos transects (RBt)	25	150 transects
Soft-benthos transects (SBt)	0	0 transect
Soft-benthos infaunal quadrats (SBq)	0	0 quadrat group
Mother-of-pearl transects (MOPt)	13	78 transects
Mother-of-pearl searches (MOPs)	0	0 search period
Reef-front searches (RFs)	10 RFs 7 RFs_w	60 search periods 42 search periods
Sea cucumber day searches (Ds)	5	30 search periods
Sea cucumber night searches (Ns)	8	48 search periods

RFS = reef-front search; RFs_w = reef-front search by walking.

Leava

Survey method	Stations	Replicate measures
Broad-scale transects (B-S)	7	41 transects
Reef-benthos transects (RBt)	7	42 transects
Soft-benthos transects (SBt)	0	0 transect
Soft-benthos infaunal quadrats (SBq)	0	0 quadrat group
Mother-of-pearl transects (MOPt)	6	36 transects
Mother-of-pearl searches (MOPs)	0	0 search period
Reef-front searches (RFs)	3 RFs 5 RFs_w	18 search periods 30 search periods
Sea cucumber day searches (Ds)	3	20 search periods
Sea cucumber night searches (Ns)	2	18 search periods

RFS = reef-front search; RFs_w = reef-front search by walking.

Vele

Survey method	Stations	Replicate measures
Broad-scale transects (B-S)	13	78 transects
Reef-benthos transects (RBt)	18	108 transects
Soft-benthos transects (SBt)	0	0 transect
Soft-benthos infaunal quadrats (SBq)	0	0 quadrat group
Mother-of-pearl transects (MOPt)	4	24 transects
Mother-of-pearl searches (MOPs)	0	0 search period
Reef-front searches (RFs)	7 RFs 2 RFs_w	42 search periods 12 search periods
Sea cucumber day searches (Ds)	4	24 search periods
Sea cucumber night searches (Ns)	2	12 search periods

RFS = reef-front search; RFs_w = reef-front search by walking.

The broad-scale assessment was conducted by manta tow, the main objective being to describe the distribution pattern of invertebrates (rareness/commonness, patchiness) at large scale and, importantly, to identify target areas for further, fine-scale assessment. Then fine-scale assessment is conducted in target areas to specifically describe the status of resource in those areas of naturally higher abundance and/or most suitable habitat.

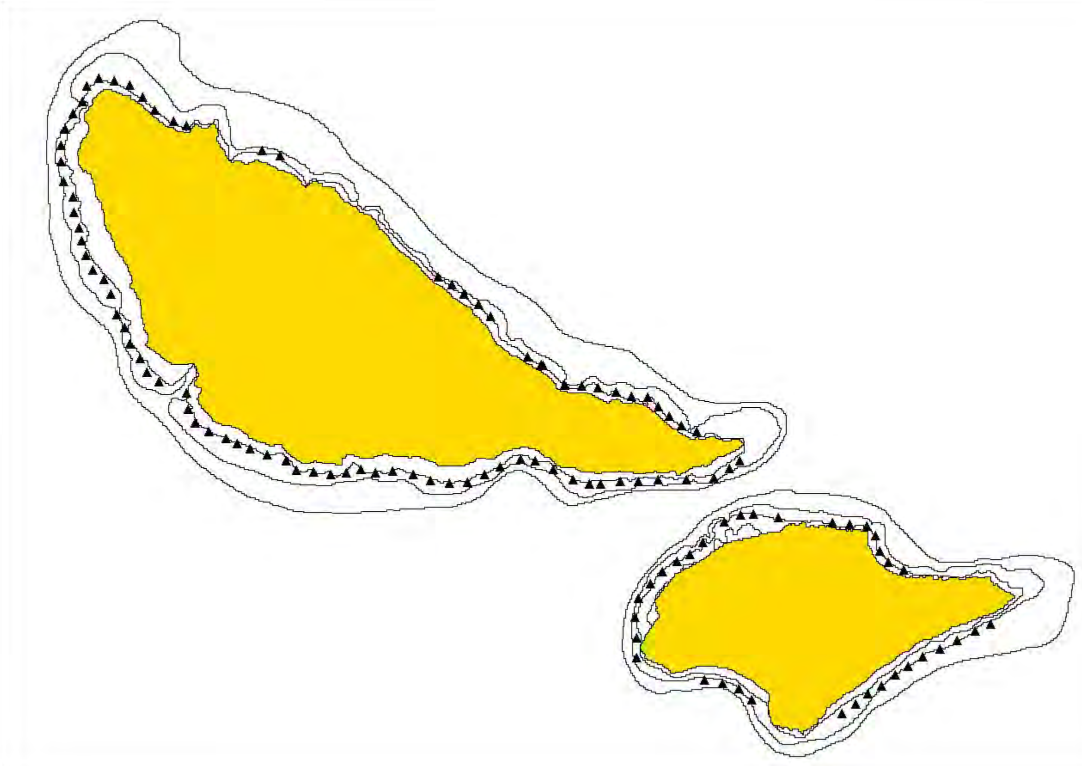

Figure 3.20: Broad-scale survey stations for invertebrates in Futuna.
Data from broad-scale surveys conducted using 'manta-tow' board;
black triangles: transect start waypoints.

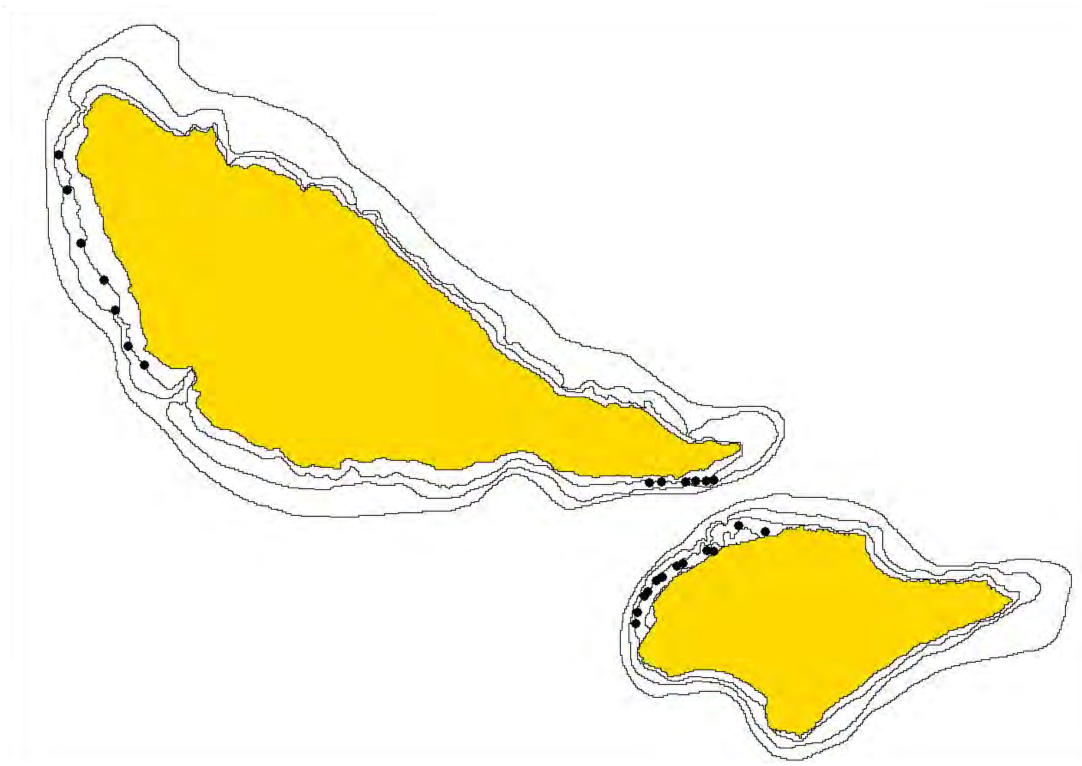

Figure 3.21: Fine-scale reef-benthos transect survey stations for invertebrates in Futuna.
Black circles: reef-benthos transect stations (RBt).

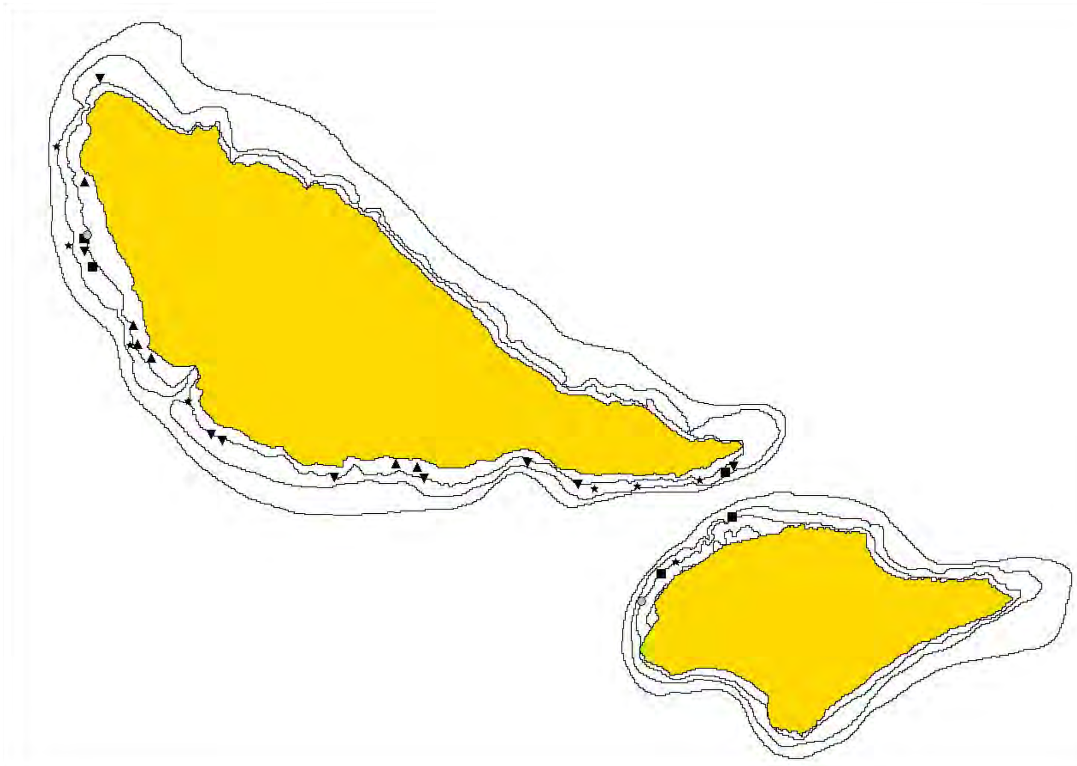

Figure 3.22: Fine-scale survey stations for invertebrates in Futuna.
Black triangles: reef-front search stations (RFs);
inverted black triangles: reef-front walk search stations (RFs_w);
black squares: mother-of-pearl search transects (MOPt);
black stars: sea cucumber day search stations (Ds);
grey circles: sea cucumber night search stations (Ns).

Fifty-three species or species groupings (groups of species within a genus) were recorded in the Futuna (Leava/Vele) invertebrate surveys; 4 (2/3) bivalves, 20 (14/16) gastropods, 10 (7/10) sea cucumbers, 5 (4/3) lobsters, 4 (2/3) starfish and 4 (4/4) urchins (Appendix 4.4.1 and Appendices for each site 4.5 and 4.6). Information on key families and species is detailed below.

3.4.1 Giant clams: Futuna

Futuna is an uplifted volcanic island (5 km x 20 km), without any major lagoon except for pockets of water on the fringing reef flat. The narrow coastal strip is 200 m wide at most. Habitat that is suitable for giant clams was generally limited to exposed reef slope with an area of 11.1 km^2 at Futuna and 5 km^2 at Alofi.

Shallow-water reef flat and reef benthos near the shoreline of Futuna tended to dry at low tides, the only exception being the west of Alofi Island, where a limited area of lagoon habitat was found (<1 km^2). From general observations, the reef slope was stratified into two depth levels around the leeward side of the main island (Futuna): 10–20 m immediately at the edge of the reef slope, then again 20–40 m before a second, sharp change in depth gradient. The presence of shoals at 10–20 m depth, which extended out from the reef edge, provided some protection from swell and held significant numbers of *Tridacna maxima* among live corals. Generally, water flow was dynamic and most shorelines were affected by oceanic swell.

Broad-scale sampling provided an overview of giant clam distribution around Futuna and Alofi Islet, although sampling was made difficult by the exposure of reef edges to swell. In these broad-scale surveys, only the elongate clam, *Tridacna maxima*, was recorded, being found in 19 stations, (67 transects) at an average density of 39.7 per ha ±8.7 per station (Figure 3.23). Broad-scale stations at Leava had a lower mean density of *T. maxima* (15.5 per ha ±3.9) than stations at Vele (52.7 per ha ±11.8).

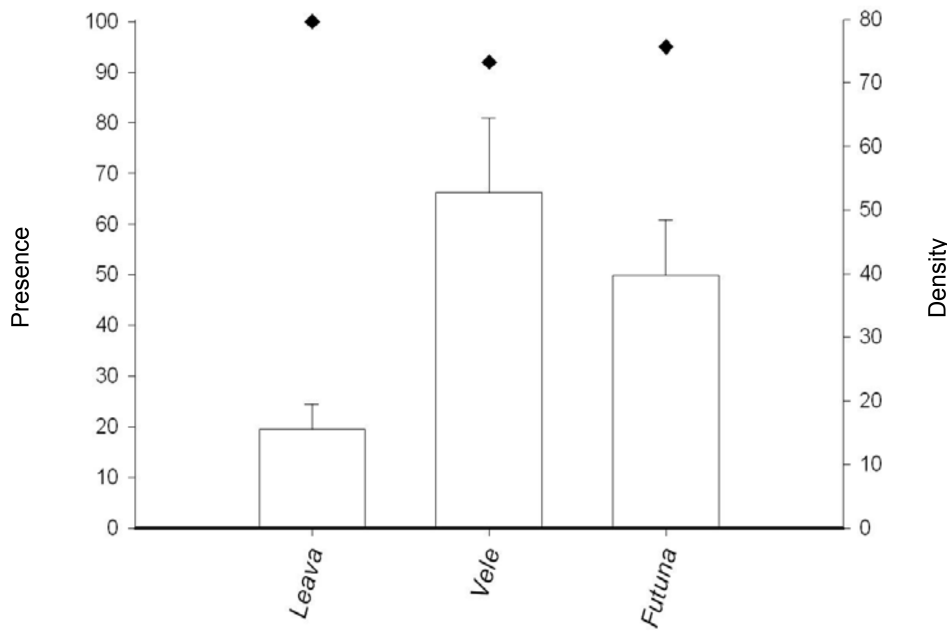

Figure 3.23: Presence and mean density of *Tridacna maxima* at Leava, Vele and all Futuna based on broad-scale survey.
Presence is measured as % of stations surveyed where clams were present and denoted by black diamonds; density is measured in numbers per hectare and is represented by bars (+SE).

Based on the findings of the broad-scale survey, finer-scale surveys targeted specific areas of shallow-water reef (clam habitat). In these reef-benthos assessments (RBt), *T. maxima* was present within 43% of stations in Leava and 83% of stations at Vele (which included the pseudo lagoon at Alofi Islet, Figure 3.24).

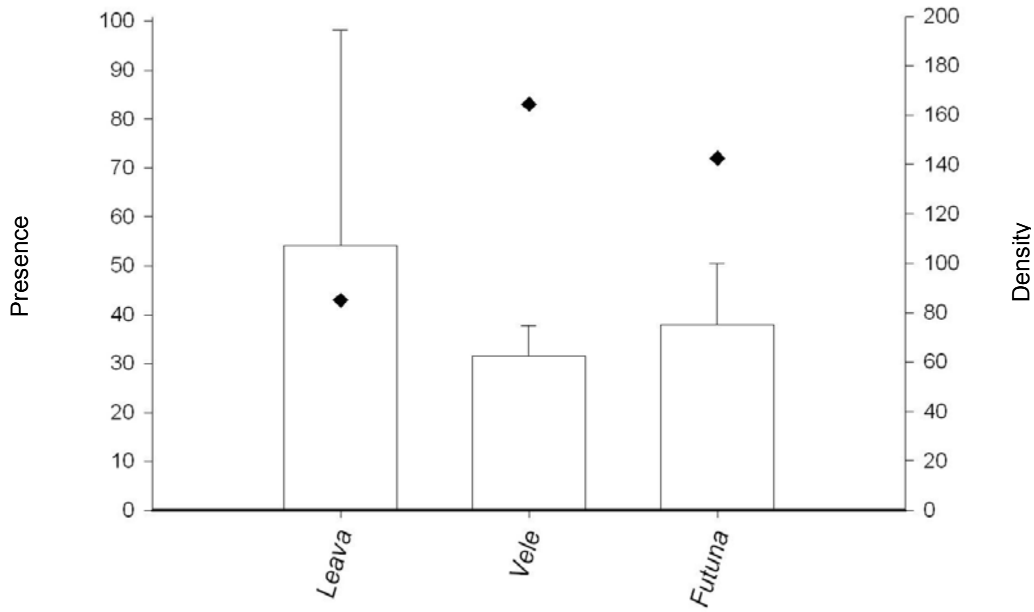

Figure 3.24: Presence and mean density of *Tridacna maxima* at Leava, Vele and all Futuna based on fine-scale reef-benthos survey.
Presence is measured as % of stations surveyed where clams were present and denoted by black diamonds; density is measured in numbers per hectare and is represented by bars (+SE).

These surveys targeting clam habitat for a closer inspection (RBt) yielded a mean density of 75.0 clams per ha ±25.0 (Vele stations 62.5 per ha ±12.3, Leava stations 107.1 per ha ±87.1). The mean density at 18 of 25 stations where clams were recorded was 104.2 per ha ±32.4. *T. maxima* were most common at one site in the west of Futuna (Leava) and on the west side of Alofi Islet (Vele).

T. maxima from reef-benthos transects (RBt, shallow-water reefs) had an average length of 14.9 cm ±1.0. When clams from deeper water or more exposed locations were included (from all assessments), the mean length varied little (15.3 cm ±0.5). As can be seen from the length-frequency graphs (Figure 3.25), clams of all lengths, including clams around the asymptotic length of approximately 30 cm were recorded in survey. In unfished stocks, there is often a predominance of larger clams, although this is rarely the case at most PROCFish study sites in the Pacific today.

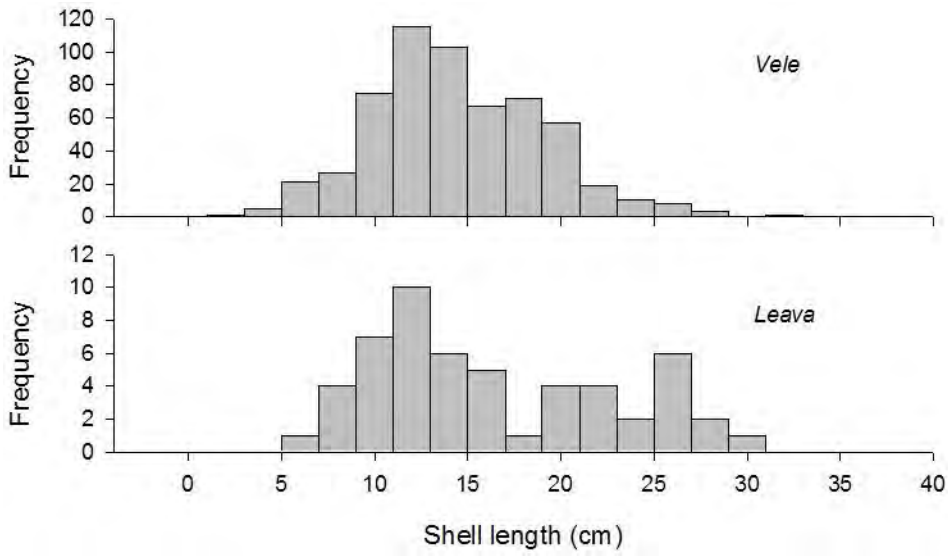

Figure 3.25: Size frequency histograms of giant clam *Tridacna maxima* in Vele and Leava.

The larger species of giant clams, which are characteristically found at lower density than elongate clams, were either not recorded (horse-hoof clam, *Hippopus hippopus*) or were rare (fluted clam, *Tridacna squamosa*). A single adult *T. squamosa* (30 cm shell length) was recorded during deeper-water sea cucumber day searches at Leava (Appendices for each site 4.5 and 4.6).

3.4.2 Mother-of-pearl species (MOP) – trochus and pearl oysters: Futuna

Futuna is on the extreme easterly limit for the natural distribution of the commercial topshell, *Trochus niloticus.* Both islands had a range of fringing reef environments and reef slope that shoaled in some areas (total lineal distance approximately 59 km; 38 km for Futuna Island and 20 km for Alofi Islet). Most fringing reef was exposed and subject to large swell on occasion. Little in the way of protected inshore reef habitat was present. Fringing reef had back-reef or reeftop flats for *Trochus niloticus* (an important habitat for juvenile trochus), but habitat dried at low tide. The physical features of reef flats at Futuna varied; in some locations they had slight depressions, which did not completely dry during low tide, while in others there was a network of perforated limestone platforms with blowholes at the reef front which merged with the reef flat. This is where the two juveniles were found in reeftop searches. Females do most of the gleaning in these locations at low tide, targeting small gastropods for making handicrafts.

The PROCFish/C survey work revealed that *T. niloticus* was relatively commonly distributed around the reefs at Futuna and Alofi Islet. *T. niloticus* were recorded on reef slopes at all mother-of-pearl transect stations (MOPt) and in broad-scale, reef-benthos and reef-front searches (Table 3.9).

Differences were noted in the densities of trochus between Leava and Vele (Figure 3.26).

Table 3.9: Presence and mean density of *Trochus niloticus* and *Tectus pyramis* in Futuna
Based on various assessment techniques; mean density measured in numbers/ha (±SE).

	Density	SE	% of stations with species	% of transects or search periods with species
Trochus niloticus				
B-S	4.5	2.2	5/20 = 25	17/119 = 14
RBt	86.7	21.1	15/25 = 60	34/150 = 23
RFs	12.2	11.3	3/10 = 30	8/60 = 13
RFs_w	0.7	0.7	1/7 = 14	1/42 = 2
MOPt	259.6	70.9	13/13 = 100	49/78 = 63
Tectus pyramis				
B-S	0.6	0.3	4/20 = 20	4/119 = 3
RBt	35.0	10.1	11/25 = 44	16/150 = 11
RFs	2.0	1.3	2/10 = 20	4/60 = 7
RFs_w	0	0	0/7 = 0	0/42 = 0
MOPt	60.9	25.1	9/13 = 69	21/78 = 27

B-S = broad-scale survey; RBt = reef-benthos transect; RFs = reef-front search; RFs_w = reef-front search by walking; MOPt = mother-of-pearl transect.

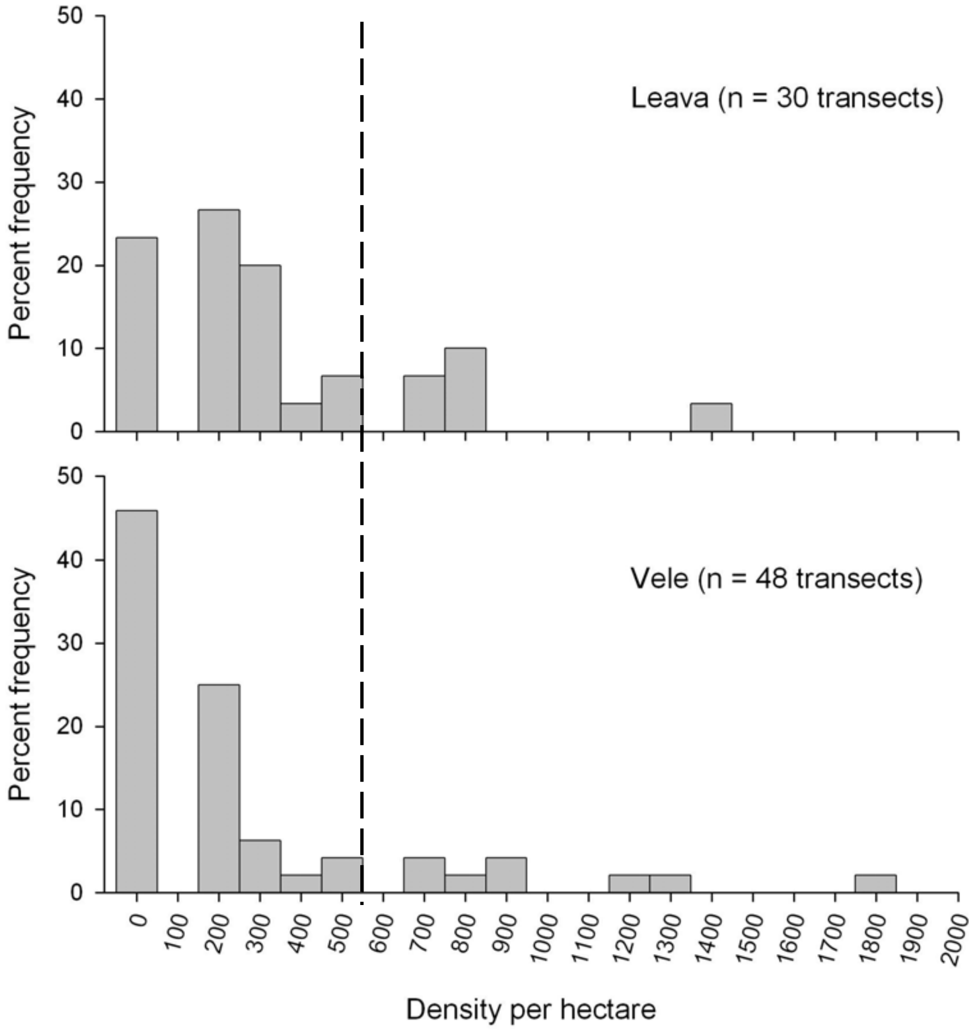

Figure 3.26: Percentage frequency plot of *Trochus niloticus* density (per ha) for mother-of-pearl 80 m^2 transects conducted at Vele and Leava.
Dotted line indicates the threshold density (500–600 trochus/ha) below which commercial harvesting is not recommended.

On the reef slope, the MOPt station with the most *T. niloticus* had a density of 896 trochus/ha. This equates to 43 shells/station, with the greatest number of trochus per 80 m^2 transect being 14 individuals. General presence within these trochus areas was high, with 63% of transects holding shells.

Shell size also gives an important indication of the status of stocks, by highlighting new recruitment (or the lack of recruitment) into the fishery and the amount of large adult spawners in the population. These factors have implications for the numbers of trochus entering the capture size classes in the next two years, and give an appreciation of fishing intensity. The mean size (basal width) of *T. niloticus* from survey was 10.5 cm ±0.1 (n = 276, Figure 3.27), and the length-frequency graph reveals that the bulk of stock are within the capture size classes (First maturity of trochus is at 7–8 cm, three years of age.). For this cryptic species, younger shells are normally only picked up in surveys from the size of about 5.5 cm, when small trochus are emerging from a cryptic style of life and joining the main stock. As can be seen from the length-frequency graph, there looks to be an indication of a small recruitment pulse of younger trochus at Leava. When considering large shell sizes, which produce larger, more viable eggs in significantly larger numbers, the stock (>11 cm basal width) makes up 32.6% of the population. This ratio is relatively normal for the mature proportion of a population in a relatively lightly fished stock. In other trochus fisheries, where stock has not been fished for an extended period or where there is a maximum basal width for commercial sale (of 11 cm), this portion of the stock makes up to 50% of the population.

Data on distribution and shell size suggest that trochus are collected at both Vele and Leava, but not heavily impacted by fishing; spawning and recruitment of trochus is continuing to replenish reefs, and large adults (broodstock) are present at reasonable densities. Anecdotal reports from fishers of 50 kg catches/trip (1–1.5 bags) support this assumption, although fishing is now halted, due to the reluctance from the buyer in Wallis to accept new shell (Market price is currently low.). Although these open-reef systems are not depleted, the lack of significant juvenile habitat (more so in Leava) and the open nature of the reefs in Futuna make such densities more vulnerable to fishing than would be the case in other reef systems. As such, trochus aggregations should be rested for as long as possible, until station densities reach a minimum average of 500–600 per ha. Only at these densities are major harvests of shells recommended (Appendices 4.4.5 to 4.4.7 and Appendices for each site 4.5 and 4.6). At the present time only two of the 13 MOPt stations (15%) are at or over this level of density (one in Leava and one in Vele).

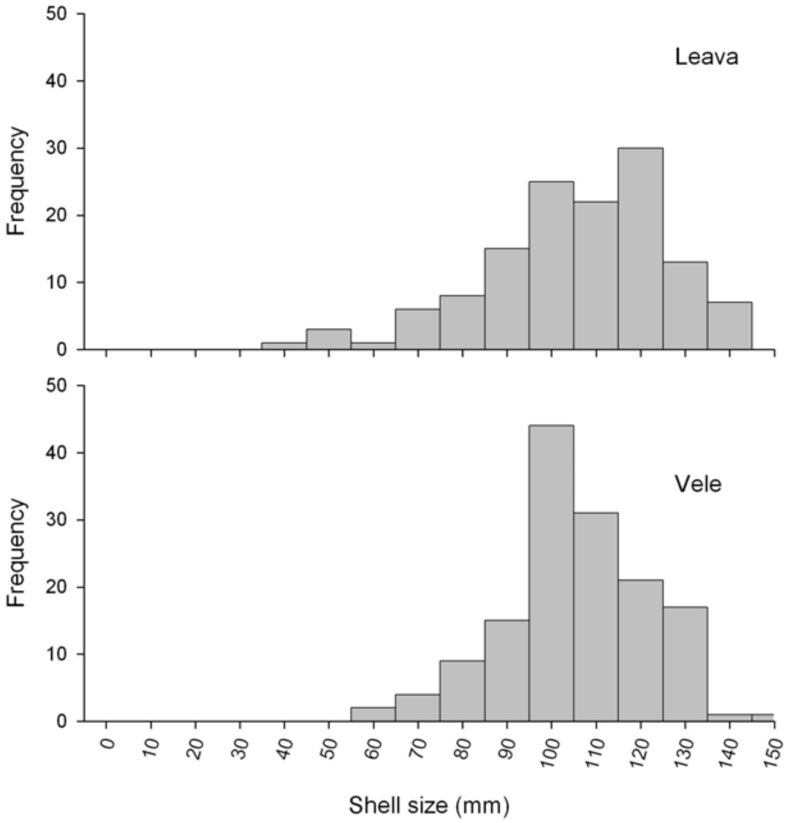

Figure 3.27: Size frequency histograms of trochus in Vele and Leava.

Green topshell, *Tectus pyramis* (of low commercial value), a species closely related to trochus, with similar distribution and life-history characteristics, was less common than commercial trochus (Table 3.9). In RBt and MOPt surveys green topshell was moderately common for this species (present in 40–60% of stations), and at moderate density (35–61 per ha). The mean size of *T. pyramis* was 6.6 cm ±0.2 (n = 58). A full range of *T. pyramis* sizes (adults and juveniles) was noted in survey.

Pinctada margaritifera, a normally cryptic and sparsely distributed pearl oyster species, was not recorded in either Vele or Leava assessments. Taking into account the cryptic nature of *P. margaritifera* and its general low density in open reef systems, this result was not unexpected.

3.4.3 Infaunal species and groups: Futuna

Submerged areas of soft benthos and seagrass were rare in Futuna and Alofi Islet, as fringing reef tended to be uplifted and lagoon systems were not present. Futuna did not possess in-ground shell resource beds holding shells, such as arc shells (*Anadara* spp.) or venus shells (*Gafrarium* spp.) and, therefore, no fine-scale assessments or infaunal stations (quadrat surveys) were made for these resources.

3.4.4 Other gastropods and bivalves: Futuna

The larger Seba spider conchs, *Lambis truncata*, were noted in both broad-scale and reef-benthos transect stations at low density (1–5 per ha). No smaller spider conchs (*L. lambis* and *L. crocata*) were recorded, although a single record of *Strombus luhuanus* was noted in a reef-benthos station at the NW of Alofi Islet (Appendices 4.4.1 to 4.4.7 and Appendices for each site 4.5 and 4.6).

Species of *Turbo* were noted at moderate-to-low density in survey (*T. setosus*, *T. crassus* [possibly a misidentification of *T. argyrostomus*], *T. chrysostomus*). These commonly collected gastropods are normally found along exposed reef fronts in the Pacific, although the swell limited access to much of the reef front during the study. The smaller turban species, *T. chrysostomus*, was found in more inshore locations on reef-benthos transect stations.

Other resource species targeted by fishers (e.g. *Astralium*, *Cerithium*, *Conus*, *Cypraea*, *Dolabella*, *Littoraria*, *Oliva*, *Pleuroploca*, *Rhinoclavis*, *Thais* and *Vasum*) were also recorded during independent survey (See lists in Appendices 4.4.1 to 4.4.7 and Appendices for each site 4.5 and 4.6.).

Data on other bivalves in broad-scale and fine-scale benthos surveys, such as *Anadara* and *Asaphis* spp., are also in Appendices 4.4.1 to 4.4.7 and Appendices for each site 4.5 and 4.6. Creel surveys were not conducted at Futuna.

3.4.5 Lobsters: Futuna

There was no dedicated night reef-front assessment of lobsters (See Methods.). However, night searches for sea cucumber species could only be completed on exposed fringing reef, so this assessment also covered some lobster habitat. The double-spined rock lobster, *Panulirus penicillatus*, which is commonly recorded on exposed reef fronts in the Pacific, was noted in two night search stations (Vele and Leava, n = 5), at a mean density of 5.3 per ha ±3.6. *P. penicillatus* was also recorded during mother-of-pearl surveys and reef-front searches. A single painted coral lobster, *Panulirus versicolor* (a species more commonly found in coral gardens of lagoon systems), was also recorded. Butterfly or mitten lobsters, *Parribacus caledonicus*, were more common, being recorded in four of the five night search stations at a mean density of 24.9 per ha ±11.0. The most seen in one station were seven individuals (Vele). In other assessments, adult lobsters were recorded during reef-front searches and mother-of-pearl assessments (Appendices 4.5 and 4.6). Also noted were the banded prawn killer, *Lysiosquillina* spp. (or sand lobster), and the crab species *Eriphia sebana* and *Etisus splendidus*.

3.4.6 Sea cucumbers[10]: Futuna

Lagoon environments are only partially presented at Alofi, where fringing reef curves away from the shoreline off the village of Alofita, where a small, shallow channel (maximum depth 2–3 m) separates it from the shore and some shallow-water reefs exist in relative shelter. Species presence and density were determined through broad-scale and fine-scale dedicated survey methods (Table 3.10, Appendices 4.5 and 4.6, also see Methods). Despite the non-optimal habitat at Futuna and Alofi Islet, 10 species of commercial sea cucumbers were recorded during in-water assessments (Table 3.10).

[10] There has been a recent change to sea cucumber taxonomy that has changed the name of the black teatfish in the Pacific from *Holothuria* (*Microthele*) *nobilis* to *H. whitmaei*. It is possible that the scientific name for white teatfish may also change in the future. This should be noted when comparing texts, as in this report the 'original' taxonomic names are used.

Sea cucumber species associated with reef, such as the medium-value tiger or leopardfish (*Bohadschia argus*), were uncommon (recorded in 7% of broad-scale transects) and the higher-value species greenfish (*Stichopus chloronotus*) was not recorded. On the other hand, black teatfish (*Holothuria nobilis*), a premium-value species, was well represented. Black teatfish was common within the coral in reef benthos (in 36% of stations, mean density 121.7 per ha ±74.9 in RBt stations) and 146 were found in all the shallow assessments. This species is generally found at low density on back-reefs in the Pacific, but is also found in deeper water. In deeper-water assessments during this survey, *H. nobilis* was recorded at a mean density of ~20 per ha (Bêche-de-mer Ds and MOPt assessments).

The exposed, oceanic nature of the site suited surf redfish (*Actinopyga mauritiana*) but, despite this species being relatively common (in 70% of reef-front searches and 43% of reef-front search by walking stations), they were only at low-to-moderate density (highest density recorded: 31 and 87 per ha, in RFs and RBt stations respectively). In other locations in the Pacific, this species is recorded in densities above 400–500 per ha.

More protected areas of soft benthos with patches of reef, were only found in Alofi Islet, and even at this location there were no rich sediments, seagrass or mangrove stands. Elephant trunkfish (*Holothuria fuscopunctata*) and brown sandfish (*Bohadschia vitiensis*) were recorded in survey, as were lower-value lollyfish (*H. atra*) and snakefish (*H. coluber*). However, all these lower-value species were at low density. No *Actinopyga miliaris* was found, although the other nocturnal species (*Stichopus horrens*) was noted at large size (30–40 cm length, see Table 3.10).

Deep dives on SCUBA (sea cucumber day searches, mean depth: 21.8 m, range: 13–40 m) were used to obtain a preliminary assessment of deep-water stocks, such as the high-value white teatfish (*H. fuscogilva*), prickly redfish (*Thelenota ananas*) and the lower value amberfish (*T. anax*). In these surveys, white teatfish were not found; however, both prickly redfish and amberfish were common but at low density (Table 3.10).

3.4.7 Other echinoderms: Futuna

Edible slate urchins (*Heterocentrotus mammillatus*) were occasionally recorded in surveys, and collector urchins (*Tripneustes gratilla*) were absent. *Echinometra mathaei* and *Echinothrix* spp. were also not common (<25% of broad-scale stations and <40% of RBt stations) and generally at moderate density (<60 per ha). No *Diadema* spp. were recorded.

The blue starfish (*Linckia laevigata*) was also uncommon in survey (10% of broad-scale transects, 32% of reef-benthos stations) and, when recorded, was at low density (48.3 per ha ±19.0 in RBt stations) compared to the more protected system of Uvea. Two coralivore (coral eating) starfish species were recorded: the cushion star (*Culcita novaeguineae*) (n = 11), and the crown of thorns starfish (*Acanthaster planci*, n = 1). Both of these starfish were rare and at very low density (Appendices 4.4.1 to 4.4.7 and Appendices 4.5 and 4.6).

3.4.8 Discussion and conclusions: invertebrate resources in Futuna

A summary of environmental, stock status and management factors for the main fisheries is given below. Please note that information on other, smaller fisheries and the status of less prominent species groups can be found within the body of the invertebrate chapter.

- There is a limited amount of shallow, protected reef habitat suitable for giant clams. Without any significant lagoon habitat, clams were restricted to exposed fringing reef (and some small pools in the pseudo lagoon on Alofi). Water movement was generally dynamic.

- Elongate clams, *Tridacna maxima*, were not severely impacted by fishing, although mean density estimates were low in many locations and the size-frequency distribution revealed that fishing was taking place.

- The exposed island reef (with no true lagoon) makes an easily overfished stock more fragile and susceptible to overfishing. Recruitment success of larvae (which are planktonic) resulting from local spawning can be more variable in such dynamic environments, where there is rapid water exchange with the open ocean. In addition, recruitment from remote reefs is unlikely, as Futuna and Alofi Islet are isolated from other major island groups.

- Although no *Hippopus hippopus* (horse-hoof or bear's paw clam) was recorded, a single fluted clam, *Tridacna squamosa*, was noted. Islands with a similar environment to Futuna, for example Niue, have seen their stocks of fluted clams devastated in recent years, and measures should be taken to protect what remnant stocks remain.

- Trochus habitat at Futuna was extensive; however, adult habitat was more common than areas for juvenile settlement and development. The fringing reefs at Futuna provided a less diversified habitat for invertebrates generally, were isolated from other sources of recruitment, and were subject to high wind and storm surges.

- The density of trochus in the main fishing areas suggests that stocks are moderately impacted by fishing. In these surveys only two mother-of-pearl stations recorded densities considered to be above the 'threshold' (500–600/ha) that should be attained before stocks are ready for commercial fishing.

- The size profile of trochus shells recorded in Futuna suggests that large broodstock are present in the population and recruitment is ongoing. Size controls that limit the sale of shell above 12 cm should continue to be enforced to ensure the most productive-sized shell (over 11–12 cm basal width) continue to provide ongoing production for the fishery (Appendix 4.7).

- Reefs at Futuna support a moderately impacted population of the commercial topshell, *Trochus niloticus*, but exposed conditions within the open reefs of Futuna make stocks somewhat more susceptible to fishing. Major harvests should be postponed until stocks build up to 500–600 per ha in the major aggregations.

- The blacklip pearl oyster, *Pinctada margaritifera*, was absent, although other mother-of-pearl stocks, such as the green topshell, *Tectus pyramis* (of low commercial value), were recorded at moderate density.

- Sea cucumber stocks in Futuna had a limited range of environments. Habitat for sea cucumber was limited, as reef areas were generally exposed to oceanic swell, and sheltered areas of soft benthos were rare. Being deposit feeders, the lack of any protected lagoon, and the oceanic, exposed nature of the site were limiting factors for many species groups.

- Sea cucumber stocks in Futuna are varied in relation to the habitat present, but the densities of individual species groups were generally low. Data collected on presence and density suggest that sea cucumbers are marginally impacted by fishing pressure, and that environmental conditions largely dictate the current status of stocks.

- In contrast to most species groups, black teatfish (*Holothuria nobilis*) were common and at high density, which indicates that they may not have been commercially fished in recent years, and are a lightly impacted resource.

- This preliminary survey suggests that occurrence and density of sea cucumbers are too low for general commercial collection at this time, although black teatfish (*H. nobilis*) are at sufficient abundance for controlled fishing.

Table 3.10: Sea cucumber species records for all Futuna

Species	Common name	Commercial value [5]	B-S transects n = 48			Reef benthos stations n = 12			Other stations RFs = 10; RFs_w = 7			Other stations MOPt = 13; Ds = 8; Ns = 5		
			D [1]	DwP [2]	PP [3]	D	DwP	PP	D	DwP	PP	D	DwP	PP
Actinopyga mauritiana	Surf redfish	M/H	3.5	21.8	16	86.7	154.8	56	7.8 2.7	11.2 6.3	70 RFs 43 RFs_w	38.5 58.7	100 58.7	38 MOPt 100 Ns
Actinopyga miliaris	Blackfish	M/H												
Bohadschia argus	Leopardfish	M	2.2	32.8	7	45.0	125.0	36				1.6 8.3 1.8	20.8 11.1 8.9	7 MOPt 75 Ds 20 Ns
Bohadschia graeffei	Flowerfish	L												
Bohadschia vitiensis	Brown sandfish	L	0.1	16.7	1							1.8	8.9	20 Ns
Holothuria atra	Lollyfish	L	0.4	16.6	3	53.3	266.7	20	7.1	10.0	71 RFs_w	3.2	20.8	15 MOPt
Holothuria coluber	Snakefish	L							0.3	0.3	14 RFs_w			
Holothuria fuscogilva [4]	White teatfish	H												
Holothuria fuscopunctata	Elephant trunkfish	M										0.6	2.4	25 Ds
Holothuria nobilis [4]	Black teatfish	H	7.6	53.4	14	121.7	338.0	36	0.8	3.9	20 RFs	20.8 11.9 3.6	135.4 23.8 8.9	15 MOPt 50 Ds 40 Ns
Holothuria scabra	Sandfish	H												
Stichopus chloronotus	Greenfish	H/M												
Stichopus hermanni	Curryfish	H/M												
Stichopus horrens	Peanutfish	H/M										28.4	47.4	60 Ns
Thelenota ananas	Prickly redfish	H	0.6	22.2	3							4.8 6.3	62.5 8.3	7 MOPt 75 Ds
Thelenota anax	Amberfish	M										4.5	8.9	50 Ds

[1] D = mean density (numbers/ha); [2] DwP = mean density (numbers/ha) for transects or stations where the species was present; [3] PP = percentage presence (units where the species was found); [4] the scientific name of the black teatfish has recently changed from *Holothuria* (*Microthele*) *nobilis* to *H. whitmaei* and the white teatfish (*H. fuscogilva*) may have also changed name before this report is published. [5] L = low value; M = medium value; H= high value; H/M is higher in value than M/H; B-S transects= broad-scale transects; RFs = reef-front search; RFs_w = reef-front search by walking; MOPt = mother-of-pearl transect; Ds = day search; Ns = night search.

3.5 Overall recommendations for Futuna

Based on the survey work undertaken and the assessments made, the following recommendations are made for Futuna:

- Commercial exploitation of reef fisheries should not be developed. However, the small-scale artisanal development of oceanic fisheries, which has already started, should be pursued to supply the demand for fish on Futuna, and for export to Wallis.

- Currently, the lack of transport facilities and the cost of transport limit any commercial, export fisheries in Futuna. A programme should be established to closely monitor the effects of fishing pressure on finfish and other marine resources. Appropriate management measures should be implemented to avoid overexploitation, especially if market and transport infrastructure is improved in the future.

- Income generation from fisheries should focus on shells collected by women's handicraft groups, and on trochus and lobster catches. Lobster fishing should be accompanied by monitoring and control of sizes, particularly in view of the share caught for export to New Caledonia, French Polynesia, and Wallis. To maximise returns from trochus resources, local fisheries services should advise fishers to properly store the shells for future commercial export (Current trochus fishing on Futuna is only for meat, and the shells are discarded due to the lack of an agent or transport facilities to Wallis.).

- Major harvests of the commercial topshell, *Trochus niloticus*, should be postponed until stocks build up to 500–600 per ha in the major aggregations. In addition, size controls that limit the sale of trochus larger than 12 cm should continue to be enforced to ensure the most productive-sized shells (over 11–12 cm basal width) continue to provide ongoing production for the fishery (Appendix 4.7).

- The occurrence and density of sea cucumbers are too low for commercial collection at this time, except for black teatfish (*Holothuria nobilis*), which are at sufficient abundance for controlled fishing.

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APPENDIX 1: SURVEY METHODS

1.1 Socioeconomic surveys, questionnaires and average invertebrate wet weights

1.1.1 Socioeconomic survey methods

Preparation

The PROCFish/C socioeconomic survey is planned in close cooperation with local counterparts from national fisheries authorities. It makes use of information gathered during the selection process for the four sites chosen for each of the PROCFish/C participating countries and territories, as well as any information obtained by resource assessments, if these precede the survey.

Information is gathered regarding the target communities, with preparatory work for a particular socioeconomic field survey carried out by the local fisheries counterparts, the project's attachment, or another person charged with facilitating and/or participating in the socioeconomic survey. In the process of carrying out the surveys, training opportunities are provided for local fisheries staff in the PROCFish/C socioeconomic field survey methodology.

Staff are careful to respect local cultural and traditional practices, and follow any local protocols while implementing the field surveys. The aim is to cause minimal disturbance to community life, and surveys have consequently been modified to suit local habits, with both the time interviews are held and the length of the interviews adjusted in various communities. In addition, an effort is made to hold community meetings to inform and brief community members in conjunction with each socioeconomic field survey.

Approach

The design of the socioeconomic survey stems from the project focus, which is on rural coastal communities in which traditional social structures are to some degree intact. Consequently, survey questions assume that the primary sectors (and fisheries in particular) are of importance to communities, and that communities currently depend on coastal marine resources for their subsistence needs. As urbanisation increases, other factors gain in importance, such as migration, as well as external influences that work in opposition to a subsistence-based socioeconomic system in the Pacific (e.g. the drive to maximise income, changes in lifestyle and diet, and increased dependence on imported foods). The latter are not considered in this survey.

The project utilises a 'snapshot approach' that provides 5–7 working days per site (with four sites per country). This timeframe generally allows about 25 households (and a corresponding number of associated finfish and invertebrate fishers) to be covered by the survey. The total number of finfish and invertebrate fishers interviewed also depends on the complexity of the fisheries practised by a particular community, the degree to which both sexes are engaged in finfish and invertebrate fisheries, and the size of the total target population. Data from finfish and invertebrate fisher interviews are grouped by habitat and fishery, respectively. Thus, the project's time and budget and the complexity of a particular site's fisheries are what determine the level of data representation: the larger the population and the number of fishers, and the more diversified the finfish and invertebrate fisheries, the lower the level of representation that can be achieved. It is crucial that this limitation be taken into consideration, because the data gathered through each survey and the emerging distribution patterns are extrapolated to estimate the total annual impact of all fishing activity reported for the entire community at each site.

If possible, people involved in marketing (at local, regional or international scale) who operate in targeted communities are also surveyed (e.g. agents, middlemen, shop owners).

Key informants are targeted in each community to collect general information on the nature of local fisheries and to learn about the major players in each of the fisheries that is of concern, and about fishing rights and local problems. The number of key informants interviewed depends on the complexity and heterogeneity of the community's socioeconomic system and its fisheries.

At each site the extent of the community to be covered by the socioeconomic survey is determined by the size, nature and use of the fishing grounds. This selection process is highly dependent on local marine tenure rights. For example, in the case of community-owned fishing rights, a fishing community includes all villages that have access to a particular fishing ground. If the fisheries of all the villages concerned are comparable, one or two villages may be selected as representative samples, and consequently surveyed. Results will then be extrapolated to include all villages accessing the same fishing grounds under the same marine tenure system.

In an open access system, geographical distance may be used to determine which fishing communities realistically have access to a certain area. Alternatively, in the case of smaller islands, the entire island and its adjacent fishing grounds may be considered as one site. In this case a large number of villages may have access to the fishing ground, and representative villages, or a cross-section of the population of all villages, are selected to be included in the survey.

In addition, fishers (particularly invertebrate fishers) are regularly asked how many people external to the surveyed community also harvest from the same fishing grounds and/or are engaged in the same fisheries. If responses provide a concise pattern, the magnitude of additional impact possibly imposed by these external fishers is determined and discussed.

Sampling

Most of the households included in the survey are chosen by simple random selection, as are the finfish and invertebrate fishers associated with any of these households. In addition, important participants in one or several particular fisheries may be selected for complementary surveying. Random sampling is used to provide an average and representative picture of the fishery situation in each community, including those who do not fish, those engaged in finfish and/or invertebrate fishing for subsistence, and those engaged in fishing activities on a small-scale artisanal basis. This assumption applies provided that selected communities are mostly traditional, relatively small (~100–300 households) and (from a socioeconomic point of view) largely homogenous. Similarly, gender and participation patterns (types of fishers by gender and fishery) revealed through the surveys are assumed to be representative of the entire community. Accordingly, harvest figures reported by male and female fishers participating in a community's various fisheries may be extrapolated to assess the impacts resulting from the entire community, sample size permitting (at least 25–30% of all households).

Data collection and analysis

Data collection is performed using a standard set of questionnaires developed by PROCFish/C's socioeconomic component, which include a household survey (key socioeconomic parameters and consumption patterns), finfish fisheries survey, invertebrate fisheries survey, marketing of finfish survey, marketing of invertebrates survey, and general information questionnaire (for key informants). In addition, further observations and relevant details are noted and recorded in a non-standardised format. The complete set of questionnaires used is attached as Appendix 1.1.2.

Most of the data are collected in the context of face-to-face interviews. Names of people interviewed are recorded on each questionnaire to facilitate cross-identification of fishers and households during data collection and to ensure that each fisher interview is complemented by a household interview. Linking data from household and fishery surveys is essential to permit joint data analysis. However, all names are suppressed once the data entry has been finalised, and thus the information provided by respondents remains anonymous.

Questionnaires are fully structured and closed, although open questions may be added on a case-to-case situation. If translation is required, each interview is conducted jointly by the leader of the project's socioeconomic team and the local counterpart. In cases where no translation is needed, the project's socioeconomist may work individually. Selected interviews may be conducted by trainees receiving advanced field training, but trainees are monitored by project staff in case clarification or support is needed.

The questionnaires are designed to allow a minimum dataset to be developed for each site, one that allows:

- the community's dependency on marine resources to be characterised;
- assessment of the community's engagement in and the possible impact of finfish and invertebrate harvesting; and
- comparison of socioeconomic information with data collected through PROCFish/C resource surveys.

Household survey

The major objectives of the household survey are to:

- **collect recent demographic information** (needed to calculate seafood consumption);
- **determine the number of fishers per household, by gender and type of fishing activity** (needed to assess a community's total fishing impact); and
- **assess the community's relative dependency on marine resources** (in terms of ranked source(s) of income, household expenditure level, agricultural alternatives for subsistence and income (e.g. land, livestock), external financial input (i.e. remittances), assets related to fishing (number and type of boat(s)), and seafood consumption patterns by frequency, quantity and type).

The demographic assessment focuses only on permanent residents, and excludes any family members who are absent more often than they are present, who do not normally share the household's meals or who only join on a short-term visitor basis (for example, students during school holidays, or emigrant workers returning for home leave).

The number of fishers per household distinguishes three categories of adult (≥15 years) fishers for each gender: (1) exclusive finfish fishers, (2) exclusive invertebrate fishers, and (3) fishers who pursue both finfish and invertebrate fisheries. This question also establishes the percentage of households that do not fish at all. We use this pattern (i.e. the total number of fishers by type and gender) to determine the number of female and male fishers, and the percentage of these who practise either finfish or invertebrate fisheries exclusively, or who practise both. The share of adult men and women pursuing each of the three fishery categories is presented as a percentage of all fishers. Figures for the total number of people in each fishery category, by gender, are also used to calculate total fishing impact (see below).

The role of fisheries as a source of income in a community is established by a ranking system. Generally, rural coastal communities represent a combined system of traditional (subsistence) and cash-generating activities. The latter are often diversified, mostly involving the primary sector, and are closely associated with traditional subsistence activities. Cash flow is often irregular, tailored to meet seasonal or occasional needs (school and church fees, funerals, weddings, etc.). Ranking of different sources of income by order of importance is therefore a better way to render useful information than trying to quantify total cash income over a certain time period. Depending on the degree of diversification, multiple entries are common. It is also possible for one household to record two different activities (such as fisheries and agriculture) as equally important (i.e. both are ranked as a first source of income, as they equally and importantly contribute to acquisition of cash within the household). In order to demonstrate the degree of diversification and allow for multiple entries, the role that each sector plays is presented as a percentage of the total number of households surveyed. Consequently, the sum of all figures may exceed 100%. Income sources include fisheries, agriculture, salaries, and 'others', with the latter including primarily handicrafts, but sometimes also small private businesses such as shops or kava bars.

Cash income is often generated in parallel by various members of one household and may also be administered by many, making it difficult to establish the overall expenditure level. On the other hand, the head of the household and/or the woman in charge of managing and organising the household are typically aware and in control of a certain amount of money that is needed to ensure basic and common household needs are met. We therefore ask for the level of average household expenditure only, on a weekly, bi-weekly or monthly basis, depending on the payment interval common in a particular community. Expenditures quoted in local currency are converted into US dollars (USD) to enable regional comparison. Conversion factors used are indicated.

Geomorphologic differences between low and high islands influence the role that agriculture plays in a community, but differences in land tenure systems and the particulars of each site are also important, and the latter factors are used in determining the percentage of households that have access to gardens and agricultural land, the average size of these areas, and the type (and if possible number) of livestock that are at the disposal of an average household. A community whose members are equally engaged in agriculture and fisheries will either show distinct groups of fishers and farmers/gardeners, or reveal active and non-active fishing seasons in response to the agricultural calendar.

We can use the frequency and amount of remittances received from family members working elsewhere in the country or overseas to assess the degree to which principles of the MIRAB economy apply. MIRAB was coined to characterise an economy dependent on migration, remittances, foreign aid and government bureaucracy as its major sources of revenue (Small and Dixon 2004; Bertram 1999; Bertram and Watters 1985). A high influx of foreign financing, and in particular remittances, is considered to yield flexible yet stable economic conditions at the community level (Evans 2001), and may also substitute for or reduce the need for local income-generating activities, such as fishing.

The number of boats per household is indicative of the level of isolation, and is generally higher for communities that are located on small islands and far from the nearest regional centre and market. The nature of the boats (e.g. non-motorised, handmade dugout canoes, dugouts equipped with sails, and the number and size of any motorised boats) provides insights into the level of investment, and usually relates to the household expenditure level. Having access to boats that are less sensitive to sea conditions and equipped with outboard engines provides greater choice of which fishing grounds to target, decreases isolation and increases independence in terms of transport, and hence provides fishing and marketing advantages. Larger and more powerful boats may also have a multiplication factor, as they accommodate bigger fishing parties. In this context it should be noted that information on boats is usually complemented by a separate boat inventory performed by interviewing key informants and senior members of the community. If possible, we prefer to use the information from the complementary boat inventory surveys rather than extrapolating data from household surveys, in order to minimise extrapolation errors.

A variety of data are collected to characterise the seafood consumption of each community. We distinguish between fresh fish (with an emphasis on reef and lagoon fish species), invertebrates and canned fish. Because meals are usually prepared for and shared by all household members, and certain dishes may be prepared in the morning but consumed throughout the day, we ask for the average quantity prepared for one day's consumption. In the case of fresh fish we ask for the number of fish per size class, or the total weight, usually consumed. However, the weight is rarely known, as most communities are largely self-sufficient in fresh fish supply and local, non-metric units are used for marketing of fish (heap, string, bag, etc.). Information on the number of size classes consumed allows calculation of weight using length–weight relationships, which are known for most finfish species (FishBase 2000, refer to Letourneur *et al.* 1998; Kulbicki pers. com.). Size classes (using fork length) are identified using size charts (Figure A1.1.1).

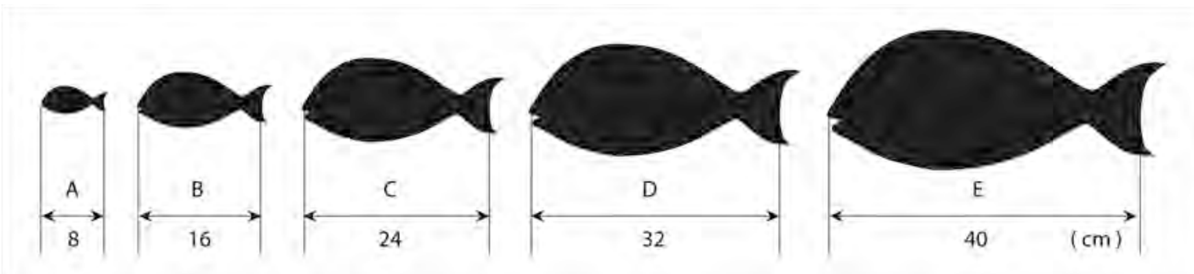

Figure A1.1.1: Finfish size field survey chart for estimating average length of reef and lagoon fish (including five size classes from A = 8 cm to E = 40 cm, in 8 cm intervals).

The frequency of all consumption data is adjusted downwards by 17% (a factor of 0.83 determined on the basis that about two months of the year are not used for fishing due to festivities, funerals and bad weather conditions) to take into account exceptional periods throughout the year when the supply of fresh fish is limited or when usual fish eating patterns are interrupted.

Equation for fresh finfish:

$$F_{wj} = \sum_{i=1}^{n} (N_{ij} \bullet W_i) \bullet 0.8 \bullet F_{dj} \bullet 52 \bullet 0.83$$

F_{wj} = finfish net weight consumption (kg edible meat/household/year) for household$_j$
n = number of size classes
N_{ij} = number of fish of size class$_i$ for household$_j$
W_i = weight (kg) of size class$_i$
0.8 = correction factor for non-edible fish parts
F_{dj} = frequency of finfish consumption (days/week) of household$_j$
52 = total number of weeks/year
0.83 = correction factor for frequency of consumption

For invertebrates, respondents provide numbers and sizes or weight (kg) per species or species groups usually consumed. Our calculation automatically transfers these data entries per species/species group into wet weight using an index of average wet weight per unit and species/species group (Appendix 1.1.3).[①] The total wet weight is then automatically further broken down into edible and non-edible proportions. Because edible and non-edible proportions may vary considerably, this calculation is done for each species/species group individually (e.g. compare an octopus that consists almost entirely of edible parts with a giant clam that has most of its wet weight captured in its non-edible shell).

Equation for invertebrates:

$$Inv_{wj} = \sum_{i=1}^{n} E_{p_i} \bullet (N_{ij} \bullet W_{wi}) \bullet F_{dj} \bullet 52 \bullet 0.83$$

Inv_{wj} = invertebrate weight consumption (kg edible meat/household/year) of household$_j$
E_{pi} = percentage edible (1 = 100%) for species/species group$_i$ (Appendix 1.1.3)
N_{ij} = number of invertebrates for species/species group$_i$ for household$_j$
n = number of species/species group consumed by household$_j$
W_{wi} = wet weight (kg) of unit (piece) for invertebrate species/species group$_i$
1000 = to convert g invertebrate weight into kg
F_{dj} = frequency of invertebrate consumption (days/week) for household$_j$
52 = total number of weeks/year
0.83 = correction factor for consumption frequency

[①] The index used here mainly consists of estimated average wet weights and ratios of edible and non-edible parts per species/species group. At present, SPC's Reef Fishery Observatory is making efforts to improve this index so as to allow further specification of wet weight and edible proportion as a function of size per species/species group. The software will be updated and users informed about changes once input data are available.

Appendix 1: Survey methods
Socioeconomics

Equation for canned fish:

Canned fish data are entered as total number of cans per can size consumed by the household at a daily meal, i.e.:

$$CF_{wj} = \sum_{i=1}^{n} (N_{cij} \bullet W_{ci}) \bullet F_{dcj} \bullet 52$$

CF_{wj} = canned fish net weight consumption (kg meat/household/year) of $household_j$

N_{cij} = number of cans of can $size_i$ for $household_j$

n = number and size of cans consumed by $household_j$

W_{ci} = average net weight (kg)/can $size_i$

F_{dcj} = frequency of canned fish consumption (days/week) for $household_j$

52 = total number of weeks/year

Age-gender correction factors are used because simply dividing total household consumption by the number of people in the household will result in underestimating per head consumption. For example, imagine the difference in consumption levels between a 40-year-old man as compared to a five-year-old child. We use simplified gender-age correction factors following the system established and used by the World Health Organization (WHO; Becker and Helsing 1991), i.e. (Kronen *et al.* 2006):

Age (years)	Gender	Factor
≤5	All	0.3
6–11	All	0.6
12–13	Male	0.8
≥12	Female	0.8
14–59	Male	1.0
≥60	Male	0.8

The per capita finfish, invertebrate and canned fish consumptions are then calculated by selecting the relevant formula from the three provided below:

Finfish per capita consumption:

$$F_{pcj} = \frac{F_{wj}}{\sum_{i=1}^{n} AC_{ij} \bullet C_i}$$

F_{pcj} = Finfish net weight consumption (kg/capita/year) for $household_j$

F_{wj} = Finfish net weight consumption (kg/household/year) for $household_j$

n = number of age-gender classes

AC_{ij} = number of people for age class i and household j

C_i = correction factor of age-gender $class_i$

Appendix 1: Survey methods
Socioeconomics

Invertebrate per capita consumption:

$$Inv_{pcj} = \frac{Inv_{wj}}{\sum_{i=1}^{n} AC_{ij} \bullet C_i}$$

Inv_{pcj} = Invertebrate weight consumption (kg edible meat/capita/year) for household_j

Inv_{wj} = Invertebrate weight consumption (kg edible meat/household/year) for household_j

n = number of age-gender classes

AC_{ij} = number of people for age class i and household j

C_i = correction factor of age-gender class_i

Canned fish per capita consumption:

$$CF_{pcj} = \frac{CF_{wj}}{\sum_{i=1}^{n} AC_{ij} \bullet C_i}$$

CF_{pcj} = canned fish net weight consumption (kg/capita/year) for household_j

CF_{wj} = canned fish net weight consumption (kg/household/year) for household_j

n = number of age-gender classes

AC_{ij} = number of people for age class_i and household_j

C_i = correction factor of age-gender class_i

The total finfish, invertebrate and canned fish consumption of a known population is calculated by extrapolating the average per capita consumption for finfish, invertebrates and canned fish of the sample size to the entire population.

Total finfish consumption:

$$F_{tot} = \frac{\sum_{j=1}^{n} F_{pcj}}{n_{ss}} \bullet n_{pop}$$

F_{pcj} = finfish net weight consumption (kg/capita/year) for household_j

n_{ss} = number of people in sample size

n_{pop} = number of people in total population

Total invertebrate consumption:

$$Inv_{tot} = \frac{\sum_{j=1}^{n} Inv_{pcj}}{n_{ss}} \bullet n_{pop}$$

Inv_{pcj} = invertebrate weight consumption (kg edible meat/capita/year) for household$_j$

n_{ss} = number of people in sample size

n_{pop} = number of people in total population

Total canned fish consumption:

$$CF_{tot} = \frac{\sum_{j=1}^{n} CF_{pcj}}{n_{ss}} \bullet n_{pop}$$

CF_{pcj} = canned fish net weight consumption (kg/capita/year) of household$_j$

n_{ss} = number of people in sample size

n_{pop} = number of people in total population

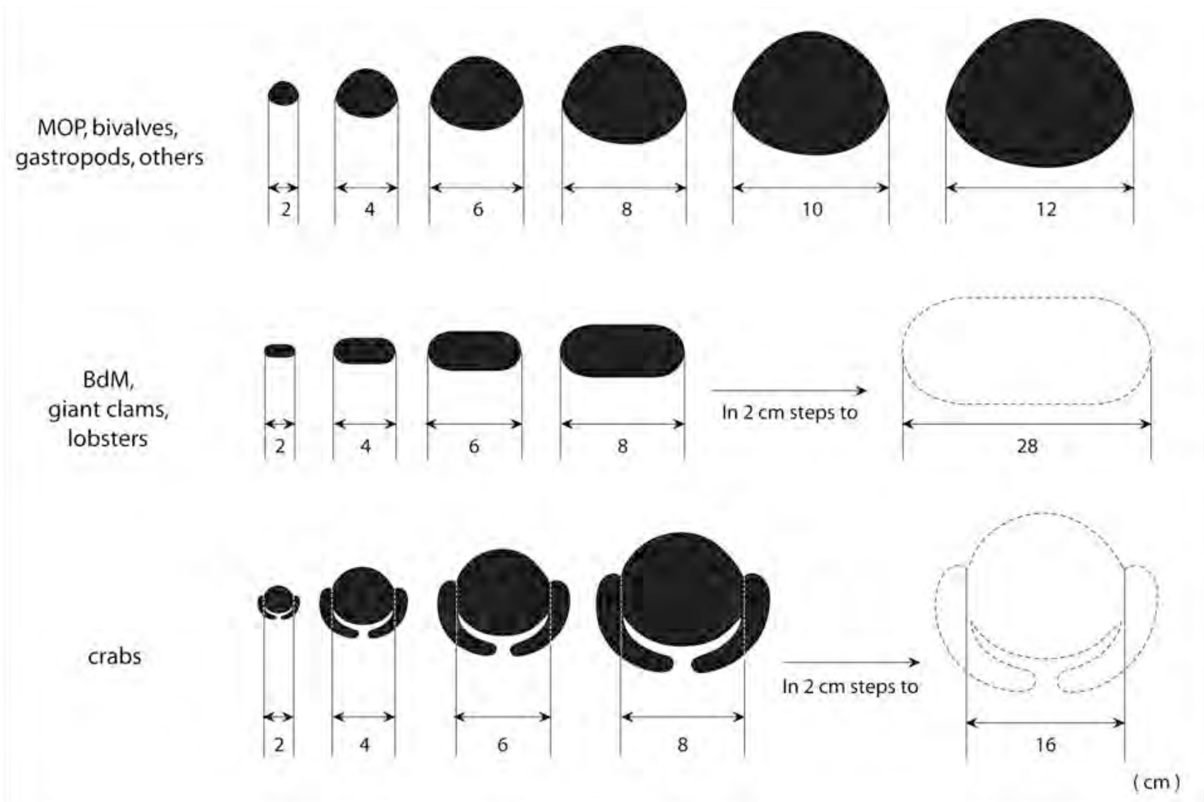

Figure A1.1.2: Invertebrate size field survey chart for estimating average length of different species groups (2 cm size intervals).

Appendix 1: Survey methods
Socioeconomics

Finfish fisher survey

The finfish fisher survey primarily aims to collect the data needed to understand finfish fisheries strategies, patterns and dimensions, and thus possible impacts on the resource. Data collection faces the challenge of retrieving information from local people that needs to match resource survey parameters, in order to make joint data analysis possible. This challenge is highlighted by the following three major issues:

(i) Fishing grounds are classified by habitat, with the latter defined using geomorphologic characteristics. Local people's perceptions of and hence distinctions between fishing grounds often differ substantially from the classifications developed by the project. Also, fishers do not target particular areas according to their geomorphologic characteristics, but instead due to a combination of different factors including time and transport availability, testing of preferred fishing spots, and preferences of members of the fishing party. As a result, fishers may shift between various habitats during one fishing trip. Fishers also target lagoon and mangrove areas, as well as passages if these are available, all of which cannot be included in the resource surveys. It should be noted that a different terminology for reef and other areas fished is needed to communicate with fishers.

    These problems are dealt with by asking fishers to indicate the areas they refer to as coastal reef, lagoon, outer-reef and pelagic fishing on hydrologic charts, maps or aerial photographs. In this way we can often further refine the commonly used terms of coastal or outer reef to better match the geomorphologic classification. The proportion of fishers targeting each habitat is provided as a percentage of all fishers surveyed; the socioeconomic analysis refers to habitats by the commonly used descriptive terms for these habitats, rather than the ecological or geomorphologic classifications.

    Fishers may travel between various habitats during a single fishing trip, with differing amounts of time spent in each of the combined habitats; the catch that is retrieved from each combined habitat may potentially vary from one trip to the next. If targeting combined habitats is a common strategy practised by most fishers, the resource data for individual geomorphologic habitats need to be lumped to enable comparison of results.

(ii) People usually provide information on fish by vernacular or common names, which are far less specific than (and thus not compatible with) scientific nomenclature. Vernacular name systems are often very localised, changing with local languages, and thus may differ significantly between the sites surveyed in one country alone. As a result, one fish species may be associated with a number of vernacular names, but each vernacular name may also apply to more than one species.

    This issue is addressed, as much as possible, through indexing the vernacular names recorded during a survey to the scientific names for those species. However, this is not always possible due to inconsistencies between informants. The use of photographic indices is helpful but can also trigger misleading information, due to the variety of photos presented and the limitations of species recognition using photos alone. In this respect, collaboration with local counterparts from fisheries departments is crucial.

(iii) The assessment of possible fishing impacts is based on the collection of average data. Accordingly, fishers are requested to provide information on a catch that is neither exceptionally good nor exceptionally bad. They are also requested to provide this information concerning the most commonly caught species. This average information suffers from two major shortcomings. Firstly, some fish species are seasonal and may be dominant during a short period of the year but do not necessarily appear frequently in the average catch. Depending on the time of survey implementation this may result in over- or under-representation of these species. Secondly, fishers usually employ more than one technique. Average catches may vary substantially by quantity and quality depending on which technique they use.

We address these problems by recording any fish that plays a seasonal role. This information may be added and helpful for joint interpretation of resource and socioeconomic data. Average catch records are complemented by information on the technique used, and fishers are encouraged to provide the average catch information for the technique that they employ most often.

The design of the finfish fisher survey allows the collection of details on fishing strategies, and quantitative and qualitative data on average catches for each habitat. Targeting men and women fishers allows differences between genders to be established.

Determination of <u>fishing strategies</u> includes:

- frequency of fishing trips
- mode and frequency of transport used for fishing
- size of fishing parties
- duration of the fishing trip
- time of fishing
- months fished
- techniques used
- ice used
- use of catch
- additional involvement in invertebrate fisheries.

The frequency of fishing trips is determined by the number of weekly (or monthly) trips that are regularly made. The average figure resulting from data for all fishers surveyed, per habitat targeted, provides a first impression of the community's engagement in finfish fisheries and shows whether or not different habitats are fished with the same frequency.

Information on the utilisation of non-motorised or motorised boat transport for fishing helps to assess accessibility, availability and choice of fishing grounds. Motorised boats may also represent a multiplication factor as they may accommodate larger fishing parties.

We ask about the size of the fishing party that the interviewee usually joins to learn whether there are particularly active or regular fisher groups, whether these are linked to fishing in certain habitats, and whether there is an association between the size of a fishing party and fishing for subsistence or sale. We also use this information to determine whether information regarding an average catch applies to one or to several fishers.

The duration of a fishing trip is defined as the time spent from any preparatory work through the landing of the catch. This definition takes into account the fact that fishing in a Pacific Island context does not follow a western economic approach of benefit maximisation, but is a more integral component of people's lifestyles. Preparatory time may include up to several hours spent reaching the targeted fishing ground. Fishing time may also include any time spent on the water, regardless of whether there was active fishing going on. The average trip duration is calculated for each habitat fished, and is usually compared to the average frequency of trips to these habitats (see discussion above).

Temporal fishing patterns – the times when most people go fishing – may reveal whether the timing of fishing activities depends primarily on individual time preferences or on the tides. There are often distinct differences between different fisher groups (e.g. those that fish mostly for food or mostly for sale, men and women, and fishers using different techniques). Results are provided in percentage of fishers interviewed for each habitat fished.

To calculate total annual fishing impact, we determine the total number of months that each interviewee fishes. As mentioned earlier, the seasonality of complementary activities (e.g. agriculture), seasonal closing of fishing areas, etc. may result in distinct fishing patterns. To take into account exceptional periods throughout the year when fishing is not possible or not pursued, we apply a correction factor of 0.83 to the total provided by people interviewed (this factor is determined on the basis that about two months of every year – specifically, 304/365 days – are not used for fishing due to festivals, funerals and bad weather conditions).

Knowing the range of techniques used and learning which technique(s) is/are predominantly used helps to identify the possible causes of detrimental impacts on the resource. For example, the predominant use of gillnets, combined with particular mesh sizes, may help to assess the impact on a certain number of possible target species, and on the size classes that would be caught. Similarly, spearfishing targets particular species, and the impacts of spearfishing on the abundance of these species in the habitats concerned may become evident. To reveal the degree to which fishers use a variety of different techniques, the percentage of techniques used refers to the proportion of all fishers who use that technique. Percentages show which techniques are used by most or even all fishers, and which are used by smaller groups. In addition, the data are presented by habitat (what percentage of fishers targeting a habitat use a particular technique, where n = the total number of fishers interviewed by habitat).

The use of ice (whether it is used at all, used infrequently or used regularly) hints at the degree of commercialisation, available infrastructure and investment level. Usually, communities targeted by our project are remote and rather isolated, and infrastructure is rudimentary. Thus, ice needs to be purchased and is often obtained from distant sources, with attendant costs in terms of transport and time. On the other hand, ice may be the decisive input that allows marketing at a regional or urban centre. The availability of ice may also be a decisive factor in determining the frequency of fishing trips.

Determining the use of the catch or shares thereof for various purposes (subsistence, non-monetary exchange and sale) is a necessary prerequisite to providing fishery management advice. Fishing pressure is relatively stable if determined predominantly by the community's subsistence demand. Fishing is limited by the quantity that the community can consume, and changes occur in response to population growth and/or changes in eating habits. In contrast, if fishing is performed mainly for external sale, fishing pressure varies according to outside market demand (which may be dynamic) and the cost-benefit (to fishers) of fishing. Fishing strategies may vary accordingly and significantly. The recorded purposes of fishing are presented as the percentage of all fishers interviewed per habitat fished. We distinguish these figures by habitat so as to allow for the fact that one fisher may fish several habitats but do so for different purposes.

Information on the additional involvement of interviewed fishers in invertebrate fisheries, for either subsistence or commercial purposes, helps us to understand the subsistence and/or commercial importance of various coastal resources. The percentage of finfish fishers who also harvest invertebrates is calculated, with the share of these who do so for subsistence and/or for commercial purposes presented in percentage (the sum of the latter percentages may exceed 100, because fishers may harvest invertebrates for both subsistence and sale).

The average catch per habitat (technique and transport used) is recorded, including:

- a list of species, usually by vernacular names; and
- the kg or number per size class for each species.

These data are used to calculate total weight per species and size class, using a weight–length conversion factor (FishBase 2000, refer to Letourneur *et al.* 1998; Kulbicki pers. com.). This requires using the vernacular/scientific name index to relate (as far as possible) local names to their scientific counterparts. Fish length is reported by using size charts that comprise five major size classes in 8 cm intervals, i.e. 8 cm, 16 cm, 24 cm, 32 cm and 40 cm. The length of any fish that exceeds the largest size class (40 cm) presented in the chart is individually estimated using a tape measure. The length–weight relationship is calculated for each site using a regression on catch records from finfish fishers' interviews weighted by the annual catch. Data used from the catch records consist of scientific names correlated to the vernacular names given by fishers, number of fish, size class (or measured size) and/or weight. In other words, we use the known length–weight relationship for the corresponding species to vernacular names recorded.

Once we have established the average and total weight per species and size class recorded, we provide an overview of the average size for each family. The resulting pattern allows analysis of the degree to which average and relative sizes of species within the various families present at a particular site are homogeneous. The same average distribution pattern is calculated for all families, per habitat, in order to reveal major differences due to the locations where the fish were caught. Finally, we combine all fish records caught, per habitat and site, to determine what proportion of the extrapolated total annual catch is composed of each of the various size classes. This comparison helps to establish the most dominant size class caught overall, and also reveals major differences between the habitats present at a site.

Catch data are further used to calculate the total weight for each family (includes all species reported) and habitat. We then convert these figures into the percentage distribution of the total annual catch, by family and habitat. Comparison of relative catch composition helps to identify commonalities and major differences, by habitat and between those fish families that are most frequently caught.

A number of parameters from the household and fisher surveys are used to calculate the total annual catch volume per site, habitat, gender, and use of the catch (for subsistence and/or commercial purposes).

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Data from the household survey regarding the number of fishers (by gender and type of fishery) in each household interviewed are extrapolated to determine the total number of men and women that target finfish, invertebrates, or both.

Data from the fisher survey are used to determine what proportion of men and women fishers target various habitats or combinations of habitats. These figures are assumed to be representative of the community as a whole, and hence are applied to the total number of fishers (as determined by the household survey). The total number of finfish fishers is the sum of all fishers who solely target finfish, and those who target both finfish and invertebrates; the same system is applied for invertebrate fishers (i.e. it includes those who collect only invertebrates and those who target both invertebrates and finfish. These numbers are also disaggregated by gender.

The total annual catch per fisher interviewed is calculated, and the average total annual catch reported for each type of fishing activity/fishery (including finfish and invertebrates) by gender is then multiplied by the total number of fishers (calculated as detailed above, for each type of fishing activity/fishery and both genders). More details on the calculation applied to invertebrate fisheries are provided below.

<u>Total annual catch (t/year):</u>

$$\text{TAC} = \sum_{h=1}^{N_h} \frac{Fif_h \bullet Acf_h + Fim_h \bullet Acm_h}{1000}$$

TAC = total annual catch t/year
Fif_h = total number of female fishers for habitat_h
Acf_h = average annual catch of female fishers (kg/year) for habitat_h
Fim_h = total number of male fishers for habitat_h
Acm_h = average annual catch of male fishers (kg/year) for habitat_h
N_h = number of habitats

Where:

$$\text{Acf}_h = \frac{\sum_{i=1}^{If_h} f_i \bullet 52 \bullet 0.83 \bullet \frac{Fm_i}{12} \bullet Cfi}{If_h} \bullet \frac{\sum_{k=1}^{Rf_h} f_k \bullet 52 \bullet 0.83 \bullet \frac{Fm_k}{12}}{\sum_{i=1}^{If_h} f_i \bullet 52 \bullet 0.83 \bullet \frac{Fm_i}{12}}$$

If_h = number of interviews of female fishers for habitat_h (total number of interviews where female fishers provided detailed information for habitat_h)
f_i = frequency of fishing trips (trips/week) as reported on interview_i
Fm_i = number of months fished (reported in interview_i)
Cf_i = average catch reported in interview_i (all species)
Rf_h = number of targeted habitats as reported by female fishers for habitat_h (total numbers of interviews where female fishers reported targeting habitat_h but did not necessarily provide detailed information)
f_k = frequency of fishing trips (trips/week) as reported for habitat_k
Fm_k = number of months fished for reported habitat_k (fishers = sum of finfish fishers and mixed fishers, i.e. people pursuing both finfish and invertebrate fishing)

Thus, we obtain the total annual catch by habitat and gender group. The sum of all catches from all habitats and both genders equals the total annual impact of the community on its fishing ground.

The accuracy of this calculation is determined by reliability of the data provided by interviewees, and the extrapolation procedure. The variability of the data obtained through fisher surveys is illuminated by providing standard errors for the calculated average total annual catches. The size of any error stemming from our extrapolation procedure will vary according to the total population at each site. As mentioned above, this approach is best suited to assess small and predominantly traditional coastal communities. Thus, the risk of over- or underestimating fishing impact increases in larger communities, and those with greater urban influences. We provide both the total annual catch by interviewees (as determined from fisher records) and the extrapolated total impact of the community, so as to allow comparison between recorded and extrapolated data.

The total annual finfish consumption of the surveyed community is used to determine the share of the total annual catch that is used for subsistence, with the remainder being the proportion of the catch that is exported (sold externally).

<u>Total annual finfish export:</u>

$$E = TAC - \left(\frac{F_{tot}}{1000} \bullet \frac{1}{0.8}\right)$$

Where:

E = total annual export (t)
TAC = total annual catch (t)
F_{tot} = total annual finfish consumption (net weight kg)
$\frac{1}{0.8}$ = to calculate total biomass/weight, i.e. compensate for the earlier deduction by 0.8 to determine edible weight parts only

In order to establish <u>fishing pressure</u>, we use the habitat areas as determined by satellite interpretation. However, as already mentioned, resource surveys and satellite interpretation do not include lagoon areas. Thus, we determine the missing areas by calculating the smallest possible polygon (Figure A1.1.3) that encompasses the total fishing ground determined with fishers and local people during the fieldwork. In cases where fishing grounds are gazetted, owned and managed by the community surveyed, the missing areas are determined using the community's fishing ground limits.

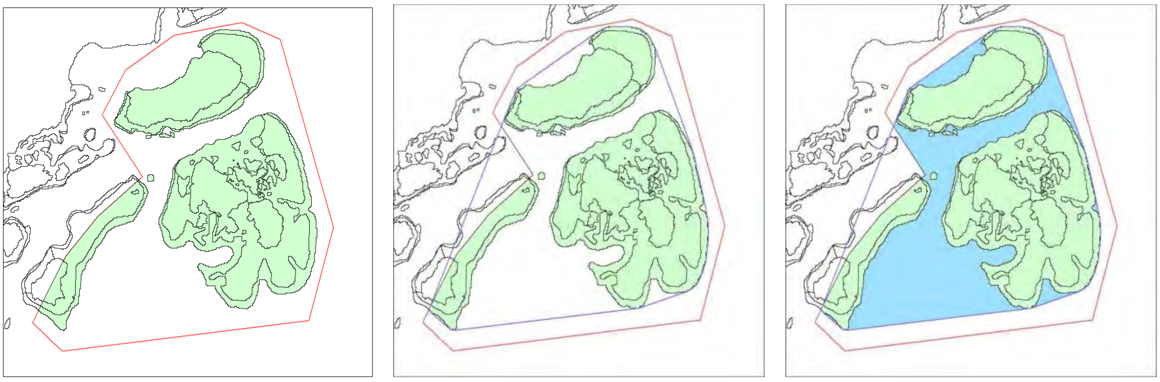

Figure A1.1.3: Determination of lagoon area.
The fishing ground (in red) is initially delineated using information from fishers. Reef areas within the fishing area (in green; interpreted from satellite data) are then identified. The remaining non-reef areas within the fishing grounds are labelled as lagoon (in blue) (Developed using MapInfo).

We use the calculated total annual impact and fishing ground areas to determine relative fishing pressure. Fishing pressure indicators include the following:

- annual catch per habitat
- annual catch per total reef area
- annual catch per total fishing ground area.

Fisher density includes the total number of fishers per km^2 of reef and total fishing ground area, and productivity is the annual catch per fisher. Due to the lack of baseline data, we compare selected indicators, such as fisher density, productivity (catch per fisher and year) and total annual catch (per reef and total fishing ground area), across all sites for each country surveyed. This comparison may also be done at the regional level in the future.

The catch per unit effort (CPUE) is generally acknowledged as an indicator of the status of a resource. If an increasing amount of time is required to obtain a certain catch, degradation of the resource is assumed. However, taking into account that our project is based on a snapshot approach, CPUE is used on a comparative basis between sites within a country, and will be employed later on a regional scale. Its application and interpretation must also take into account the fact that fishing in the Pacific Islands does not necessarily follow efficiency or productivity maximisation strategies, but is often an integral component of people's lifestyles. As a result, CPUE has limited applicability.

In order to capture comparative data, in calculating CPUE we use the entire time spent on a fishing trip, including travel, fishing and landing. Thus, we divide the total average catch per fisher by the total average time spent per fishing trip. CPUE is determined as an overall average figure, by gender and habitat fished.

Invertebrate fisher survey

The objective, purpose and design of the invertebrate fisher survey largely follow those of the finfish fisher survey. Thus, the primary aim of the invertebrate fisher survey is to collect data needed to understand the strategies, patterns and dimensions of invertebrate fisheries, and hence the possible impacts on invertebrate resources. Invertebrate data collection faces several challenges, as retrieval of information from local people needs to match the resource survey parameters in order to enable joint data analysis. Some of the major issues are:

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(i) The invertebrate resource survey defines invertebrate fisheries using differing parameters (several are primarily determined by habitat, others by target species). However, these fisheries classifications do not necessarily coincide with the perceptions and fishing strategies of local people. In general, there are two major types of invertebrate fishers: those who walk and collect with simple tools, and those who free-dive using masks, fins, snorkel, hands, simple tools or spears. The latter group is often more commercially oriented, targeting species that are exploited for export (trochus, BdM, lobster, etc.). However, some of the divers may harvest invertebrates as a by-product of spearfishing for finfish. Fishers who primarily walk (some may or may not use non-motorised or even motorised transport to reach fishing grounds) are mainly gleaners targeting available habitats (or a combination of habitats, if convenient). While gleaning is often performed for subsistence needs, it may also be used as a source of income, albeit mostly serving national rather than export markets. While gleaning is an activity that may be performed by both genders, diving is usually men's domain.

We have addressed the problem of collecting information according to fisheries as defined by the resource survey by asking people to report according to the major habitats they target and/or species-specific dive fisheries they engage in. Very often this results in the grouping of various fisheries, as they are jointly targeted or performed on one fishing trip. Where possible, we have disaggregated data for these groups and allocated individuals to specific fisheries. Examples of such data disaggregation are the proportion of all fishers and fishers by gender targeting each of the possible fisheries at one site.

We have also disaggregated some of the catch data, because certain species are always or mostly associated with a particular fishery. However, the disagreement between people's perception and the resource classification becomes visible when comparing species composition per fishery (or combination of fisheries) as reported by interviewed fishers, and the species and total annual wet weight harvested allocated individually by fishery, as defined by the resource survey.

(ii) As is true for finfish, people usually provide information on invertebrate species by vernacular or common names, which are far less specific and thus not directly compatible with scientific nomenclature. Vernacular name systems are often very localised, changing with local languages, and thus may differ significantly between the sites surveyed in one country. Differing from finfish, vernacular names for invertebrates usually combine a group (often a family) of species, and are rarely species specific.

Similar to finfish, the issue of vernacular versus scientific names is addressed by trying to index as many scientific names as possible for any vernacular name recorded during the ongoing survey. Inconsistencies between informants are a limiting factor. The use of photographic indices is very useful, but may trigger misleading information; in addition, some reported species may not be depicted. Again, collaboration with local counterparts from fisheries departments is crucial.

The lack of specificity in the vernacular names used for invertebrates is an issue that cannot be resolved, and specific information regarding particular species that are included with others under one vernacular name cannot be accurately provided.

(iii) The assessment of possible fishing impacts is based on the collection of average data. This means that fishers are requested to provide information on a catch that is neither exceptionally good nor exceptionally bad. They are also requested to provide this information concerning the most commonly caught species. In the case of invertebrate fisheries this results in underestimation of the total number of species caught, and often greater attention is given to commercial species than to rare species that are used mainly for consumption. Seasonality of invertebrate species appears to be a less important issue than when compared to finfish.

We address these problems by encouraging people to also share with us the names of species they may only rarely catch.

(iv) Assessment of possible fishing impact requires knowledge of the size–weight relationship of (at least) the major species groups harvested. Unfortunately, a comparative tool (such as FishBase and others that are used for finfish) is not available for invertebrates. In addition, the proportion of edible and non-edible parts varies considerably among different groups of invertebrates. Further, non-edible parts may still be of value, as for instance in the case of trochus. However, these ratios are also not readily available and hence limit current data analysis.

We have dealt with this limitation by applying average weights (drawn from the literature or field measurements) for certain invertebrate groups. The applied wet weights are listed in Appendix 1.1.3. We used this approach to estimate total biomass (wet weight) removed; we have also listed approximations of the ratio between edible and non-edible biomass for each species.

Information on invertebrate fishing strategies by fishery and gender includes:

- frequency of fishing trips
- duration of an average fishing trip
- time when fishing
- total number of months fished per year
- mode of transport used
- size of fishing parties
- fishing external to the community's fishing grounds
- purpose of the fisheries
- whether or not the fisher also targets finfish.

In addition, for each fishery (or combination of fisheries) the species composition of an average catch is listed, and the average catch for each fishery is specified by number, size and/or total weight. If local units such as bags (plastic bags, flour bags), cups, bottles or buckets are used, the approximate weight of each unit is estimated and/or weighed during the field survey and average weight applied accordingly. For size classes, size charts for different species groups are used (Figure A1.1.2).

The proportion of fishers targeting each fishery (as defined by the resource survey) is presented as a percentage of all fishers. Records of fisheries that are combined in one trip are disaggregated by counting each fishery as a single data entry. The same process is applied to determine the share of women and men fishers per fishery (as defined by the resource survey).

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The number of different vernacular names recorded for each fishery is useful to distinguish between opportunistic and specialised harvesting strategies. This distribution is particularly interesting when comparing gleaning fisheries, while commercial dive fisheries are species specific by definition.

The calculation of <u>catch volumes</u> is based on the determination of the total number of invertebrate fishers and fishers targeting both finfish and invertebrates, by gender group and by fishery, as described above.

The average invertebrate catch composition by number, size and species (with vernacular names transferred to scientific nomenclature), and by fishery and gender group, is extrapolated to include all fishers concerned. Conversion of numbers and species by average weight factors (Appendix 1.1.3) results in a determination of total biomass (wet weight) removed, by fishery and by gender. The sum of all weights determines the total annual impact, in terms of biomass removed.

To calculate <u>total annual impact</u>, we determine the total numbers of months fished by each interviewee. As mentioned above, seasonality of complementary activities, seasonal closing of fishing areas, etc. may result in distinct fishing patterns. Based on data provided by interviewees, we apply – as for finfish – a correction factor of 0.83 to take into account exceptional periods throughout the year when fishing is not possible or not pursued (this is determined on the basis that about two months (304/365 days) of each year are not used for fishing due to festivals, funerals and bad weather conditions).

<u>Total annual catch:</u>

$$\mathrm{TACj} = \sum_{h=1}^{N_h} \frac{F_{inv}f_h \bullet Ac_{inv}f_{hj} + F_{inv}m_h \bullet Ac_{inv}m_{hj}}{1000}$$

TACj = total annual catch t/year for species_j

$F_{inv}f_h$ = total number of female invertebrate fishers for habitat_h

$Ac_{inv}f_{hj}$ = average annual catch by female invertebrate fishers (kg/year) for habitat_h and species_j

$F_{inv}m_h$ = total number of male invertebrate fishers for habitat_h

$Ac_{inv}m_{hj}$ = average annual catch by male invertebrate fishers (kg/year) for habitat_h and species_j

N_h = number of habitats

Where:

$$\mathrm{Ac_{inv}f_{hj}} = \frac{\sum_{i=1}^{I_{inv}f_h} f_i \bullet 52 \bullet 0.83 \bullet \frac{Fm_i}{12} \bullet Cf_{ij}}{I_{inv}f_h} \bullet \frac{\sum_{k=1}^{R_{inv}f_h} f_k \bullet 52 \bullet 0.83 \bullet \frac{Fm_k}{12}}{\sum_{i=1}^{I_{inv}f_h} f_i \bullet 52 \bullet 0.83 \bullet \frac{Fm_i}{12}}$$

$I_{inv}f_h$ = number of interviews of female invertebrate fishers for habitat_h (total numbers of interviews where female invertebrate fishers provided detailed information for habitat_h)

f_i = frequency of fishing trips (trips/week) as reported in interview_i

Fm_i = number of months fished as reported in interview$_i$
Cf_{ij} = average catch reported for species$_j$ as reported in interview$_i$
$R_{inv}f_h$ = number of targeted habitats reported by female invertebrate fishers for habitat$_h$ (total numbers of interviews where female invertebrate fishers reported targeting habitat$_h$ but did not necessarily provide detailed information)
f_k = frequency of fishing trips (trips/week) as reported for habitat$_k$
Fm_k = number of months fished for reported habitat$_k$

The total annual biomass (t/year) removed is also calculated and presented by species after transferring vernacular names to scientific nomenclature. Size frequency distributions are provided for the most important species, by total annual weight removed, expressed in percentage of each size group of the total annual weight harvested. The size frequency distribution may reveal the impact of fishing pressure for species that are represented by a wide size range (from juvenile to adult state). It may also be a useful parameter to compare the status of a particular species or species group across various sites at the national or even regional level.

To further determine fishing strategies, we also inquire about the purpose of harvesting each species (as recorded by vernacular name). Results are depicted as the proportion (in kg/year) of the total annual biomass (net weight) removed for each purpose: consumption, sale or both. We also provide an index of all species recorded through fisher interviews and their use (in percentage of total annual weight) for any of the three categories.

In order to gain an idea of the productivity of and differences between the fisheries practices used in each site we calculate the average annual catch per fisher, by gender and fishery. This calculation is based on the total biomass (net weight) removed from each fishery and the total number of fishers by gender group.

For invertebrate species that are marketed, detailed information is collected on total numbers (weight and/or combination of number and size), processing level, location of sale or client, frequency of sales and price received per unit sold. At this stage of our project we do not fully analyse this marketing information. However, prices received for major commercial species, as well as an approximation of sale volumes by fishery and fisher, help to assess what role invertebrate fisheries (or a particular fishery) play(s) in terms of income generation for the surveyed community, and in comparison to the possible earnings from finfish fisheries.

We use the calculated total annual impact in combination with the fishing ground area to determine relative fishing pressure. Fishing pressure indicators are calculated as the annual catch per km^2 for each area that is considered to support any of the fisheries present at each study site. In some instances (e.g. intertidal fisheries), areas are replaced by linear km; accordingly, fishing pressure is then related to the length (in km) of the supporting habitat. Due to the lack of baseline data, we compare selected indicators, such as the fisher density (number of fishers per km^2 – or linear km – of fishing ground, for each fishery), productivity (catch per fisher and year) and total annual catch per fishery, across all sites for each country surveyed. This comparison may also be done at the regional level in the future.

The differing nature of invertebrate species that may be caught during one fishing trip, and hence the great variability between edible and non-edible, useful and non-useful parts of species caught, make the determination of CPUE difficult. Substantial differences in the economic value of species add another challenge. We have therefore refrained from calculating CPUE values at this stage of the project.

Data entry and analysis

Data from all questionnaire forms are entered in the Reef Fisheries Integrated Database (RFID) system. All data entered are first verified and 'cleaned' prior to analysis. In the process of data entry, a comprehensive list of vernacular and corresponding scientific names for finfish and invertebrate species is developed.

Database queries have been defined and established that allow automatic retrieval of the descriptive statistics used when summarising results at the site and national levels.

1.1.2 Socioeconomic survey questionnaires

- Household census and consumption survey
- Finfish fishing and marketing survey (for fishers)
- Invertebrate fishing and marketing survey (for fishers)
- Fisheries (finfish and invertebrate and socioeconomics) general information survey

HOUSEHOLD CENSUS AND CONSUMPTION SURVEY

HH NO. ☐

Name of head of household: ________________ Village: _________________

Name of person asked: _____________________ Date: __________________

Surveyor's ID: __________________

	male	female
1. Who is the head of your household? *(must be living there; tick box)*	☐	☐

2. How old is the head of household? *(enter year of birth)* ☐

3. How many people ALWAYS live in your household? *(enter number)* ☐

4. How many are male and how many are female? (*tick box and enter age in years or year of birth)*

male	age	female	age
☐	☐	☐	☐
☐	☐	☐	☐
☐	☐	☐	☐
☐	☐	☐	☐
☐	☐	☐	☐
☐	☐	☐	☐

5. Does this household have any agricultural land?

yes ☐ no ☐

6. How much (*for this household only*)?

for permanent/regular cultivation ☐ (unit)

for permanent/regular livestock ☐ (unit)

type of animals__________ no. ☐

7. How many fishers live in your household? ☐
(*enter number of people who go fishing/collecting regularly)*

invertebrate fishers		finfish fishers		invertebrate & finfish fishers	
M	F	M	F	M	F
☐	☐	☐	☐	☐	☐

8. Does this household own a boat? yes ☐ no ☐

9a. Canoe	☐	length? ☐	metres/feet		
Sailboat	☐	length? ☐	metres/feet		
Boat with outboard engine	☐	length? ☐	metres/feet	☐	HP
9b. Canoe	☐	length? ☐	metres/feet		
Sailboat	☐	length? ☐	metres/feet		
Boat with outboard engine	☐	length? ☐	metres/feet	☐	HP
9c. Canoe	☐	length? ☐	metres/feet		
Sailboat	☐	length? ☐	metres/feet		
Boat with outboard engine	☐	length? ☐	metres/feet	☐	HP

10. Where does the CASH money in this household come from? (*rank options, 1 = most money, 2 = second important income source, 3 = 3rd important income source, 4 = 4th important income source*)

Fishing/seafood collection ☐

Agriculture (crops & livestock) ☐

Salary ☐

Others (handicrafts, etc.) ☐ specify: ____________________

11. Do you get remittances? yes ☐ no ☐

12. How often?

1 per month	1 per 3 months	1 per 6 months	other *(specify)*
☐	☐	☐	☐

13. How much? *(enter amount)* Every time? (currency) ☐

14. How much CASH money do you use on average for household expenditures (food, fuel for cooking, school bus, etc.)?

(currency) ☐ per week/2-weekly/month (or? specify_______)

15. What is the educational level of your household members?

no. of people	having achieved:
☐	elementary/primary education
☐	secondary education
☐	tertiary education (college, university, special schools, etc.)

CONSUMPTION SURVEY

16. During an average/normal week, on how many days do you prepare fish, other seafood and canned fish for your family? *(tick box)*

	7 days	6 days	5 days	4 days	3 days	2 days	1 day	other, specify
Fresh fish	☐	☐	☐	☐	☐	☐	☐	☐
Other seafood	☐	☐	☐	☐	☐	☐	☐	☐
Canned fish	☐	☐	☐	☐	☐	☐	☐	☐

17. Mainly at	breakfast	lunch	supper
Fresh fish	☐	☐	☐
Other seafood	☐	☐	☐
Canned fish	☐	☐	☐

18. How much do you cook on average per day for your household? *(tick box)*

	number	kg	size: A	B	C	D	E	>E (cm)
Fresh fish	☐	☐	☐	☐	☐	☐	☐	☐

Other seafood

name:	no.	size	kg	plastic bag ¼	½	¾	1
____________	☐	☐	☐	☐	☐	☐	☐
____________	☐	☐	☐	☐	☐	☐	☐
____________	☐	☐	☐	☐	☐	☐	☐
____________	☐	☐	☐	☐	☐	☐	☐

19. Canned fish No. of cans: ☐ Size of can: ☐ small

☐ medium

☐ big

20. Where do you normally get your fish and seafood from?

Fish:

☐ caught by myself/member of this household

☐ get it from somebody in the family/village (no money paid)

☐ buy it at ____________

Which is the most important source? ☐ caught ☐ given ☐ bought

Invertebrates:

☐ caught by myself/member of this household

☐ get it from somebody in the family/village (no money paid)

☐ buy it at ____________

Which is the most important source? ☐ caught ☐ given ☐ bought

21. Which is the last day you had fish? ____________

22. Which is the last day you had other seafood? ____________

–THANK YOU–

FISHING (FINFISH) AND MARKETING SURVEY

Name: ____________________ F ☐ M ☐ **HH NO.** ☐

Name of head of household: ________________________ Village: _______________

Surveyor's name: ______________________ Date: _______________

1. Which areas do you fish?

coastal reef	lagoon	outer reef	mangrove	pelagic
☐	☐	☐	☐	☐

2. Do you go to only one habitat per trip?

Yes ☐ no ☐

3. If no, how many and which habitats do you visit during an average trip?

total no.	habitats:	coastal reef	lagoon	mangrove	outer reef
☐		☐	☐	☐	☐

4. How often (days/week) do you fish in each of the habitats visited?

coastal reef	lagoon	mangrove	outer reef	
☐	☐	☐	☐	___________/times per week/month
☐	☐	☐	☐	___________/times per week/month
☐	☐	☐	☐	___________/times per week/month

5. Do you use a boat for fishing?

	Always	sometimes	never
coastal reef	☐	☐	☐
lagoon	☐	☐	☐
mangrove	☐	☐	☐
outer reef	☐	☐	☐

6. If you use a boat, which one?

1 canoe (paddle) ☐ sailing ☐
motorised ☐ HP outboard ☐ 4-stroke engine ☐

coastal reef ☐ lagoon ☐ outer reef ☐

2
canoe (paddle) ☐ sailing ☐
motorised ☐ HP outboard ☐ 4-stroke engine ☐
coastal reef ☐ lagoon ☐ outer reef ☐

3
canoe (paddle) ☐ sailing ☐
motorised ☐ HP outboard ☐ 4-stroke engine ☐
coastal reef ☐ lagoon ☐ outer reef ☐

7. How many fishers ALWAYS go fishing with you?

Names:____
____
____
____

Appendix 1: Survey methods
Socioeconomics

INFORMATION BY FISHERY **Name of fisher:** ______________ **HH NO.** ☐

coastal reef ☐ lagoon ☐ mangrove ☐ outer reef ☐

1. HOW OFTEN do you normally go out FISHING for this habitat? *(tick box)*

Every Day	5 days/ week	4 days/ week	3 days/ week	2 days/ week	1 day/ week	other, specify:
☐	☐	☐	☐	☐	☐	____________________

2. What time do you spend fishing this habitat per average trip? ____________________
(if the fisher can't specify, tick a box)

<2 hrs	2–6 hrs	6–12 hrs	>12 hrs
☐	☐	☐	☐

3. WHEN do you go fishing? *(tick box)* day ☐ night ☐ day & night ☐

4. Do you go all year?

Yes ☐ no ☐

5. If no, which months don't you fish?

Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

6. Which fishing techniques do you use (*in the habitat referred to here*)?

☐ handline

☐ castnet ☐ gillnet

☐ spear (dive) ☐ longline

☐ trolling ☐ spear (handheld) walking ☐ canoe ☐

☐ deep bottom line ☐ poison: which one? ______________

☐ other, specify: ____

7. Do you use more than one technique per trip for this habitat? If yes, which ones usually?

☐ one technique/trip ☐ more than one technique/trip:

____

8. Do you use ice on your fishing trips?

☐ always ☐ sometimes ☐ never

☐ is it homemade? ☐ or bought?

9. What is your average catch (kg) per trip? ☐ Kg <u>OR:</u>

size class:	A	B	C	D	E	>E (cm)
number:	☐	☐	☐	☐	☐	☐

10. Do you sell fish? yes ☐ no ☐

11. Do you give fish as a gift (for no money)? yes ☐ no ☐

12. Do you use your catch for family consumption? yes ☐ no ☐

13. How much of your usual catch do you keep for family consumption?

kg ☐ <u>OR:</u>

size class	A	B	C	D	E	>E (cm)
no	☐	☐	☐	☐	☐	☐

and the rest you gift? yes ☐

how much? kg ☐ <u>OR:</u>

size class	A	B	C	D	E	>E (cm)
no.	☐	☐	☐	☐	☐	☐

and/or sell? yes ☐

how much? kg ☐ <u>OR</u>:

size class	A	B	C	D	E	>E (cm)
no.	☐	☐	☐	☐	☐	☐

14. What sizes of fish do you use for your family consumption, what for sale and what do you give away without getting any money?

size classes:	all	A	B	C	D	E	and larger (no. and cm)
consumption	☐	☐	☐	☐	☐	☐	☐
sale	☐	☐	☐	☐	☐	☐	☐
give away	☐	☐	☐	☐	☐	☐	☐

15. You sell where?

☐ inside village ☐ outside village where? ____________________________

and to whom?

market ☐ agents/middlemen ☐ shop owners ☐ others ☐ ___________

16. In an average catch what fish do you catch, and how much of each species? *(write down the species in the table)*

technique usually used:____________________ boat type usually used:_______________
habitat usually fished: ____

Specify the number by size

Name of fish	kg	A	B	C	D	E	>E cm

20. Do you also fish invertebrates?

Yes ☐ no ☐ <u>if yes</u> for consumption? ☐ sale? ☐

–THANK YOU–

INVERTEBRATE FISHING AND MARKETING SURVEY
FISHERS

HH NO. ☐

Name: ____

Gender: ☐ female ☐ male Age: ☐

Village: ____

Date: ________________ Surveyor's name: ____________________

Invertebrates = everything that is not a fish with fins!

1. Which type of fisheries do you do?

☐ seagrass gleaning ☐ mangrove & mud gleaning

☐ sand & beach gleaning ☐ reeftop gleaning

☐ bêche-de mer diving ☐ mother-of-pearl diving
trochus, pearl shell, etc.

☐ lobster diving ☐ other, such as clams, octopus

2. *(if more than one fishery in question 1):* Do you usually go fishing at only one of the fisheries or do you visit several during one fishing trip?

☐ one only ☐ several

If several fisheries at a time, which ones do you combine?

----

3. How often do you go gleaning/diving (*tick as from questions 1 and 2 above and watch for combinations*) and for how long, and do you also finfish at the same time?

	times/week		duration in hours (*if the fisher can't specify, tick the box*)				glean/dive at			fish no. of months/year
			<2	2–4	4–6	>6	D	N	D&N	
☐ seagrass gleaning	☐	____	☐	☐	☐	☐	☐	☐	☐	________
☐ mangrove & mud gleaning	☐	____	☐	☐	☐	☐	☐	☐	☐	________
☐ sand & beach gleaning	☐	____	☐	☐	☐	☐	☐	☐	☐	________
☐ reeftop gleaning	☐	____	☐	☐	☐	☐	☐	☐	☐	________
☐ bêche-de-mer diving	☐	____	☐	☐	☐	☐	☐	☐	☐	________
☐ lobster diving	☐	____	☐	☐	☐	☐	☐	☐	☐	________
☐ mother-of-pearl diving trochus, pearl shell, etc.	☐	____	☐	☐	☐	☐	☐	☐	☐	________
☐ other diving (clams, octopus)	☐	____	☐	☐	☐	☐	☐	☐	☐	________

D = day, N = night, D&N = day and night (no preference but fish with tide)

4. Do you sometimes go gleaning/fishing for invertebrates outside your village fishing grounds?

yes ☐ no ☐

If yes, where? ____

5. Do you finfish? yes ☐ no ☐

for: ☐ consumption? ☐ sale?

at the same time? yes ☐ no ☐

INVERTEBRATE FISHING AND MARKETING SURVEY – FISHERS

GLEANING: seagrass ☐ mangrove & mud ☐ sand & beach ☐ reeftop ☐ ☐

DIVING: bêche-de-mer ☐ lobster ☐ mother-of-pearl, trochus, pearl shell, etc. ☐ other (clams, octopus) ☐

SHEET 1: EACH FISHERY PER FISHER INTERVIEWED: ☐ **HH NO. __Name of fisher: ______________** **gender: F** ☐ **M** ☐

What transport do you mainly use? ☐ walk ☐ canoe (no engine) ☐ motorised boat (HP) ☐ sailboat

How many fishers are usually on a trip? (total no.) ☐ walk ☐ canoe (no engine) ☐ motorised boat (HP) ☐ sailboat

Species vernacular/common name and scientific code if possible	**Average quantity/trip**							**Used for** (specify how much from average for each category (cons., given or sold), and the main size for sale and cons. or given) gift = giving away for no money		
	total number/ trip	weight/trip					average size cm	cons.	gift	sale
		total kg	plastic bag unit							
			1	3/4	1/2	1/4				

Appendix 1: Survey methods
Socioeconomics

Species vernacular/common name and scientific code if possible	**Average quantity/trip**							**Used for** (specify how much from average for each category (cons., given or sold), and the main size for sale and cons. or given) gift = giving away for no money		
	total number/ trip	weight/trip					average size cm	cons.	gift	sale
		total kg	plastic bag unit							
			1	3/4	1/2	1/4				

INVERTEBRATE FISHING AND MARKETING SURVEY – FISHERS

GLEANING: seagrass ☐ mangrove & mud ☐ sand & beach ☐ reeftop ☐

DIVING: bêche-de-mer ☐ lobster ☐ mother-of-pearl, trochus, pearl shell, etc. ☐ other (clams, octopus) ☐

SHEET 2: SPECIES SOLD PER FISHER INTERVIEWED: **HH NO**. ☐ **Name of fisher:** ____________________

Copy all species that have been named for 'SALE' in previous sheet

Who markets your products? ☐ you ☐ your wife ☐ your husband ☐ a group of fishers ☐ other ______________

Species for sale – copy from sheet 2 (for each fishery per fisher) above	Processing level of product sold (see list)	Where do you sell? (see list)	How often? Days/week?	How much each time? Quantity/unit	Price

FISHERIES (FINFISH AND INVERTEBRATE AND SOCIOECONOMICS) GENERAL INFORMATION SURVEY

Target group: key people, groups of fishers, fisheries officers, etc.

1. Are there management rules that apply to your fisheries? Do they specifically target finfish or invertebrates, or do they target both sectors?

a) legal/Ministry of Fisheries

b) traditional/community/village determined:

2. What do you think – do people obey:

traditional/village management rules?

mostly ☐ sometimes ☐ hardly ☐

legal/Ministry of Fisheries management rules?

mostly ☐ sometimes ☐ hardly ☐

3. Are there any particular rules that you know people do not respect or follow at all? And do you know why?

4. What are the main techniques used by the community for:

a) finfishing

gillnets – most-used mesh sizes:

What is usually used for bait? And is it bought or caught?

b) invertebrate fishing → ***see end!***

5. Please give a quick inventory and characteristics of boats used in the community (length, material, motors, etc.).

Seasonality of species

What are the **FINFISH** species that you do not catch during the total year? Can you specify the particular months that they are **NOT** fished?

Vernacular name	Scientific name(s)	Months NOT fished

Seasonality of species

What are the **INVERTEBRATE** species that you do not catch during the total year? Can you specify the particular months that they are **NOT** fished?

Vernacular name	Scientific name(s)	Months NOT fished

Appendix 1: Survey methods
Socioeconomics

How many people carry out the invertebrate fisheries below, from inside and from outside the community?

GLEANING	**no. from this village**	**no.**	**from village**	**no.**	**from village**
☐ seagrass gleaning	☐	☐	____________	☐	____________
☐ mangrove & mud gleaning	☐	☐	____________	☐	____________
☐ sand & beach gleaning	☐	☐	____________	☐	____________
☐ reeftop gleaning	☐	☐	____________	☐	____________
DIVING					
☐ bêche-de-mer diving	☐	☐	____________	☐	____________
☐ lobster diving	☐	☐	____________	☐	____________
☐ mother-of-pearl diving trochus, pearl shell, etc.	☐	☐	____________	☐	____________
☐ other (clams, octopus)	☐	☐	____________	☐	____________

What gear do invertebrate fishers use? *(tick box of technique per fishery)*

GLEANING (soft bottom = seagrass)

☐ spoon	☐ wooden stick	☐ knife	☐ iron rod	☐ spade
☐ hand net	☐ net	☐ trap	☐ goggles	☐ dive mask
☐ snorkel	☐ fins	☐ weight belt		
☐ air tanks	☐ hookah	☐ other __________		

GLEANING (soft bottom = mangrove & mud)

☐ spoon	☐ wooden stick	☐ knife	☐ iron rod	☐ spade
☐ hand net	☐ net	☐ trap	☐ goggles	☐ dive mask
☐ snorkel	☐ fins	☐ weight belt		
☐ air tanks	☐ hookah	☐ other __________		

GLEANING (soft bottom = sand & beach)

☐ spoon	☐ wooden stick	☐ knife	☐ iron rod	☐ spade
☐ hand net	☐ net	☐ trap	☐ goggles	☐ dive mask
☐ snorkel	☐ fins	☐ weight belt		
☐ air tanks	☐ hookah	☐ other __________		

GLEANING (hard bottom = reeftop)

☐ spoon	☐ wooden stick	☐ knife	☐ iron rod	☐ spade
☐ hand net	☐ net	☐ trap	☐ goggles	☐ dive mask
☐ snorkel	☐ fins	☐ weight belt		
☐ air tanks	☐ hookah	☐ other __________		

DIVING (bêche-de-mer)

☐ spoon	☐ wooden stick	☐ knife	☐ iron rod	☐ spade
☐ hand net	☐ net	☐ trap	☐ goggles	☐ dive mask
☐ snorkel	☐ fins	☐ weight belt		
☐ air tanks	☐ hookah	☐ other __________		

DIVING (lobster)

☐ spoon	☐ wooden stick	☐ knife	☐ iron rod	☐ spade
☐ hand net	☐ net	☐ trap	☐ goggles	☐ dive mask
☐ snorkel	☐ fins	☐ weight belt		
☐ air tanks	☐ hookah	☐ other __________		

DIVING (mother-of-pearl, trochus, pearl shell, etc.)

☐ spoon ☐ wooden stick ☐ knife ☐ iron rod ☐ spade

☐ hand net ☐ net ☐ trap ☐ goggles ☐ dive mask

☐ snorkel ☐ fins ☐ weight belt

☐ air tanks ☐ hookah ☐ other ___________

DIVING (other, such as clams, octopus)

☐ spoon ☐ wooden stick ☐ knife ☐ iron rod ☐ spade

☐ hand net ☐ net ☐ trap ☐ goggles ☐ dive mask

☐ snorkel ☐ fins ☐ weight belt

☐ air tanks ☐ hookah ☐ other ___________

Any traditional/customary/village fisheries?

Name:

Season/occasion:

Frequency:

Quantification of marine resources caught:

Species name	**Size**	**Quantity (unit?)**

1.1.3 Average wet weight applied for selected invertebrate species groups

Unit weights used in conversions for invertebrates.

Scientific names	g/piece	% edible part	% non-edible part	Edible part (g/piece)	Group
Acanthopleura gemmata	29	35	65	10.15	Chiton
Actinopyga lecanora	300	10	90	30	BdM (1)
Actinopyga mauritiana	350	10	90	35	BdM (1)
Actinopyga miliaris	300	10	90	30	BdM (1)
Anadara spp.	21	35	65	7.35	Bivalves
Asaphis violascens	15	35	65	5.25	Bivalves
Astralium spp.	20	25	75	5	Gastropods
Atactodea striata, Donax cuneatus, Donax cuneatus	2.75	35	65	0.96	Bivalves
Atrina vexillum, Pinctada margaritifera	225	35	65	78.75	Bivalves
Birgus latro	1000	35	65	350	Crustacean
Bohadschia argus	462.5	10	90	46.25	BdM (1)
Bohadschia spp.	462.5	10	90	46.25	BdM (1)
Bohadschia vitiensis	462.5	10	90	46.25	BdM (1)
Cardisoma carnifex	227.8	35	65	79.74	Crustacean
Carpilius maculatus	350	35	65	122.5	Crustacean
Cassis cornuta, Thais aculeata, Thais aculeata	20	25	75	5	Gastropods
Cerithium nodulosum, Cerithium nodulosum	240	25	75	60	Gastropods
Chama spp.	25	35	65	8.75	Bivalves
Codakia punctata	20	35	65	7	Bivalves
Coenobita spp.	50	35	65	17.5	Crustacean
Conus miles, Strombus gibberulus gibbosus	240	25	75	60	Gastropods
Conus spp.	240	25	75	60	Gastropods
Cypraea annulus, Cypraea moneta	10	25	75	2.5	Gastropods
Cypraea caputserpensis	15	25	75	3.75	Gastropods
Cypraea mauritiana	20	25	75	5	Gastropods
Cypraea spp.	95	25	75	23.75	Gastropods
Cypraea tigris	95	25	75	23.75	Gastropods
Dardanus spp.	10	35	65	3.5	Crustacean
Dendropoma maximum	15	25	75	3.75	Gastropods
Diadema spp.	50	48	52	24	Echinoderm
Dolabella auricularia	35	50	50	17.5	Others
Donax cuneatus	15	35	65	5.25	Bivalves
Drupa spp.	20	25	75	5	Gastropods
Echinometra mathaei	50	48	52	24	Echinoderm
Echinothrix spp.	100	48	52	48	Echinoderm
Eriphia sebana	35	35	65	12.25	Crustacean
Gafrarium pectinatum	21	35	65	7.35	Bivalves
Gafrarium tumidum	21	35	65	7.35	Bivalves
Grapsus albolineatus	35	35	65	12.25	Crustacean
Hippopus hippopus	500	19	81	95	Giant clams
Holothuria atra	100	10	90	10	BdM (1)
Holothuria coluber	100	10	90	10	BdM (1)

1.1.3 Average wet weight applied for selected invertebrate species groups (continued)

Unit weights used in conversions for invertebrates.

Scientific names	g/piece	% edible part	% non-edible part	Edible part (g/piece)	Group
Holothuria fuscogilva	2000	10	90	200	BdM [1]
Holothuria fuscopunctata	1800	10	90	180	BdM [1]
Holothuria nobilis	2000	10	90	200	BdM [1]
Holothuria scabra	2000	10	90	200	BdM [1]
Holothuria spp.	2000	10	90	200	BdM [1]
Lambis lambis	25	25	75	6.25	Gastropods
Lambis spp.	25	25	75	6.25	Gastropods
Lambis truncata	500	25	75	125	Gastropods
Mammilla melanostoma, Polinices mammilla	10	25	75	2.5	Gastropods
Modiolus auriculatus	21	35	65	7.35	Bivalves
Nerita albicilla, Nerita polita	5	25	75	1.25	Gastropods
Nerita plicata	5	25	75	1.25	Gastropods
Nerita polita	5	25	75	1.25	Gastropods
Octopus spp.	550	90	10	495	Octopus
Panulirus ornatus	1000	35	65	350	Crustacean
Panulirus penicillatus	1000	35	65	350	Crustacean
Panulirus spp.	1000	35	65	350	Crustacean
Panulirus versicolor	1000	35	65	350	Crustacean
Parribacus antarcticus	750	35	65	262.5	Crustacean
Parribacus caledonicus	750	35	65	262.5	Crustacean
Patella flexuosa	15	35	65	5.25	Limpet
Periglypta puerpera, Periglypta reticulate	15	35	65	5.25	Bivalves
Periglypta spp., *Periglypta* spp., *Spondylus* spp., *Spondylus* spp.,	15	35	65	5.25	Bivalves
Pinctada margaritifera	200	35	65	70	Bivalves
Pitar proha	15	35	65	5.25	Bivalves
Planaxis sulcatus	15	25	75	3.75	Gastropods
Pleuroploca filamentosa	150	25	75	37.5	Gastropods
Pleuroploca trapezium	150	25	75	37.5	Gastropods
Portunus pelagicus	227.83	35	65	79.74	Crustacean
Saccostrea cucullata	35	35	65	12.25	Bivalves
Saccostrea spp.	35	35	65	12.25	Bivalves
Scylla serrata	700	35	65	245	Crustacean
Serpulorbis spp.	5	25	75	1.25	Gastropods
Sipunculus indicus	50	10	90	5	Seaworm
Spondylus squamosus	40	35	65	14	Bivalves
Stichopus chloronotus	100	10	90	10	BdM [1]
Stichopus spp.	543	10	90	54.3	BdM [1]
Strombus gibberulus gibbosus	25	25	75	6.25	Gastropods
Strombus luhuanus	25	25	75	6.25	Gastropods
Tapes literatus	20	35	65	7	Bivalves
Tectus pyramis, Trochus niloticus	300	25	75	75	Gastropods
Tellina palatum	21	35	65	7.35	Bivalves

1.1.3 Average wet weight applied for selected invertebrate species groups (continued)

Unit weights used in conversions for invertebrates.

Scientific names	g/piece	% edible part	% non-edible part	Edible part (g/piece)	Group
Tellina spp.	20	35	65	7	Bivalves
Terebra spp.	37.5	25	75	9.39	Gastropods
Thais armigera	20	25	75	5	Gastropods
Thais spp.	20	25	75	5	Gastropods
Thelenota ananas	2500	10	90	250	BdM (1)
Thelenota anax	2000	10	90	200	BdM (1)
Tridacna maxima	500	19	81	95	Giant clams
Tridacna spp.	500	19	81	95	Giant clams
Trochus niloticus	200	25	75	50	Gastropods
Turbo crassus	80	25	75	20	Gastropods
Turbo marmoratus	20	25	75	5	Gastropods
Turbo setosus	20	25	75	5	Gastropods
Turbo spp.	20	25	75	5	Gastropods

BdM = Bêche-de-mer; (1) edible part of dried Bêche-de-mer, i.e. drying process consumes about 90% of total wet weight; hence 10% are considered as the edible part only.

1.2 Methods used to assess the status of finfish resources

Fish counts

In order to count and size fish in selected sites, we use the **distance-sampling underwater visual census (D-UVC)** method (Kulbicki and Sarramegna 1999, Kulbicki *et al.* 2000), fully described in Labrosse *et al.* (2002). Briefly, the method consists of recording the species name, abundance, body length and the distance to the transect line for each fish or group of fish observed; the transect consists of a 50 m line, represented on the seafloor by an underwater tape (Figure A1.2.1). For security reasons, two divers are required to conduct a survey, each diver counting fish on a different side of the transect. Mathematical models are then used to estimate fish density (number of fish per unit area) and biomass (weight of fish per unit area) from the counts.

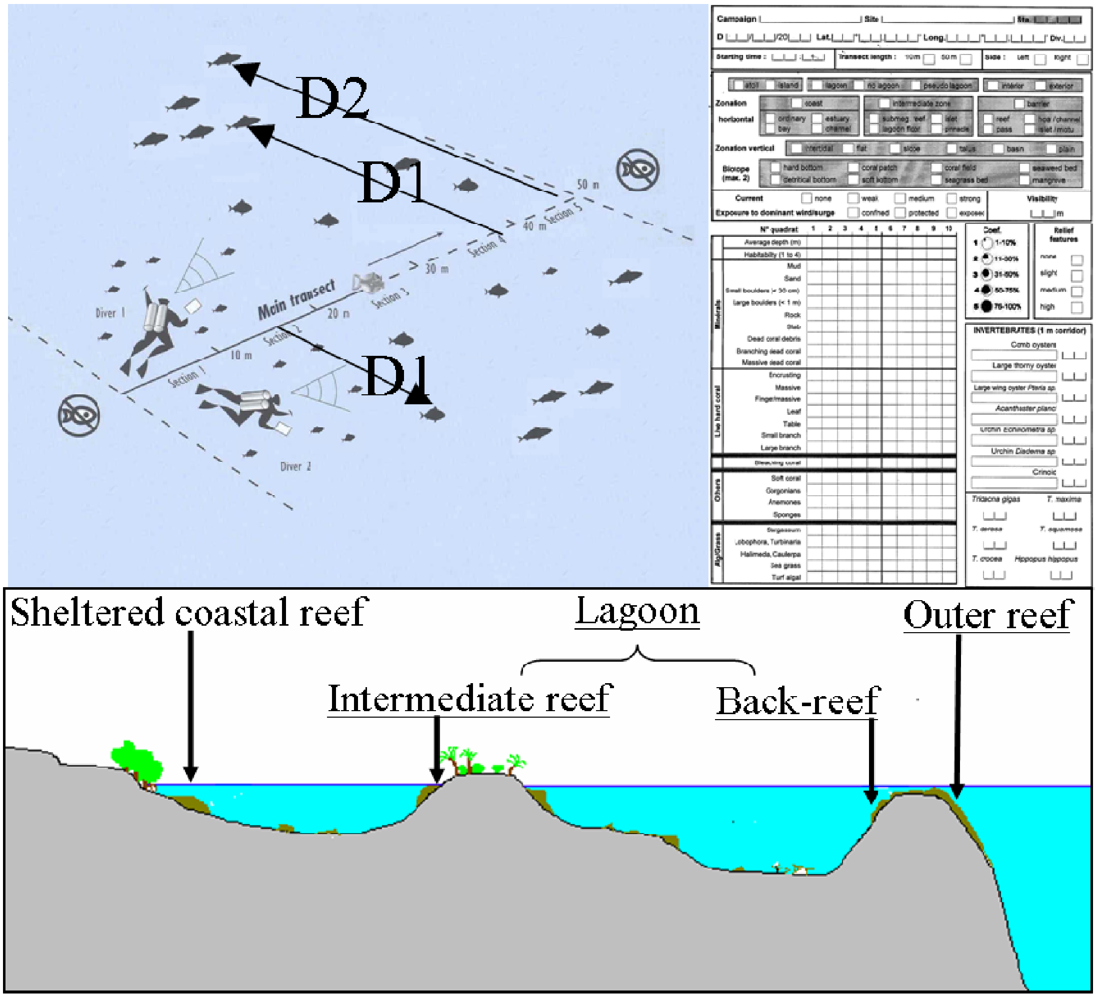


Figure A1.2.1: Assessment of finfish resources and associated environments using distance-sampling underwater visual censuses (D-UVC).
Each diver records the number of fish, fish size, distance of fish to the transect line, and habitat quality, using pre-printed underwater paper. At each site, surveys are conducted along 24 transects, with six transects in each of the four main geomorphologic coral reef structures: sheltered coastal reefs, intermediate reefs and back-reefs (lumped into the 'lagoon reef' category of socioeconomic assessment), and outer reefs. D1 is the distance of an observed fish from the transect line. If a school of fish is observed, D1 is the distance from the transect line to the closest fish; D2 the distance to the furthest fish.

Species selection

Only reef fish of interest for consumption or sale and species that could potentially serve as indicators of coral reef health are surveyed (see Table A1.2.1; Appendix 3.2 provides a full list of counted species and abundance for each site surveyed).

Table A1.2.1: List of finfish species surveyed by distance sampling underwater visual census (D-UVC)
Most frequently observed families on which reports are based are highlighted in yellow.

Family	Selected species
Acanthuridae	All species
Aulostomidae	*Aulostomus chinensis*
Balistidae	All species
Belonidae	All species
Caesionidae	All species
Carangidae	All species
Carcharhinidae	All species
Chaetodontidae	All species
Chanidae	All species
Dasyatidae	All species
Diodontidae	All species
Echeneidae	All species
Ephippidae	All species
Fistulariidae	All species
Gerreidae	*Gerres* spp.
Haemulidae	All species
Holocentridae	All species
Kyphosidae	All species
Labridae	*Bodianus axillaris, Bodianus loxozonus, Bodianus perditio, Bodianus* spp., *Cheilinus:* all species, *Choerodon:* all species, *Coris aygula, Coris gaimard, Epibulus insidiator, Hemigymnus:* all species, *Oxycheilinus diagrammus, Oxycheilinus* spp.
Lethrinidae	All species
Lutjanidae	All species
Monacanthidae	*Aluterus scriptus*
Mugilidae	All species
Mullidae	All species
Muraenidae	All species
Myliobatidae	All species
Nemipteridae	All species
Pomacanthidae	*Pomacanthus semicirculatus, Pygoplites diacanthus*
Priacanthidae	All species
Scaridae	All species
Scombridae	All species
Serranidae	Epinephelinae: all species
Siganidae	All species
Sphyraenidae	All species
Tetraodontidae	*Arothron*: all species
Zanclidae	All species

Analysis of percentage occurrence in surveys at both regional and national levels indicates that of the initial 36 surveyed families, only 15 families are frequently seen in country counts.

Appendix 1: Survey methods
Finfish

Since low percentage occurrence could either be due to rarity (which is of interest) or low detectability (representing a methodological bias), we decided to restrict our analysis to the 15 most frequently observed families, for which we can guarantee that D-UVC is an efficient resource assessment method.

These are:

- Acanthuridae (surgeonfish)
- Balistidae (triggerfish)
- Chaetodontidae (butterflyfish)
- Holocentridae (squirrelfish)
- Kyphosidae (drummer and seachubs)
- Labridae (wrasse)
- Lethrinidae (sea bream and emperor)
- Lutjanidae (snapper and seaperch)
- Mullidae (goatfish)
- Nemipteridae (coral bream and butterfish)
- Pomacanthidae (angelfish)
- Scaridae (parrotfish)
- Serranidae (grouper, rockcod, seabass)
- Siganidae (rabbitfish)
- Zanclidae (moorish idol).

Substrate

We used the **medium-scale approach** (MSA) to record substrate characteristics along transects where finfish were counted by D-UVC. MSA has been developed by Clua *et al.* (2006) to specifically complement D-UVC surveys. Briefly, the method consists of recording depth, habitat complexity, and 23 substrate parameters within ten 5 m x 5 m quadrats located on each side of a 50 m transect, for a total of 20 quadrats per transect (Figure A1.2.1). The transect's habitat characteristics are then calculated by averaging substrate records over the 20 quadrats.

Parameters of interest

In this report, the status of finfish resources has been characterised using the following seven parameters:

- **biodiversity –** the number of families, genera and species counted in D-UVC transects;
- **density** (fish/m^2) – estimated from fish abundance in D-UVC;
- **size** (cm fork length) – direct record of fish size by D-UVC;
- **size ratio** (%) – the ratio between fish size and maximum reported size of the species. This ratio can range from nearly zero when fish are very small to nearly 100 when a given fish has reached the greatest size reported for the species. Maximum reported size (and source of reference) for each species are stored in our database;
- **biomass** (g/m^2) – obtained by combining densities, size, and weight–size ratios (Weight–size ratio coefficients are stored in our database and were provided by Mr Michel Kulbicki, IRD Noumea, Coreus research unit);
- **community structure –** density, size and biomass compared among families; and

- **trophic structure –** density, size and biomass compared among trophic groups. Trophic groups are stored in our database and were provided by Mr Michel Kulbicki, IRD Noumea, Coreus research unit. Each species was classified into one of five broad trophic groups: 1) carnivore (feed predominantly on zoobenthos), 2) detritivore (feed predominantly on detritus), 3) herbivore (feed predominantly on plants), 4) piscivore (feed predominantly on nekton, other fish and cephalopods) and 5) plankton feeder (feed predominantly on zooplankton). More details on fish diet can be found online at: http://www.fishbase.org/manual/english/FishbaseThe_FOOD_ITEMS_Table.htm.

The relationship between environment quality and resource status has not been fully explored at this stage of the project, as this task requires complex statistical analyses on the regional dataset. Rather, the living resources assessed at all sites in each country are placed in an environmental context via the description of several crucial habitat parameters. These are obtained by grouping the original 23 substrate parameters recorded by divers into the following six parameters:

- **depth** (m)
- **soft bottom** (% cover) – sum of substrate components:
  (1) mud (sediment particles <0.1 mm), and
  (2) sand and gravel (0.1 mm <hard particles <30 mm)
- **rubble and boulders** (% cover) – sum of substrate components:
  (3) dead coral debris (carbonated structures of heterogeneous size, broken and removed from their original locations),
  (4) small boulders (diameter <30 cm), and
  (5) large boulders (diameter <1 m)
- **hard bottom** (% cover) – sum of substrate components:
  (6) slab and pavement (flat hard substratum with no relief), rock (massive minerals) and eroded dead coral (carbonated edifices that have lost their coral colony shape),
  (7) dead coral (dead carbonated edifices that are still in place and retain a general coral shape), and
  (8) bleaching coral
- **live coral** (% cover) – sum of substrate components:
  (9) encrusting live coral,
  (10) massive and sub-massive live corals,
  (11) digitate live coral,
  (12) branching live coral,
  (13) foliose live coral,
  (14) tabulate live coral, and
  (15) *Millepora* spp.
- **soft coral** (% cover) – substrate component:
  (16) soft coral.

Sampling design

Coral reef ecosystems are complex and diverse. The NASA Millennium Coral Reef Mapping Project (MCRMP) has identified and classified coral reefs of the world in about 1000 categories. These very detailed categories can be used directly to try to explain the status of living resources or be lumped into more general categories to fit a study's particular needs. For the needs of the finfish resource assessment, MCRMP reef types were grouped into the four main coralline geomorphologic structures found in the Pacific (Figure A1.2.2):

- **sheltered coastal reef**: reef that fringes the land but is located inside a lagoon or a pseudo-lagoon
- **lagoon reef**:
  - **intermediate reef** – patch reef that is located inside a lagoon or a pseudo-lagoon, and
  - **back-reef** – inner/lagoon side of outer reef
- **outer reef**: ocean side of fringing or barrier reefs.

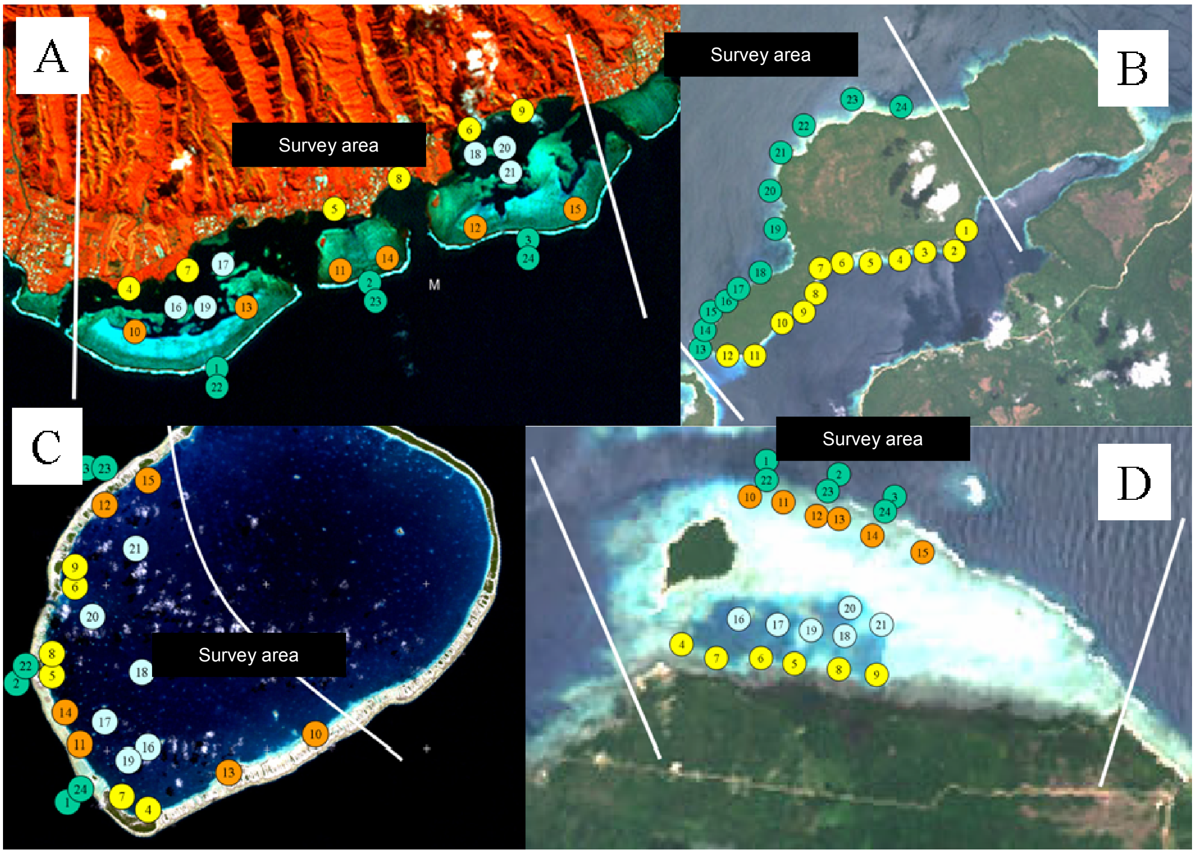


Figure A1.2.2: Position of the 24 D-UVC transects surveyed in A) an island with a lagoon, B) an island with a pseudo-lagoon C) an atoll and D) an island with an extensive reef enclosing a small lagoon pool.
Sheltered coastal reef transects are in yellow, lagoon intermediate-reef transects in blue, lagoon back-reef transects in orange and outer-reef transects in green. Transect locations are determined using satellite imagery prior to going into the field, which greatly enhances fieldwork efficiency. The white lines delimit the borders of the survey area.

Fish and associated habitat parameters are recorded along 24 transects per site, with a balanced design among the main geomorphologic structures present at a given site (Figure A1.2.2). For example, our design results in at least six transects in each of the sheltered coastal, lagoon intermediate, lagoon back-reef, and outer reefs of islands with lagoons (Figure A1.2.2A) or 12 transects in each of the sheltered coastal and outer reefs of islands with pseudo-lagoons (Figure A1.2.2B). This balanced, stratified and yet flexible sampling design was chosen to optimise the quality of the assessment, given the logistical and time constraints that stem from the number and diversity of sites that have to be covered over the life of the project. The exact position of transects is determined in advance using satellite imagery, to assist in locating the exact positions in the field; this maximises accuracy and allows replication for monitoring purposes (Figure A1.2.2).

Appendix 1: Survey methods
Finfish

Scaling

Maps from the Millennium Project allow the calculation of reef areas in each studied site, and those areas can be used to scale (using weighted averages) the resource assessment at any spatial level. For example, the average biomass (or density) of finfish at site (i.e. village) level would be calculated by relating the biomass (or density) recorded in each of the habitats sampled at the site ('the data') to the proportion of surface of each type of reef over the total reef present in the site ('the weights'), by using a weighted average formula. The result is a village-level figure for finfish biomass that is representative of both the intrinsic characteristics of the resource and its spatial distribution. Technically, the weight given to the average biomass (or density) of each habitat corresponds to the ratio between the total area of that reef habitat (e.g. the area of sheltered coastal reef) and the total area of reef present (e.g. the area of sheltered coastal reef + the area of intermediate reef, etc.). Thus the calculated weighted biomass value for the site would be:

$$B_{Vk} = \sum j_l \, [B_{Hj} \bullet S_{Hj}] \, / \sum_j S_{Hj}$$

Where:

B_{Vk} = computed biomass or fish stock for village k
B_{Hj} = average biomass in habitat H_j
S_{Hj} = surface of that habitat H_j

A comparative approach only

Density and biomass estimated by D-UVC for each species recorded in the country are given in Appendix 3.2. However, it should be stressed that, since estimates of fish density and biomass (and other parameters) are largely dependent upon the assessment method used (this is true for any assessment), the resource assessment provided in this report can only be used for management in a comparative manner. Densities, biomass and other figures given in this report provide only estimates of the available resource; it would be a great mistake (possibly leading to mismanagement) to consider these as true indicators of the actual available resource.

Campaign |________| Site |________| Diver |__|__| Transect |__|__|__|

D |__|__|/|__|__|/20|__|__| Lat.|__|__|°|__|__|,|__|__|__|' Long.|__|__|__|°|__|__|,|__|__|__|' WT |__|__|__|

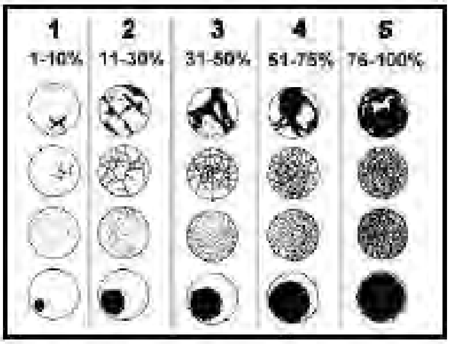
Starting time : |__|__| :|__|__| Visibility |__|__| m Side : Left ☐ Right ☐

☐ coast		☐ intermediate zone		☐ barrier	
☐ linear	☐ cape	☐ submerg. reef	☐ pinnacle	☐ outer slope	☐ pass
☐ bay mouth	☐ back of bay	☐ near surf. reef	☐ islet lagoon	☐ reef crest	☐ hoa/channel
☐ estuary	☐ channel	☐ lagoon floor	☐ islet fringing reef	☐ back reef	☐ motu

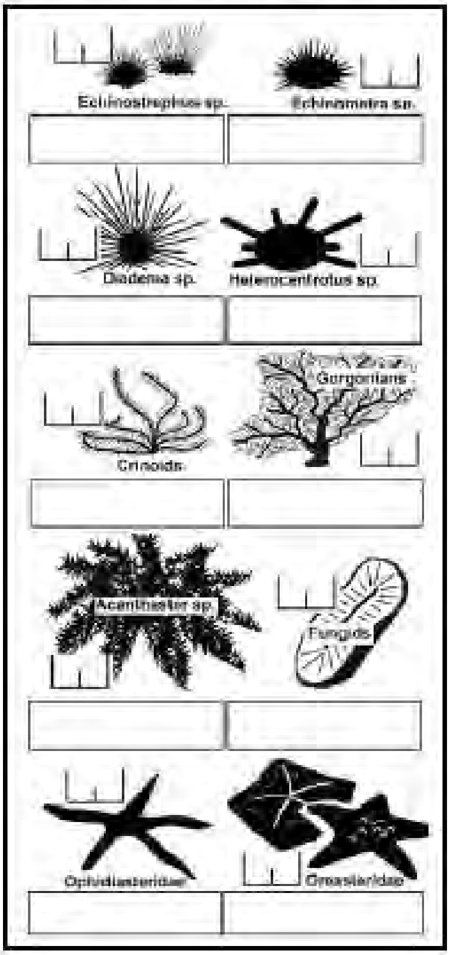
☐ intertidal ☐ flat ☐ gentle slope ☐ steep slope ☐ talus ☐ basin ☐ lagoon plain

☐ hard bottom ☐ detritical bottom ☐ large coral patches ☐ soft bottom ☐ small coral patches ☐ coral field ☐ seagrass bed ☐ seaweed bed ☐ mangrove

	current	relief features	exposure to dominant wind	oceanic influence	terrigenous influence
none	☐	☐	☐	☐	☐
medium	☐	☐	☐	☐	☐
strong	☐	☐	☐	☐	☐



	Quadrat limits	0	5	10	15	20	25	30	35	40	45	50
	Average depth (m)											
	Habitability (1 to 4)											
General coverage	Mud											
	Sand											
	Dead coral debris											
	Small boulders (< 30 cm)											
	Large boulders (< 1 m)											
	Eroded dead coral, rock											
	Old dead coral in place											
	Bleaching coral											
	(1) Live corals											
	(2) Soft invertebrates											
(1) Live corals	Encrusting											
	Massive											
	Digitate											
	Branch											
	Foliose											
	Tabulate											
	Millepora sp.											
(2)	Soft corals											
	Sponges											
Grass/alg	Cyanophyceae											
	Sea grass											
	Encrusting algae											
	Small macro-algae											
	Large macro-algae											
	Drifting algae											
	Micro-algae, Turf											
	Others :											



Finfish

Campaign |_________________| Site |__________________________| Diver |__|__| Transect |__|__|__|

D |__|__|/|__|__|/20|__|__| Lat.|__|__|°|__|__|,|__|__|__|’ Long.|__|__|__|°|__|__|,|__|__|__|’ Left ☐ Right ☐

ST	SCIENTIFIC NAME	NBER	LGT	D1	D2	COMMENTS

1.3 Invertebrate resource survey methods

1.3.1 Methods used to assess the status of invertebrate resources

Introduction

Coastal communities in the Pacific access a range of invertebrate resources. Within the PROCFish/C study, a range of survey methods were used to provide information on key invertebrate species commonly targeted. These provide information on the status of resources at scales relevant to species (or species groups) and the fishing grounds being studied that can be compared across sites, countries and the region, in order to assess relative status.

Species data resulting from the resource survey are combined with results from the socioeconomic survey of fishing activity to describe invertebrate fishing activity within specific 'fisheries'. Whereas descriptions of commercially orientated fisheries are generally recognisable in the literature (e.g. the sea cucumber fishery), results from non-commercial stocks and subsistence-orientated fishing activities (e.g. general reef gleaning) will also be presented as part of the results, so as to give managers a general picture of invertebrate fishery status at study sites.

Field methods

We examined invertebrate stocks (and fisheries) for approximately seven days at each site, with at least two research officers (SPC Invertebrate Biologist and Fisheries Officer) plus officers from the local fisheries department. The work completed at each site was determined by the availability of local habitats and access to fishing activity.

Two types of survey were conducted: fishery-dependent surveys and fishery independent surveys.

- Fishery-dependent surveys rely on information from those engaged in the fishery, e.g. catch data;
- Fishery-independent surveys are conducted by the researchers independently of the activity of the fisheries sector.

Fishery-dependent surveys were completed whenever the opportunity arose. This involved accompanying fishers to target areas for the collection of invertebrate resources (e.g. reef-benthos, soft-benthos, trochus habitat). The location of the fishing activity was marked (using a GPS) and the catch composition and catch per unit effort (CPUE) recorded (kg/hour).

This record was useful in helping to determine the species complement targeted by fishers, particularly in less well-defined 'gleaning' fisheries. A CPUE record, with related information on individual animal sizes and weights, provided an additional dataset to expand records from reported catches (as recorded by the socioeconomic survey). In addition, size and weight measures collected through fishery-dependent surveys were compared with records from fishery-independent surveys, in order to assess which sizes fishers were targeting.

For a number of reasons, not all fisheries lend themselves to independent snapshot assessments: density measures may be difficult to obtain (e.g. crab fisheries in mangrove systems) or searches may be greatly influenced by conditions (e.g. weather, tide and lunar conditions influence lobster fishing). In the case of crab or shoreline fisheries, searches are very subjective and weather and tidal conditions affect the outcome. In such cases, observed and reported catch records were used to determine the status of species and fisheries.

A further reason for accompanying groups of fishers was to gain a first-hand insight into local fishing activities and facilitate the informal exchange of ideas and information. By talking to fishers in the fishing grounds, information useful for guiding independent resource assessment was generally more forthcoming than when trying to gather information using maps and aerial photographs while in the village. Fishery-independent surveys were not conducted randomly over a defined site 'study' area. Therefore assistance from knowledgeable fishers in locating areas where fishing was common was helpful in selecting areas for fishery-independent surveys.

A series of fishery-independent surveys (direct, in-water resource assessments) were conducted to determine the status of targeted invertebrate stocks. These surveys needed to be wide ranging within sites to overcome the fact that distribution patterns of target invertebrate species can be strongly influenced by habitat, and well replicated as invertebrates are often highly aggregated (even within a single habitat type).

PROCFish/C assessments do not aim to determine the size of invertebrate populations at study sites. Instead, these assessments aim to determine the status of invertebrates within the main fishing grounds or areas of naturally higher abundance. The implications of this approach are important, as the haphazard measures taken in main fishing grounds are indicative of stock health in these locations only and should not be extrapolated across all habitats within a study site to gain population estimates.

This approach was adopted due to the limited time allocated for surveys and the study's goal of 'assessing the status of invertebrate resources' (as opposed to estimating the standing stock). Making judgements on the status of stocks from such data relies on the assumption that the state of these estimates of 'unit stock'[2] reflects the health of the fishery. For example, an overexploited trochus fishery would be unlikely to have high-density 'patches' of trochus, just as a depleted shallow-reef gleaning fishery would not hold high densities of large clams. Conversely, a fishery under no stress would be unlikely to be depleted or show skewed size ratios that reflected losses of the adult component of the stock.

In addition to examining the density of species, information on spatial distribution and size/weight was collected, to add confidence to the study's inferences.

The basic assumption that looking at a unit stock will give a reliable picture of the status of that stock is not without weaknesses. Resource stocks may appear healthy within a much-restricted range following stress from fishing or environmental disturbance (e.g. a cyclone), and historical information on stock status is not usually available for such remote locations. The lack of historical datasets also precludes speculation on 'missing' species, which may be 'fished-out' or still remain in remnant populations at isolated locations within study sites.

[2] As used here, 'unit stock' refers to the biomass and cohorts of adults of a species in a given area that is subject to a well-defined fishery, and is believed to be distinct and have limited interchange of adults from biomasses or cohorts of the same species in adjacent areas (Gulland 1983).

As mentioned, specific independent assessments were not conducted for mud crab and shore crabs (mangrove fishery), lobster or shoreline stocks (e.g. nerites, surf clams and crabs), as limited access or the variability of snapshot assessments would have limited relevance for comparative assessments.

Generic terminology used for surveys: site, station and replicates

Various methods were used to conduct fishery-independent assessments. At each site, surveys were generally made within specific areas (termed 'stations'). At least six replicate measures were made at each station (termed 'transects', 'searches' or 'quadrats', depending on the resource and method) (Figure A1.3.1).

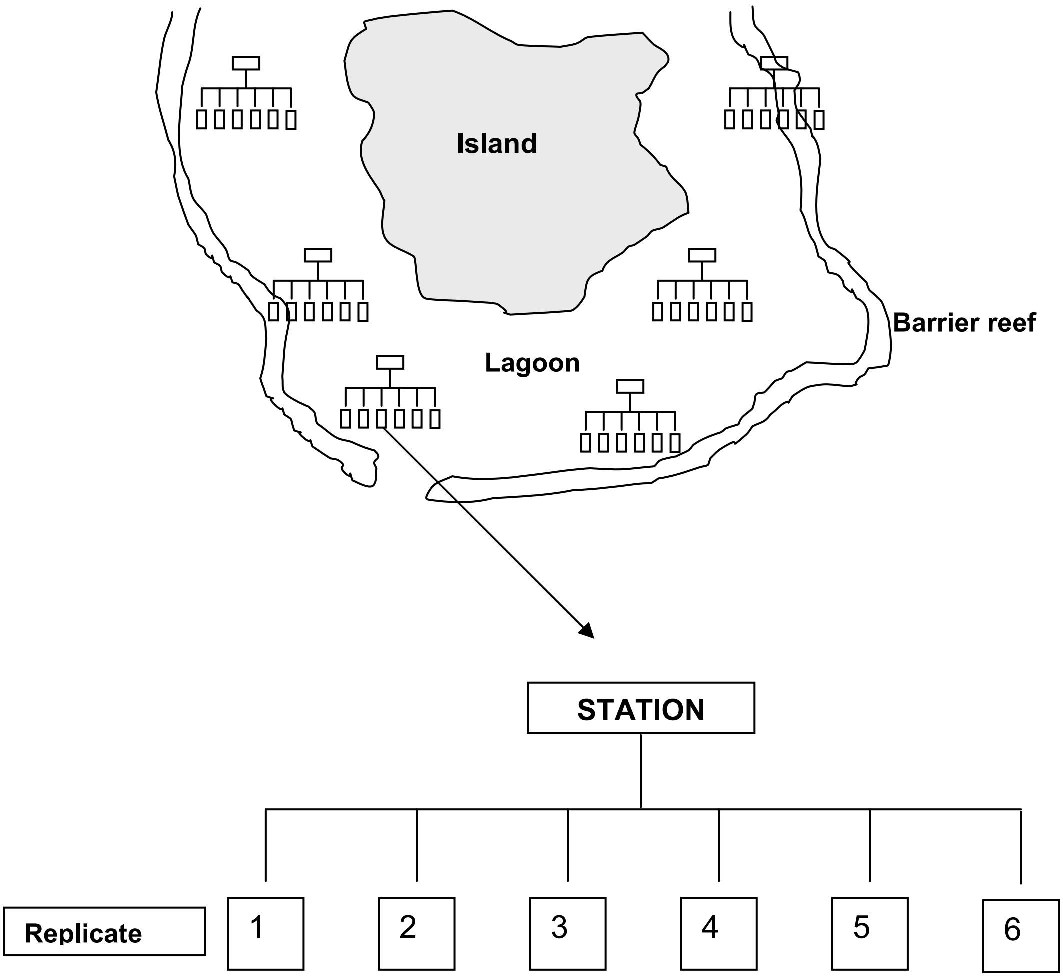


Figure A1.3.1: Stations and replicate measures at a given site.
A replicate measure could be a transect, search period or quadrat group.

Invertebrate species diversity, spatial distribution and abundance were determined using fishery-independent surveys at stations over broad-scale and more targeted surveys. Broad-scale surveys aimed to record a range of macro invertebrates across sites, whereas more targeted surveys concentrated on specific habitats and groups of important resource species.

Recordings of habitat are generally taken for all replicates within stations (see Appendix 1.3.3). Comparison of species complements and densities among stations and sites does not factor in fundamental differences in macro and micro habitat, as there is presently no established method that can be used to make allowances for these variations. The complete dataset from PROCFish/C will be a valuable resource to assess such habitat effects, and by identifying salient habitat factors that reliably affect resource abundance, we may be able to account for these habitat differences when inferring 'status' of important species groups. This will be examined once the full Pacific dataset has been collected.

More detailed explanations of the various survey methods are given below.

Broad-scale survey

Manta 'tow-board' transect surveys

A general assessment of large sedentary invertebrates and habitat was conducted using a tow-board technique adapted from English *et al.* (1997), with a snorkeller towed at low speed (<2.5 km/hour). This is a slower speed than is generally used for manta transects, and is less than half the normal walking pace of a pedestrian.

Where possible, manta surveys were completed at 12 stations per site. Stations were positioned near land masses on fringing reefs (inner stations), within the lagoon system (middle stations) and in areas most influenced by oceanic conditions (outer stations). Replicate measures within stations (called transects) were conducted at depths between 1 m and <10 m of water (mostly 1.5–6 m), covering broken ground (coral stone and sand) and at the edges of reefs. Transects were not conducted in areas that were too shallow for an outboard-powered boat (<1 m) or adjacent to wave-impacted reef.

Each transect covered a distance of ~300 m (thus the total of six transects covered a linear distance of ~2 km). This distance was calibrated using the odometer function within the trip computer option of a Garmin 76Map® GPS. Waypoints were recorded at the start and end of each transect to an accuracy of ≤10 m. The abundance and size estimations for large sedentary invertebrates were taken within a 2 m swathe of benthos for each transect. Broad-based assessments at each station took approximately one hour to complete (7–8 minutes per transect × 6, plus recording and moving time between transects). Hand tally counters and board-mounted bank counters (three tally units) were used to assist with enumerating common species.

The tow-board surveys differed from traditional manta surveys by utilising a lower speed and concentrating on a smaller swathe on the benthos. The slower speed, reduced swathe and greater length of tows used within PROCFish/C protocols were adopted to maximise efficiency when spotting and identifying cryptic invertebrates, while covering areas that were large enough to make representative measures.

Targeted surveys

Reef- and soft-benthos transect surveys (RBt and SBt), and soft-benthos quadrats (SBq)

To assess the range, abundance, size and condition of invertebrate species and their habitat with greater accuracy at smaller scales, reef- and soft-benthos assessments were conducted within fishing areas and suitable habitat. Reef benthos and soft benthos are not mutually exclusive, in that coral reefs generally have patches of sand, while soft-benthos seagrass areas can be strewn with rubble or contain patches of coral. However, these survey stations (each covering approximately 5000 m^2) were selected in areas representative of the habitat (those generally accessed by fishers, although MPAs were examined on occasion). Six 40 m transects (1 m swathe) were examined per station to record most epi-benthic invertebrate resources and some sea stars and urchin species (as potential indicators of habitat condition). Transects were randomly positioned but laid across environmental gradients where possible (e.g. across reefs and not along reef edges). A single waypoint was recorded for each station (to an accuracy of ≤10 m) and habitat recordings were made for each transect (see Figure A1.3.2 and Appendix 1.3.2).

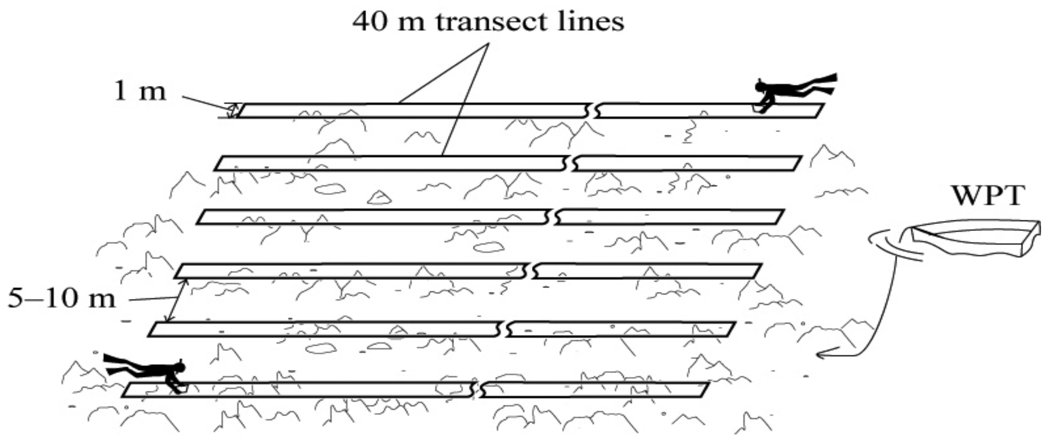


Figure A1.3.2: Example of a reef-benthos transect station (RBt).

To record infaunal resources, quadrats (SBq) were used within a 40 m × 2 m strip transect to measure densities of molluscs (mainly bivalves) in soft-benthos 'shell bed' areas. Four 25 cm x 25 cm quadrats (one quadrat group) were dug to approximately 5–8 cm to retrieve and measure infaunal target species and potential indicator species. Eight randomly spaced quadrat groups were sampled along the 40 m transect line (Figure A1.3.3). A single waypoint and habitat recording was taken for each infaunal station.

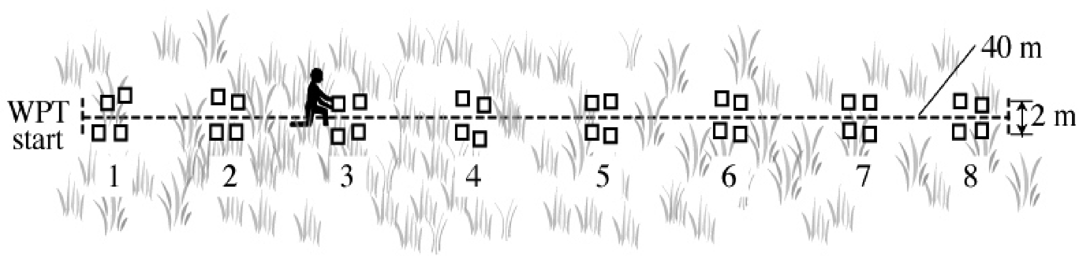


Figure A1.3.3: Soft-benthos (infaunal) quadrat station (SBq).
Single quadrats are 25 cm x 25 cm in size and four make up one 'quadrat group'.

<u>Mother-of-pearl (MOP) or sea cucumber (BdM) fisheries</u>

To assess fisheries such as those for trochus or sea cucumbers, results from broad-scale, reef- and soft-benthos assessments were used. However, other specific surveys were incorporated into the work programme, to more closely target species or species groups not well represented in the primary assessments.

<u>Reef-front searches (RFs and RFs_w)</u>

If swell conditions allowed, three 5-min search periods (conducted by two snorkellers, i.e. 30 min total) were conducted along exposed reef edges (RFs) where trochus (*Trochus niloticus*) and surf redfish (*Actinopyga mauritiana*) generally aggregate (Figure A1.3.4). Due to the dynamic conditions of the reef front, it was not generally possible to lay transects, but the start and end waypoints of reef-front searches were recorded, and two snorkellers recorded the abundance (generally not size measures) of large sedentary species (concentrating on trochus, surf redfish, gastropods and clams).

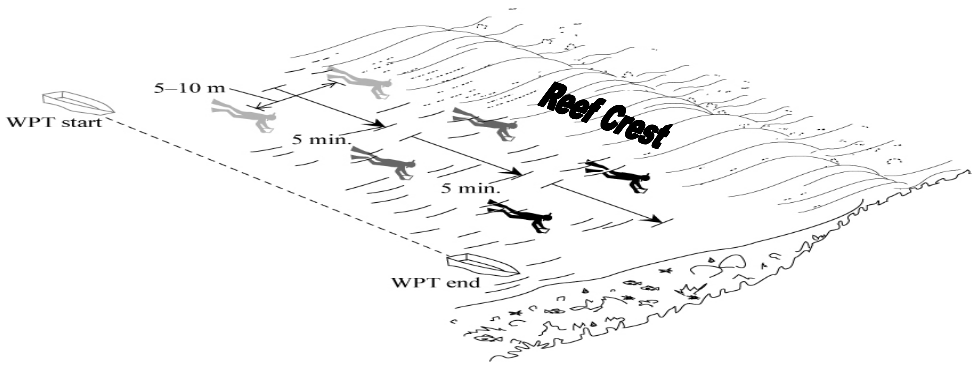


Figure A1.3.4: Reef-front search (RFs) station.

On occasions when it was too dangerous to conduct in-water reef-front searches (due to swell conditions or limited access) and the reeftop was accessible, searches were conducted on foot along the top of the reef front (RFs_w). In this case, two officers walked side by side (5–10 m apart) in the pools and cuts parallel to the reef front. This search was conducted at low tide, as close as was safe to the wave zone. In this style of assessment, reef-front counts of sea cucumbers, gastropod shells, urchins and clams were made during three 5-min search periods (total of 30 minutes search per station).

In the case of *Trochus niloticus*, reef-benthos transects, reef-front searches and local advice (trochus areas identified by local fishers) led us to reef-slope and shoal areas that were surveyed using SCUBA. Initially, searches were undertaken using SCUBA, although SCUBA transects (greater recording accuracy for density) were adopted if trochus were shown to be present at reasonable densities.

<u>Mother-of-pearl search (MOPs)</u>

Initially, two divers (using SCUBA) actively searched for trochus for three 5-min search periods (30 min total). Distance searched was estimated from marked GPS start and end waypoints. If more than three individual shells were found on these searches, the stock was considered dense enough to proceed with the more defined area assessment technique (MOPt).

<u>Mother-of-pearl transects (MOPt)</u>

Also on SCUBA, this method used six 40-m transects (2 m swathe) run perpendicular to the reef edge and not exceeding 15 m in depth (Figure A1.3.5). In most cases the depth ranged between 2 and 6 m, although dives could reach 12 m at some sites where more shallow-water habitat or stocks could not be found. In cases where the reef dropped off steeply, more oblique transect lines were followed. On MOP transect stations, a hip-mounted (or handheld) Chainman® measurement system (thread release) was used to measure out the 40 m. This allowed a hands-free mode of survey and saved time and energy in the often dynamic conditions where *Trochus niloticus* are found.

Appendix 1: Survey methods
Invertebrates

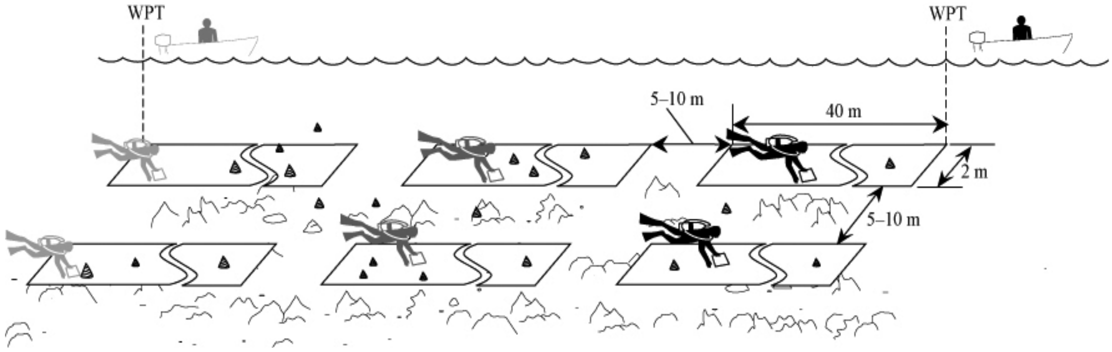


Figure A1.3.5: Mother-of-pearl transect station (MOPt).

Sea cucumber day search (Ds)

When possible, dives to 25–35 m were made to establish if white teatfish (*Holothuria (Microthele) fuscogilva*) populations were present and give an indication of abundance. In these searches two divers recorded the number and sizes of valuable deep-water sea cucumber species within three 5-min search periods (30 min total). This assessment from deep water does not yield sufficient presence/absence data for a very reliable inference on the status (i.e. 'health') of this and other deeper-water species.

Sea cucumber night search (Ns)

In the case of sea cucumber fisheries, dedicated night searches (Ns) for sea cucumbers and other echinoderms were conducted using snorkel for predominantly nocturnal species (blackfish *Actinopyga miliaris*, *A. lecanora*, and *Stichopus horrens*). Sea cucumbers were collected for three 5-min search periods by two snorkellers (30 min total), and if possible weighed (length and width measures for *A. miliaris* and *A. lecanora* are more dependent on the condition than the age of an individual).

Reporting style

For country site reports, results highlight the presence and distribution of species of interest, and their density at scales that yield a representative picture. Generally speaking, mean densities (average of all records) are presented, although on occasion mean densities for areas of aggregation ('patches') are also given. The later density figure is taken from records (stations or transects, as stated) where the species of interest is present (with an abundance >zero). Presentation of the relative occurrence and densities (without the inclusion of zero records) can be useful when assessing the status of aggregations within some invertebrate stocks.

An example and explanation of the reporting style adopted for invertebrate results follows.

1. The mean density range of *Tridacna* spp. on broad-scale stations (n = 8) was 10–120 per ha.

Density range includes results from all stations. In this case, replicates in each station are added and divided by the number of replicates for that station to give a mean. The lowest and highest station averages (here 10 and 120) are presented for the range. The number in brackets (n = 8) highlights the number of stations examined.

2. The mean density (per ha, ±SE) of all *Tridacna* clam species observed in broad-scale transects (n = 48) was 127.8 ±21.8 (occurrence in 29% of transects).

Mean density is the arithmetic mean, or average of measures across all replicates taken (in this case broad-scale transects). On occasion mean densities are reported for stations or transects where the species of interest is found at an abundance greater than zero. In this case the arithmetic mean would only include stations (or replicates) where the species of interest was found (excluding zero replicates). If this was presented for stations, even stations with a single clam from six transects would be included. (Note: a full breakdown of data is presented in the appendices.)

Written after the mean density figure is a descriptor that highlights variability in the figures used to calculate the mean. Standard error[3] (SE) is used in this example to highlight variability in the records that generated the mean density (SE = (standard deviation of records)/√n). This figure provides an indication of the dispersion of the data when trying to estimate a population mean (the larger the standard error, the greater variation of data points around the mean presented).

Following the variability descriptor is a presence/absence indicator for the total dataset of measures. The presence/absence figure describes the percentage of stations or replicates with a recording >0 in the total dataset; in this case 29% of all transects held *Tridacna* spp., which equated to 14 of a possible 48 transects (14/48*100 = 29%).

3. The mean length (cm, ±SE) of *T. maxima* was 12.4 ±1.1 (n = 114).

The number of units used in the calculation is indicated by *n*. In the last case, 114 clams were measured.

[3] In order to derive confidence limits around the mean, a transformation (usually y = log (x+1)) needs to be applied to data, as samples are generally non-normally distributed. Confidence limits of 95% can be generated through other methods (bootstrapping methods) and will be presented in the final report where appropriate.

1.3.2 General fauna invertebrate recording sheet with instructions to users

DATE		RECORDER		Pg No	

STATION NAME																		
WPT - WIDTH																		
RELIEF / COMPLEXITY **1–5**																		
OCEAN INFLUENCE **1–5**																		
DEPTH (M)																		
% SOFT SED (M – S – CS)																		
% RUBBLE / BOULDERS																		
% CONSOL RUBBLE / PAVE																		
% CORAL *LIVE*																		
% CORAL *DEAD*																		
SOFT / SPONGE / FUNGIDS																		
ALGAE *CCA*																		
CORALLINE																		
OTHER																		
GRASS																		
EPIPHYTES **1–5** / SILT **1–5**																		
bleaching: % of benthos																		
entered / checked																		

Figure A1.3.6: Sample of the invertebrate fauna survey sheet.

The sheet above (Figure A1.3.6) has been modified to fit on this page (the original has more line space (rows) for entering species data). When recording abundance or length data against species names, columns are used for individual transects or 5-min search replicates. If more space is needed, more than a single column can be used for a single replicate.

A separate sheet is used by a recorder in the boat to note information from handheld GPS equipment. In addition to the positional information, this boat sheet has space for manta transect distance (from GPS odometer function) and for sketches and comments.

1.3.3 Habitat section of invertebrate recording sheet with instructions to users

Figure A1.3.7 depicts the habitat part of the form used during invertebrate surveys; it is split into seven broad categories.

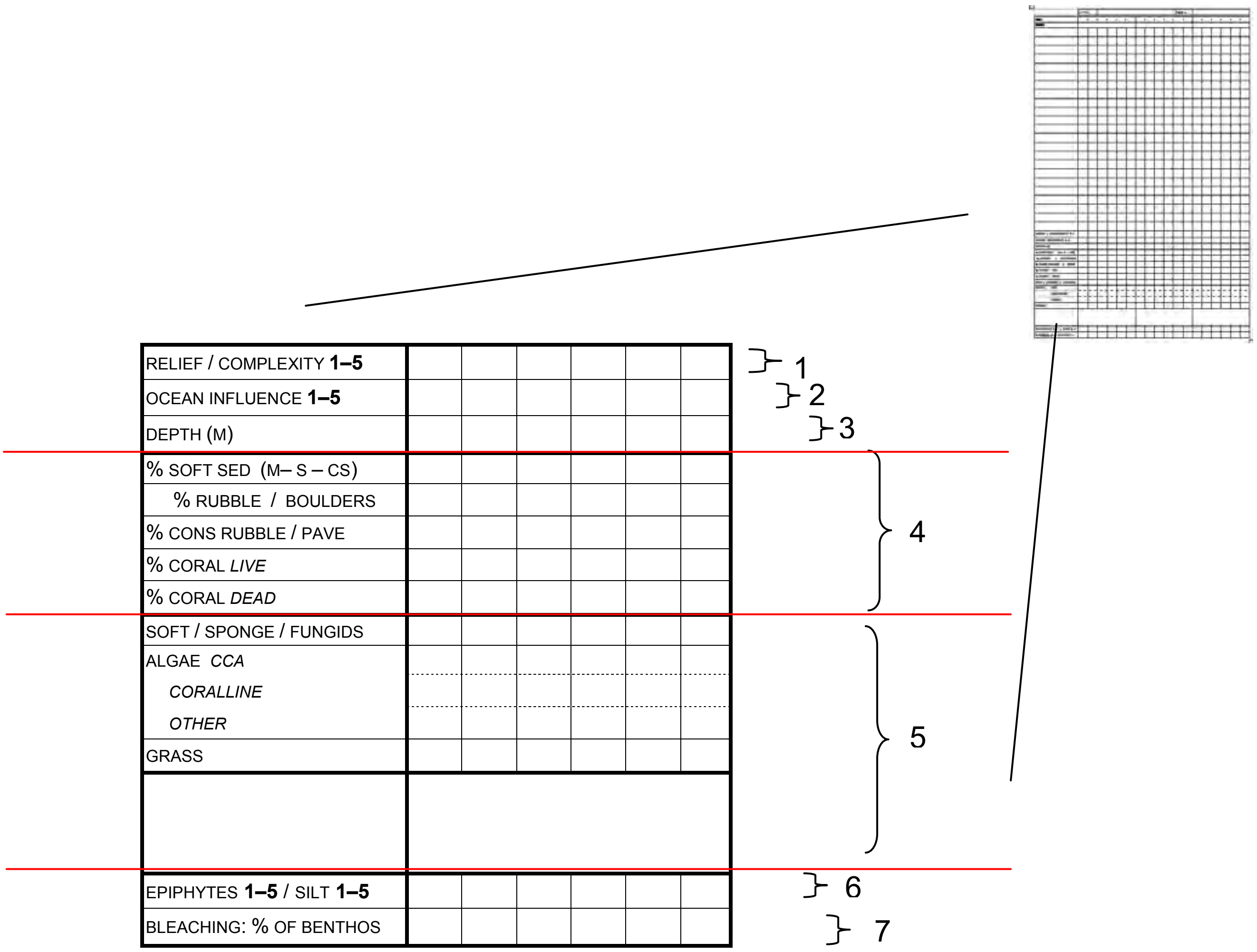


Figure A1.3.7: Sample of the invertebrate habitat part of survey form.

Relief and complexity (section 1 of form)

Each is on a scale of 1 to 5. If a record is written as 1/5, relief is 1 and complexity is 5, with the following explanation.

Relief describes average height variation for hard (and soft) benthos transects:

1 = flat (to ankle height)
2 = ankle up to knee height
3 = knee to hip height
4 = hip to shoulder/head height
5 = over head height

Complexity describes average surface variation for substrates (relative to places for animals to find shelter) for hard (and soft) benthos transects:

1 = smooth – no holes or irregularities in substrate
2 = some complexity to the surfaces but generally little

3 = generally complex surface structure
4 = strong complexity in surface structure, with cracks, spaces, holes, etc.
5 = very complex surfaces with lots of spaces, nooks, crannies, under-hangs and caves

Ocean influence (section 2 of form)

1 = riverine, or land-influenced seawater with lots of allochthonous input
2 = seawater with some land influence
3 = ocean and land-influenced seawater
4 = water mostly influenced by oceanic water
5 = oceanic water without land influence

Depth (section 3 of form)

Average depth in metres

Substrate – bird's-eye view of what's there (section 4 of form)

All of section 4 must make up 100%. Percentage substrate is estimated in units of 5% so, e.g. 5, 10, 15, 20 (%) etc. and not 2, 13, 17, 56.

Elements to consider:

Soft substrate	Soft sediment – mud
Soft substrate	Soft sediment – mud and sand
Soft substrate	Soft sediment – sand
Soft substrate	Soft sediment – coarse sand
Hard substrate	Rubble
Hard substrate	Boulders
Hard substrate	Consolidated rubble
Hard substrate	Pavement
Hard substrate	Coral live
Hard substrate	Coral dead

Mud, sand, coarse sand: The sand is not sieved – it is estimated visually and manually. Surveyors can use the 'drop test', where sand drops through the water column and mud stays in suspension. Patchy settled areas of silt/clay/mud in very thin layers on top of coral, pavement, etc. are not listed as soft substrate unless the layer is significant (>a couple of cm).

Rubble is small (<25–30 cm) fragments of coral (reef), pieces of coral stone and limestone debris. AIMS' definition is very similar to that for Reefcheck (found on the 'C-nav' interactive CD): 'pieces of coral (reef) between 0.5 and 15 cm. If smaller, it is sand; if larger, then rock or whatever organism is growing upon it'.

Boulders are detached, big pieces (>30 cm) of stone, coral stone and limestone debris.

Consolidated rubble is attached, cemented pieces of coral stone and limestone debris. We tend to use 'rubble' for pieces or piles loose in the sediment of seagrass, etc., and 'consolidated rubble' for areas that are not flat pavement but concreted rubble on reeftops and cemented talus slopes.

Pavement is solid, substantial, fixed, flat stone (generally limestone) benthos.

Coral live is any live hard coral.

Coral dead is coral that is recognisable as coral even if it is long dead. Note that long-dead and *eroded* coral that is found in flat pavements is called ‘pavement’ and when it is found in loose pieces or blocks it is termed ‘rubble’ or ‘boulders’ (depending on size).

Cover – what is on top of the substrate (section 5 of form)

This cannot exceed 100%, but can be anything from 0 to 100%. Surveyors give scores in blocks of 5%, so e.g. 5, 10, 15, 20 (%) etc. and not 2, 13, 17, 56.

Elements to consider:

Cover	Soft coral
Cover	Sponge
Cover	Fungids
Cover	Crustose-nongeniculate coralline algae
Cover	Coralline algae
Cover	Other (algae like *Sargassum*, *Caulerpa* and *Padina* spp.)
Cover	Seagrass

Soft coral is all soft corals but not Zoanthids or anemones.

Sponge includes half-buried sponges in seagrass beds – only sections seen on the surface are noted.

Fungids are fungids.

Crustose – nongeniculate coralline algae are pink rock. Crustose or nongeniculate coralline algae (NCA) are red algae that deposit calcium carbonate in their cell walls. Generally they are members of the division Rhodophyta.

Coralline algae – halimeda are red coralline algae (often seen in balls – *Galaxaura*). (Note: AIMS lists *halimeda* and other coralline algae as macro algae along with fleshy algae not having $CaCo_3$ deposits.)

Other algae include fleshy algae such as *Turbinaria*, *Padina* and *Dictyota*. Surveyors describe coverage by taking a bird’s-eye view of what is covered, not by delineating the spatial area of the algae colony within the transect (i.e. differences in very low or high density are accounted for). The large space on the form is used to write species information if known.

Seagrass includes seagrass spp. such as *Halodule*, *Thalassia*, *Halophila* and *Syringodium*. Surveyors note types by species if possible or by structure (i.e. flat versus reed grass), and describe coverage by taking a bird’s-eye view of what benthos is covered, not by delineating the spatial area of the grass meadow within the transect (i.e. differences in very low or high density are accounted for).

Cover continued – epiphytes and silt (section 6 of form)

Epiphytes 1–5 grade are mainly turf algae – turf that grows on hard and soft substrates, but also on algae and grasses. The growth is usually fine-stranded filamentous algae that have few noticeable distinguishing features (more like fuzz).

1 = none
2 = small areas or light coverage
3 = patchy, medium coverage
4 = large areas or heavier coverage
5 = very strong coverage, long and thick almost choking epiphytes – normally including strands of blue-green algae as well

Silt 1–5 grade (or a similar fine-structured material sometimes termed 'marine snow') consists of fine particles that slowly settle out from the water but are easily re-suspended. When re-suspended, silt tends to make the water murky and does not settle quickly like sand does. Sand particles are not silt and should not be included here when seen on outer-reef platforms that are wave affected.

1 = clear surfaces
2 = little silt seen
3 = medium amount of silt-covered surfaces
4 = large areas covered in silt
5 = surfaces heavily covered in silt

Bleaching (section 7 of form)

The percentage of bleached live coral is recorded in numbers from 1 to 100% (Not 5% blocks). This is the percentage of benthos that is dying hard coral (just-bleached) or very recently dead hard coral showing obvious signs of recent bleaching.

APPENDIX 2: SOCIOECONOMIC SURVEY DATA

2.1 Wallis socioeconomic survey data

2.1.1 Annual catch (kg) of fish groups per habitat – Vailala
(includes only reported catch data by interviewed finfish fishers)

Vernacular name	Family	Scientific name	Total weight (kg)	% of total catch
Sheltered coastal reef				
Pone	Acanthuridae	*Acanthurus lineatus, Ctenochaetus striatus*	343	14.8
Ika ina	Lethrinidae	*Lethrinus harak*	323	14.0
Palangi	Acanthuridae	*Acanthurus xanthopterus*	306	13.2
Mauli	Acanthuridae	*Acanthurus gahhm*	151	6.5
Kaloama	Mullidae	*Mulloidichthys vanicolensis*	127	5.5
Kuago	Lethrinidae	*Lethrinus xanthochilus*	107	4.6
Matu	-	-	98	4.2
Mu	Lethrinidae	*Monotaxis grandoculis*	75	3.2
Ume	Acanthuridae	*Naso unicornis*	72	3.1
Tau tu	Diodontidae	*Diodon hystrix*	71	3.1
Hiku manunu	Mullidae	*Upeneus vittatus*	68	2.9
Lupo	Carangidae	*Caranx* spp.	65	2.8
Malau	Holocentridae	*Sargocentron spiniferum*	63	2.7
Aua	-	-	62	2.7
Mutu	Serranidae	*Cephalopholis argus*	57	2.5
Nue	Kyphosidae	*Kyphosus vaigiensis*	54	2.3
Toke	-	-	42	1.8
Mama	Acanthuridae	*Acanthurus* spp.	42	1.8
Moamoa	-	-	42	1.8
Homo	Scaridae	*Chlorurus microrhinos, Scarus rubroviolaceus*	33	1.4
Ulafi	Scaridae	*Scarus rubroviolaceus, Scarus globiceps*	32	1.4
Hue	-	-	20	0.9
Taelulu	Lutjanidae	*Lutjanus gibbus*	14	0.6
Kanae	Mugilidae	*Crenimugil crenilabis, Liza vaigiensis*	14	0.6
Ngatala pata	-	-	13	0.5
Manini	Acanthuridae	*Acanthurus triostegus*	12	0.5
Tanutanu	-	-	7	0.3
Total:			**2314**	**100.0**
Outer reef				
Lupo	Carangidae	*Caranx* spp.	972	34.1
Palangi	Acanthuridae	*Acanthurus xanthopterus*	397	13.9
Pone	Acanthuridae	*Acanthurus lineatus, Ctenochaetus striatus*	255	9.0
Perroquet bumphead	Scaridae	*Bolbometopon muricatum*	228	8.0
Saosao	Sphyraenidae	*Sphyraena barracuda*	228	8.0
Ume	Acanthuridae	*Naso unicornis*	152	5.3
Taea	Lutjanidae	*Lutjanus monostigma*	130	4.6
Taua	-	-	130	4.6
Taelulu	Lutjanidae	*Lutjanus gibbus*	109	3.8

2.1.1 Annual catch (kg) of fish groups per habitat – Vailala (continued)
(includes only reported catch data by interviewed finfish fishers)

Vernacular name	Family	Scientific name	Total weight (kg)	% of total catch
Outer reef (continued)				
Kuago	Lethrinidae	*Lethrinus xanthochilus*	65	2.3
Barracuda	Sphyraenidae	*Sphyraena* spp.	65	2.3
Homo	Scaridae	*Chlorurus microrhinos, Scarus rubroviolaceus*	60	2.1
Laea	-	-	60	2.1
Total			**2851**	**100.0**
Sheltered coastal reef & lagoon				
Pone	Acanthuridae	*Acanthurus lineatus, Ctenochaetus striatus*	1696	18.9
Kanae	Mugilidae	*Crenimugil crenilabis, Liza vaigiensis*	1433	16.0
Lupo	Carangidae	*Caranx* spp.	1043	11.6
Palangi	Acanthuridae	*Acanthurus xanthopterus*	858	9.6
Ika ina	Lethrinidae	*Lethrinus harak*	600	6.7
Matu	-	-	424	4.7
Ume	Acanthuridae	*Naso unicornis*	312	3.5
Perroquet bumphead	Scaridae	*Bolbometopon muricatum*	306	3.4
Kafakafa	-	-	273	3.0
Toke	-	-	261	2.9
Kivi	Lutjanidae	*Lutjanus bohar*	240	2.7
Malau	Holocentridae	*Sargocentron spiniferum*	217	2.4
Laokofe	Priacanthidae	*Priacanthus hamrur*	195	2.2
Tomalau	-	-	174	1.9
Kulapo	Lethrinidae	*Gymnocranius euanus*	158	1.8
Ulafi	Scaridae	*Scarus rubroviolaceus, Scarus globiceps*	152	1.7
Kaloama	Mullidae	*Mulloidichthys vanicolensis*	140	1.6
Laea	-	-	87	1.0
Tufilo	-	-	87	1.0
Foafou	-	-	75	0.8
Humu	Balistidae	*Rhinecanthus aculeatus*	46	0.5
Tau tu	Diodontidae	*Diodon hystrix*	43	0.5
Mu	Lethrinidae	*Monotaxis grandoculis*	33	0.4
Matula	-	-	33	0.4
Mutu	Serranidae	*Cephalopholis argus*	25	0.3
Manini	Acanthuridae	*Acanthurus triostegus*	24	0.3
Lolo	Scaridae	*Scarus ghobban*	22	0.2
Tanutanu	-	-	8	0.1
Total:			**8964**	**100.0**
Sheltered coastal reef & lagoon & outer reef				
Hoputu	Lethrinidae	*Lethrinus ornatus*	434	15.6
Kanae	Mugilidae	*Crenimugil crenilabis, Liza vaigiensis*	347	12.5
Laea	-	-	261	9.4
Taelulu	Lutjanidae	*Lutjanus gibbus*	261	9.4
Lupo	Carangidae	*Caranx* spp.	174	6.3
Palangi	Acanthuridae	*Acanthurus xanthopterus*	174	6.3
Mutukau	-	-	174	6.3

2.1.1 Annual catch (kg) of fish groups per habitat – Vailala (continued)
(includes only reported catch data by interviewed finfish fishers)

Vernacular name	Family	Scientific name	Total weight (kg)	% of total catch
Sheltered coastal reef & lagoon & outer reef (continued)				
Koango	-	-	174	6.3
Havane	Lutjanidae	*Lutjanus kasmira*	174	6.3
Kulapo	Lethrinidae	*Gymnocranius euanus*	130	4.7
Pone	Acanthuridae	*Acanthurus lineatus, Ctenochaetus striatus*	87	3.1
Ulafi	Scaridae	*Scarus rubroviolaceus, Scarus globiceps*	87	3.1
Paala	-	-	87	3.1
Mamanu	Scaridae	*Scarus niger*	87	3.1
Mu	Lethrinidae	*Monotaxis grandoculis*	87	3.1
Matula	-	-	43	1.6
Total			**2779**	**100.0**
Lagoon & outer reef				
Mutu	Serranidae	*Cephalopholis argus*	413	15.6
Homo	Scaridae	*Chlorurus microrhinos, Scarus rubroviolaceus*	326	12.3
Gagafu	-	-	326	12.3
Ume	Acanthuridae	*Naso unicornis*	174	6.6
Kanae	Mugilidae	*Crenimugil crenilabis, Liza vaigiensis*	163	6.2
Palangi	Acanthuridae	*Acanthurus xanthopterus*	163	6.2
Taelulu	Lutjanidae	*Lutjanus gibbus*	163	6.2
Kavakava	Lutjanidae	*Lutjanus kasmira*	163	6.2
Papa uola	-	-	157	6.0
Fuaika	Carangidae	*Caranx ignobilis*	107	4.1
Kuago	Lethrinidae	*Lethrinus xanthochilus*	98	3.7
Gutula	Lethrinidae	*Lethrinus miniatus*	98	3.7
Saosao	Sphyraenidae	*Sphyraena barracuda*	65	2.5
Tonu	Serranidae	*Plectropomus leopardus*	50	1.9
Ika ina	Lethrinidae	*Lethrinus harak*	43	1.6
Malau	Holocentridae	*Sargocentron spiniferum*	43	1.6
Mama	Acanthuridae	*Acanthurus* spp.	43	1.6
Mai mai	Coryphaenidae	*Coryphaena hippurus*	43	1.6
Total			**2638**	**100.0**

2.1.2 Annual catch (kg) of fish groups per habitat – Halalo
(includes only reported catch data by interviewed finfish fishers)

Vernacular name	Family	Scientific name	Total weight (kg)	% of total catch
Lagoon				
Gutula	Lethrinidae	*Lethrinus miniatus*	1863	11.8
Fuaika	Carangidae	*Caranx ignobilis*	1772	11.3
Taelulu	Lutjanidae	*Lutjanus gibbus*	1714	10.9
Ume	Acanthuridae	*Naso unicornis*	1238	7.9
Palangi	Acanthuridae	*Acanthurus xanthopterus*	1155	7.3
Ika ina	Lethrinidae	*Lethrinus harak*	1071	6.8
Atule	Carangidae	*Selar crumenophthalmus*	1064	6.8
Homo	Scaridae	*Chlorurus microrhinos, Scarus rubroviolaceus*	975	6.2
Saosao	Sphyraenidae	*Sphyraena barracuda*	456	2.9
Kanae	Mugilidae	*Crenimugil crenilabis, Liza vaigiensis*	437	2.8
Taea	Lutjanidae	*Lutjanus monostigma*	434	2.8
Hoputu	Lethrinidae	*Lethrinus ornatus*	430	2.7
Kaloama	Mullidae	*Mulloidichthys vanicolensis*	321	2.0
Pone	Acanthuridae	*Acanthurus lineatus, Ctenochaetus striatus*	321	2.0
Malau	Holocentridae	*Sargocentron spiniferum*	271	1.7
Moaga	Mullidae	*Parupeneus barberinus*	261	1.7
Nue	Kyphosidae	*Kyphosus vaigiensis*	250	1.6
Kuago	Lethrinidae	*Lethrinus xanthochilus*	241	1.5
Fapuku	Serranidae	*Cephalopholis* spp., *Epinephelus chlorostigma*	228	1.5
Havane	Lutjanidae	*Lutjanus kasmira*	163	1.0
Ahu afi	Serranidae	*Cephalopholis argus*	163	1.0
Tata ila	Lutjanidae	*Lutjanus fulviflamma*	143	0.9
Gutu oaloa	Lethrinidae	*Lethrinus olivaceus*	135	0.9
Hiku manunu	Mullidae	*Upeneus vittatus*	111	0.7
Kulapo	Lethrinidae	*Gymnocranius euanus*	78	0.5
Matu	-	-	59	0.4
Mauli	Acanthuridae	*Acanthurus gahhm*	54	0.3
Mamanu	Scaridae	*Scarus niger*	54	0.3
Katakata	Scombridae	*Scomberomorus commerson*	54	0.3
Mama	Acanthuridae	*Acanthurus* spp.	54	0.3
Utu	Lutjanidae	*Aprion virescens*	43	0.3
Afaafa tai	Labridae	*Cheilinus undulatus*	35	0.2
Ava uta	Chanidae	*Chanos chanos*	35	0.2
Humu	Balistidae	*Rhinecanthus aculeatus*	29	0.2
Kavakava	Lutjanidae	*Lutjanus kasmira*	8	0.1
Total:			**15,721**	**100.0**

2.1.2 Annual catch (kg) of fish groups per habitat – Halalo (continued)
(includes only reported catch data by interviewed finfish fishers)

Vernacular name	Family	Scientific name	Total weight (kg)	% of total catch
Passage				
Saosao	Sphyraenidae	*Sphyraena barracuda*	1260	16.1
Fuaika	Carangidae	*Caranx ignobilis*	1217	15.6
Taelulu	Lutjanidae	*Lutjanus gibbus*	860	11.0
Hoputu	Lethrinidae	*Lethrinus ornatus*	851	10.9
Gutula	Lethrinidae	*Lethrinus miniatus*	781	10.0
Kuago	Lethrinidae	*Lethrinus xanthochilus*	557	7.1
Havane	Lutjanidae	*Lutjanus kasmira*	454	5.8
Ika ina	Lethrinidae	*Lethrinus harak*	277	3.5
Kalolo	-	-	210	2.7
Gutu oaloa	Lethrinidae	*Lethrinus olivaceus*	177	2.3
Tata ila	Lutjanidae	*Lutjanus fulviflamma*	175	2.2
Mutu	Serranidae	*Cephalopholis argus*	152	1.9
Kivi	Lutjanidae	*Lutjanus bohar*	152	1.9
Palangi	Acanthuridae	*Acanthurus xanthopterus*	121	1.5
Malau	Holocentridae	*Sargocentron spiniferum*	110	1.4
Pone	Acanthuridae	*Acanthurus lineatus, Ctenochaetus striatus*	105	1.3
Tau tu	Diodontidae	*Diodon hystrix*	105	1.3
Anga	Carcharhinidae	*Carcharhinus* spp.	93	1.2
Taea	Lutjanidae	*Lutjanus monostigma*	70	0.9
Fapuku	Serranidae	*Cephalopholis* spp., *Epinephelus chlorostigma*	52	0.7
Ahu afi	Serranidae	*Cephalopholis argus*	26	0.3
Ume	Acanthuridae	*Naso unicornis*	12	0.2
Utu	Lutjanidae	*Aprion virescens*	7	0.1
Total:			**7823**	**100.0**

2.1.3 Invertebrate species caught by habitat type and weight – Vailala
(% of total annual wet weight caught)

Fishery	Vernacular name	Scientific name	% annual catch (weight)	Reported		Extrapolated	
				no/year	kg/year	no/year	kg/year
Lobster	Lobster	*Panulirus* spp.	100.0	1671	1671	7310	7310
Reeftop	Troca	*Trochus niloticus*	71.7	2249	450	6176.7	1235.3
	Funafuna	*Bohadschia argus*	22.1	300	139	818	378
	Giant clam	*Tridacna maxima*	5.2	65	33	654	327
	Octopus	*Octopus* spp.	0.9		0	27	15
	Kaloa (1)	*Anadara* spp.	0.1	30		(1)	(1)
	Kalea (1)	*Strombus gibberulus gibbosus*	0.0	10		(1)	(1)
Intertidal	Pule	*Cypraea* spp.	94.3	5943	565	16,326	1551
	Kalea	*Strombus gibberulus gibbosus*	3.3	800	20	2326	58
	Ahule	*Atactodea striata, Donax cuneatus*	0.8	1817	5	4956	14
	Pueki	-	0.8	1999	5	5570	14
	Kaloa	*Anadara* spp.	0.3	97	2	373	8
	Too	*Gafrarium pectinatum, Gafrarium tumidum*	0.3	97	2	383	8
Intertidal & reeftop	Pule	*Cypraea* spp.	56.4	43		(2)	(2)
	Kalea	*Strombus gibberulus gibbosus*	14.8	43		(2)	(2)
	Hopu	*Chama* spp.	14.8	43	1	118	3
	Too	*Gafrarium pectinatum, Gafrarium tumidum*	12.5	43		(2)	(2)
	Pueki	-	1.5	43		(2)	(2)
Soft benthos & intertidal & reeftop	Giant clam	*Tridacna maxima*	99.8	175		(2)	(2)
	Kaloa	*Anadara* spp.	0.2	10		(2)	(2)
	Lomu	-		275		750	
Trochus	Troca	*Trochus niloticus*	100.0	10		(2)	(2)

(1) Quantities and numbers extrapolated are summarised under 'intertidal' fishery data; (2) Quantities and numbers extrapolated are summarised under single fisheries data.

2.1.4 Invertebrate species caught by habitat type and weight – Halalo
(% of total annual wet weight caught)

Fishery	Vernacular name	Scientific name	% annual catch (weight)	Reported		Extrapolated	
				no/year	kg/year	no/year	kg/year
Other	Giant clam	*Tridacna maxima*	50.0	239	119	1060	530
	Octopus	*Octopus* spp.	50.0	217	119	926	509
Reeftop	Giant clam (1)	*Tridacna maxima*	78.5	8	4	(1)	(1)
	Hopu	*Chama* spp.	21.5	43	1	799	20
Intertidal (sand)	Tolitoli	*Scylla serrata, Scylla serrata*	63.5	810	567	3477	2434
	Tupa	*Cardisoma* spp.	13.6	533	121	2801	638
	Kaloa	*Anadara* spp.	13.3	5654	119	28,666	602
	Too	*Gafrarium pectinatum, Gafrarium tumidum*	5.6	2393	50	13,144	276
	Pule	*Cypraea* spp.	1.5	1837	174	762	72
	Kalea	*Strombus gibberulus gibbosus*	0.6	232	6	1218	30
	Ahule	*Atactodea striata, Donax cuneatus*	0.6	2062	6	10,834	30
	Pueki	-	0.6	2162	5	11,359	28
	Petit pule	*Cypraea* spp.	0.5	145	0	9653	24
	Tava	*Periglypta* spp., *Spondylus* spp.	0.0	20	0	105	2
	Tui	-		125		656	
Intertidal (sand) & reeftop	Hopu	*Chama* spp.	37.3	109		(2)	(2)
	Kaloa	*Anadara* spp.	31.3	109		(2)	(2)
	Too	*Gafrarium pectinatum, Gafrarium tumidum*	31.3	109		(2)	(2)
Trochus	Keli kao	*Trochus niloticus*	100.0	7600	1515	32,409	6462

(1) Quantities and numbers extrapolated are summarised under 'intertidal' fishery data; (2) Quantities and numbers extrapolated are summarised under single fisheries data.

2.1.5 Average invertebrate length-frequency distribution – Vailala
(% of total annual catch weight)

Vernacular name	Scientific name	Size class	% of total catch (weight)
Ahule	*Atactodea striata, Donax cuneatus,*	01-02 cm	100.0
Funafuna	*Bohadschia argus*	20 cm	100.0
Giant clam	*Tridacna maxima*	14-26 cm	12.5
		18 cm	14.6
		22-24 cm	72.9
Hopu	*Chama* spp.	04 cm	100.0
Kalea	*Strombus gibberulus gibbosus*	04 cm	6.3
		06-08 cm	93.7
Kaloa	*Anadara* spp.	04-08 cm	21.9
		06 cm	70.8
		06-08 cm	7.3
Lobster	*Panulirus penicillatus, Panulirus* spp., *Panulirus versicolor*	20-24 cm	50.7
		20-28 cm	23.3
		24-26 cm	26.0
Lomu	-	10-12 cm	
Octopus	*Octopus* spp.	10 cm	100.0
Pueki		01-02 cm	100.0
Pule	*Cypraea* spp.	01-02 cm	13.6
		02 cm	76.4
		06-08 cm	10.0
Too	*Gafrarium pectinatum, Gafrarium tumidum*	02 cm	61.9
		02-04 cm	31.0
		04 cm	7.1
Troca	*Trochus niloticus*	08-10 cm	99.6
		08-12 cm	0.4

2.1.6 Average invertebrate length-frequency distribution – Halalo
(% of total annual catch weight)

Vernacular name	Scientific name	Size class	% of total catch (weight)
Ahule	*Atactodea striata, Donax cuneatus*	01 cm	100.0
Giant clam	*Tridacna maxima*	06 cm	1.0
		16-28 cm	2.2
		20-28 cm	96.8
Hopu	*Chama* spp.	08 cm	100.0
Kalea	*Strombus gibberulus gibbosus*	01-02 cm	53.9
		02 cm	8.6
		06 cm	37.5
Kaloa	*Anadara* spp.	02-06 cm	1.5
		02-08 cm	1.2
		04 cm	1.6
		06 cm	38.6
		06-08 cm	56.5
		08 cm	0.2
		10 cm	0.4
Keli kao	*Trochus niloticus*	10-14 cm	100.0
Octopus	*Octopus* spp.	10 cm	100.0
Petit pule	*Cypraea* spp.	01 cm	100.0
Pueki	-	01 cm	100.0
Pule	*Cypraea* spp.	01 cm	86.2
		08 cm	13.8
Tava	*Periglypta spp., Spondylus* spp.	04-06 cm	100.0
Tolitoli	*Scylla serrata*	14 cm	7.4
		14-16 cm	92.6
Too	*Gafrarium pectinatum, Gafrarium tumidum*	02 cm	11.3
		02-04 cm	0.8
		04 cm	8.5
		04-06 cm	79.4
Tui	-	01 cm	
Tupa	*Cardisoma* spp.	06-08 cm	100.0

2.1.7 Governmental fisheries regulations in Wallis and Futuna

RÉGLEMENTATIONS RÉGISSANT LA PÊCHE À WALLIS ET FUTUNA

PÊCHE EN PLONGEE - Arrêté n° 94-202 du 1er juillet 1994

La pêche sous-marine se pratique en nageant en surface ou en plongée.

Il est interdit de pratiquer la pêche sous-marine à l'aide d'un équipement, autonome ou non, permettant à une personne immergée de respirer sans revenir à la surface.

Il est rappelé que le ramassage des coquillages constitue un acte de pêche.

<u>La pêche sous-marine est interdite de nuit, entre le coucher et le lever du soleil.</u>

Ne sont autorisés que les appareils destinés à tuer directement ou indirectement les animaux marins, ne faisant pas appel à l'utilisation du pouvoir détonant d'un mélange chimique ou à la détente d'un gaz comprimé.

Il est interdit de détenir simultanément à bord d'un bateau un engin de pêche sous-marine et un appareil permettant à une personne immergée de respirer sans revenir à la surface.

Il est interdit aux pêcheurs sous-marins :
- de s'approcher à moins de cent cinquante mètres (150 m) des établissements de culture marine et des filets et engins de pêche balisés;
- de capturer les animaux marins pris dans les filets posés par d'autres pêcheurs.

UTILISATION DES FILETS - Arrêté n° 94-199 du 1er juillet 1994

Quelle qu'en soit la nature, les parties en filets des engins de pêche, à l'exception des éperviers et nasses, ne doivent comporter aucun maillage inférieur à quarante cinq millimètres (45 mm).

La vente de filet de maillage inférieur à 45 mm est interdite.

La longueur totale installée des filets dormants (temporairement calés ou ancrés) ou dérivants ne peuvent excéder deux cent cinquante mètres (250 m).
Les filets dormants ou dérivants doivent être signalés au moyen de flotteurs à leurs deux extrémités.

Les arts traînants, c'est-à-dire les filets ou dragues qui sont traînés par un moyen mécanique sur le fond de la mer ou entre deux eaux ne peuvent être utilisées à l'intérieur du lagon.

Des dérogations à cette interdiction pourront être accordées pour des motifs scientifiques.

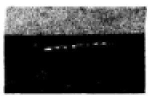
CRUSTACES - Arrêté n° 94-203 du 1er juillet 1994

Est interdite la pêche de spécimens de langoustes ("uo") (toutes espèces de la famille des Palinuridés) dont la dimension, mesurée du niveau des yeux (entre la base des épines supraorbitales) à l'arrière de la tête (à l'extrémité postérieure du céphalothorax), est inférieure à soixante quinze millimètres.

Est interdite la pêche de spécimens de langoustes ("uo") (toutes espèces de la famille des Palinuridés) porteuses d'oeufs (grainées).

Est interdite la capture de spécimens de crabe de cocotier ("uu") (*Birgus latro*) en période de mue (carapace molle), dont la longueur du thorax est inférieure à trente six millimètres (36 mm), ou porteurs d'oeufs, ou dont l'abdomen est de couleur orange.

PÊCHE AUTOUR DES DCP - Arrêté n° 94-201 du 1er juillet 1994



Il est interdit d'amarrer une embarcation ou une ligne à une bouée de DCP.

En cas de pêche à la palangre verticale ou horizontale, il est interdit de poser la ligne dans le sens du courant en amont du DCP.

Il est interdit de pêcher à la traîne à moins de cinquante mètres (50 m) d'un DCP.

EXPLOSIFS, NARCOTIQUES, BARRE A MINE... - Arrêté n° 94-200 du 1er juillet 1994

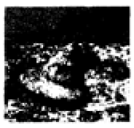
Il est interdit d'utiliser des substances explosives en vue de tuer, effrayer ou paralyser les animaux marins.

La détention à bord de toute embarcation de substance explosive est interdite.

Il est interdit l'usage de barre à mine, pioche ou tout outil ou engin susceptible de bouleverser l'habitat de la faune marine.

Il est interdit d'utiliser toute substance naturelle ou artificielle susceptible de détruire, enivrer, endormir, ou paralyser les animaux marins.

TROCAS - Arrêté n° 94-204 du 1er juillet 1994 (Service de la pêche)



Est interdite l'exploitation des trocas (*Trochus niloticus*) dont le plus grand diamètre est inférieur à neuf centimètres (9 cm) ou supérieur à douze centimètres (12 cm).

Toute personne pratiquant la pêche des Trocas doit disposer sur les lieux de pêche d'une jauge présentant deux anneaux rigides de neuf et douze centimètres de diamètre intérieur pour être en mesure d'appliquer la règle de l'article précédent. Les Trocas qui ne passent pas dans l'anneau de douze centimètres et ceux qui passent dans l'anneau de neuf centimètres doivent être immédiatement rejetés à la mer sur les lieux de pêche

L'exportation de coquilles de Trocas est soumise à autorisation délivrée annuellement par le chef du service de la pêche.

Délibération n° 31/AT/2003 du 8 juillet 2003 - Arrêté n° 2003-195 du 24 juillet 2003 (Service de l'Environnement)

Tout prélèvement d'organismes [...] destinés à l'exportation est soumise à autorisation administrative. La demande d'autorisation est examinée par le Service de l'Environnement qui émet alors tous avis, observations et recommandations jugés nécessaires.

SANCTIONS
Délibération n°38/CP/94 du 7 juin 1994

Les infractions aux dispositions de la présente réglementation relatives aux engins, équipements et moyens de pêche interdits sont punies des peines prévues pour les contraventions de quatrième catégorie (10 908 à 21 816 CFP) et, en cas de récidive, de cinquième catégorie (21 816 à 54 540 CFP).

Les produits pêchés, transportés, détenus ou commercialisés en infraction aux dispositions de la présente réglementation sont saisis et rejetés à la mer, détruits ou remis contre décharge à des établissements sociaux et de bienfaisance ou à des personnes nécessiteuses. Les produits pêchés à l'aide de substances interdites ne peuvent faire l'objet que d'un rejet à la mer ou d'une destruction.

En cas d'infraction aux disposition de la présente réglementation relative aux engins, équipements ou substances dont l'utilisation est interdite, lesdits engins, équipements et substances, les embarcations et tous les moyens ayant servi à transporter lesdits engins, équipements ou substances (bateau - remorque - véhicule), à se rendre sur les lieux de l'infraction ou à s'en éloigner sont confisqués.

2.2 Futuna socioeconomic survey data

2.2.1 Autorités Coutumières – Futuna

SIGAVE

Tuisioa Roi de SIGAVE (Visei MOELIKU)
Saakafu Suppléant du roi (Simione MANUOHALALO)

LEAVA	NUKU	VAISEI	FIUA	TOLOKE	TAVAI
Safeitoga	Kaifakaula Premier Ministre	Saatula	Manafa	Tuitoloke	
Fololiano TAKALA (Santé)	(Enseignement)	(Soane KAIKILEKOFE) (Agriculture)	Polikalepo KOLIVAI (Affaires Culturelles)	Mikaele KELETOLONA (Voirie)	
SAFEISAU 'Léava' (Lafaele LAVASELE)	TUISAAVAKA 'Nuku' (Sufenale TAUGAMOA)	SEALEU 'Vaisei' (Lenisio NIUHINA)	MOETOTO 'Fiua' (Amasio KAUVAITUPU)	UFIGAKI 'Toloke' (Soane Malia TUUGAHALA)	TAPEA 'Tavai' (Peato LAKINA)
			MATA'TGATA 'Fiua' (Soane LUAKI) (Maître de cérémonie)		

ALO

Tuiagaifo Roi d'ALO (Soane Patita MAITUKU)
Saakafu Suppléant du roi (Kamilo TUFELE)

TAOA	MALAE	ONO	KOLIA	ALOFI
Tiafoi Premier Ministre	Saatula	Tuiasoa	Tuisaavaka	Vakalasi
Lukano MATAELE (Santé)	Sétéfano TAKANIKO (Sports/Agriculture)	Atonio KATEA (Affaires Culturelles)	Petelo SAVEA (Enseignement)	Kilisitofo SAVEA (Voirie)
FAINUMAUMAU 'Taoa' (Personne pour l'instant)	SAFEITOGA 'Tamana' (Manuele TAKANIKO)	MAUIFA (Malesilino LATAI)	FAINUMALAFU 'Kolia village' (Sosefo MOEFANA)	MANIULUA 'Alofi' (Patita MATAILA)
SAAGOGO 'Taoa' Ipasio MASEI	SAFEISAU 'Malae village' (Sokini TAKASI)	FAINUVELE 'Ono Village' (Sanualio LELEIVAI)	FAINUAVA 'Poi' Soane Malia KELETOLONA	
MATA'TGATA 'Fiua' Kusito NIULIKI (Maître de cérémonie)				

2.2.2 Annual catch (kg) of fish groups per habitat – Futuna
(includes only reported catch data by interviewed finfish fishers)

Vernacular name	Family	Scientific name	Total weight (kg)	% of total catch
Sheltered coastal reef				
Kanae	Mugilidae	*Crenimugil crenilabis, Liza vaigiensis*	2404	11.9
Ume	Acanthuridae	*Naso unicornis*	2200	10.9
Malau	Holocentridae	*Sargocentron spiniferum*	1217	6.0
Manini	Acanthuridae	*Acanthurus triostegus*	1215	6.0
Nue	Kyphosidae	*Kyphosus vaigiensis*	1039	5.2
Atule	Carangidae	*Selar crumenophthalmus*	870	4.3
Fuaika	Carangidae	*Caranx ignobilis*	690	3.4
Palangi	Acanthuridae	*Acanthurus xanthopterus*	733	3.6
Homo	Scaridae	*Chlorurus microrhinos, Scarus rubroviolaceus*	627	3.1
Matula	-	-	592	2.9
Nefu	Serranidae	*Epinephelus howlandi, Epinephelus spp., Epinephelus fuscoguttatus, Epinephelus melanostigma*	576	2.9
Pone	Acanthuridae	*Acanthurus lineatus, Ctenochaetus striatus*	557	2.8
Gagafu	-	-	520	2.6
Tangau	Lutjanidae	*Lutjanus fulvus*	490	2.4
Kalomaki	-	-	461	2.3
Api	Acanthuridae	*Acanthurus guttatus*	444	2.2
Lufilufi	-	-	439	2.2
Kaloama	Mullidae	*Mulloidichthys vanicolensis*	407	2.0
Maa	-	-	383	1.9
Fangamea	Lutjanidae	*Lutjanus bohar*	356	1.8
Moaga	Mullidae	*Parupeneus barberinus*	326	1.6
Tina mataele	-	-	310	1.5
Papa uola	-	-	308	1.5
Lapelape	-	-	254	1.3
Mu	Lethrinidae	*Monotaxis grandoculis*	249	1.2
Alogo	-	-	139	0.7
Laea	-	-	55	0.3
Ika ina	Lethrinidae	*Lethrinus harak*	0	0.0
Mataele	Serranidae	*Cephalopholis* spp.	206	1.0
Ulutuki	Serranidae	*Epinephelus septemfasciatus*	184	0.9
Gutu oaloa	Lethrinidae	*Lethrinus olivaceus*	0	0.0
Tangafa	-	-	166	0.8
Koapi	-	-	154	0.8
Mafole	Carangidae	*Ulua aurochs*	152	0.8
Telekisi	-	-	148	0.7
Lape	-	-	126	0.6
Lolo	Scaridae	*Scarus ghobban*	126	0.6
Manoko	-	-	111	0.6
Mutu	Serranidae	*Cephalopholis argus*	108	0.5
Kolo	-	-	100	0.5
Mutumutu	-	-	92	0.5
Manifi	-	-	92	0.5
Magau	-	-	86	0.4

2.2.2 Total annual weight (kg) of fish groups per habitat – Futuna (continued)
(includes only reported catch data by interviewed finfish fishers)

Vernacular name	Family	Scientific name	Total weight (kg)	% of total catch
Sheltered coastal reef (continued)				
Gutula	Lethrinidae	*Lethrinus miniatus*	83	0.4
Utu	Lutjanidae	*Aprion virescens*	83	0.4
Umu	-	-	57	0.3
Tafiti	-	-	45	0.2
Pusi	-	-	45	0.2
Tata ila	Lutjanidae	*Lutjanus fulviflamma*	28	0.1
Aua	-	-	27	0.1
Aku	Belonidae	*Tylosurus crocodilus crocodilus*	26	0.1
Moapi	-	-	19	0.1
Nokotale	-	-	14	0.1
Laokofe	Priacanthidae	*Priacanthus hamrur*	5	0.0
Veve	-	-	5	0.0
Ufu	-	-	3	0.0
Sumu	-	-	1	0.0
Ngatata	Serranidae	*Epinephelus merra*	1	0.0
Masunu	-	-	1	0.0
Total:			**20,155**	**100.0**
Outer reef				
Fuaika	Carangidae	*Caranx ignobilis*	782	36.7
Malau	Holocentridae	*Sargocentron spiniferum*	217	10.2
Nefu	Serranidae	*Epinephelus howlandi*, *Epinephelus* spp., *Epinephelus fuscoguttatus*, *Epinephelus melanostigma*	217	10.2
Alogo	-	-	217	10.2
Laea	-	-	217	10.2
Ika ina	Lethrinidae	*Lethrinus harak*	217	10.2
Gutu oaloa	Lethrinidae	*Lethrinus olivaceus*	174	8.2
Tina mataele	-	-	87	4.1
Total:			**2128**	**100.0**

2.2.3 Invertebrate species caught by habitat type and weight – Futuna
(% of total annual wet weight caught)

Fishery	Vernacular name	Scientific name	% annual catch (weight)	Reported		Extrapolated	
				no/year	kg/year	no/year	kg/year
Lobster	Lobster	*Panulirus* spp.	97.0	3685	3685	78,095	78,095
	Polu polu	*Carpilius maculatus*	3.0	326	114	5463	1912
Other	Giant clam (2)	*Tridacna maxima*	98.4	2454	1227	238,380	119,190
	Lobster (1)	*Panulirus* spp.	1.6	20		(1)	(1)
Reeftop	Giant clam	*Tridacna maxima*	54.9	11,368	5684	(2)	(2)
	Keli kao	*Trochus niloticus*	19.9	10,322	2064	29,135	5827
	Alili	*Turbo crassus*	4.5	5863	469	99,827	7986
	Fu	*Conus litteratus*	4.5	1954	469	33,362	8007
	Petit pule	*Cypraea* spp.	4.4	181,718	454	3102,177	7755
	Octopus	*Octopus* spp.	3.7	690	380	11,779	6478
	Muli loa	*Cerithium nodulosum*	2.0	869	208	14,828	3559
	Funafuna	*Bohadschia argus*	1.9	434	201	7,414	3429
	Pule uli (noir)	-	1.7	71,631	179	1222,845	3057
	Mataalaala	*Cassis cornuta, Thais aculeata*	1.3	6601	132	112,691	2254
	Pueki	-	1.1	44,928	112	766,981	1918
	Ahule	*Atactodea striata, Donax cuneatus*	0.0	217	1	3707	10
Trochus	Keli kao	*Trochus niloticus*	100.0	8686	1737	324,575	64,915
Trochus & lobster	Lobster	*Panulirus* spp.	83.3	300	300	(3)	(3)
	Keli kao	*Trochus niloticus*	16.7	300	1499	(3)	(3)
Trochus & lobster & other	Lobster	*Panulirus* spp.	60.6	651	651	(3)	(3)
	Keli kao	*Trochus niloticus*	30.3			(3)	(3)
	Giant clam	*Tridacna maxima*	9.1	195	98	(3)	(3)
	Trochus	*Trochus niloticus*	0.3	1629	326	(3)	(3)

(1) Quantities and numbers extrapolated are summarised under 'lobster' fishery data; (2) Quantities and numbers extrapolated are summarised under 'other' fishery data; (3) Quantities and numbers extrapolated are accommodated under single fisheries.

2.2.4 Average invertebrate length-frequency distribution – Futuna
(% of total annual catch weight)

Vernacular name	Scientific name	Size class	% of total catch (weight)
Ahule	*Atactodea striata, Donax cuneatus*	04-06 cm	100.0
Alili	*Turbo crassus*	04-06 cm	29.6
		06-08 cm	44.4
		06-10 cm	25.9
Fu	*Conus litteratus*	02-04 cm	66.7
		04-08 cm	33.3
Funafuna	*Bohadschia argus*	06-08 cm	100.0
Giant clam	*Tridacna maxima*	04 cm	4.3
		04-06 cm	1.5
		04-08 cm	24.8
		06 cm	19.3
		06-08 cm	13.8
		06-10 cm	9.3
		08 cm	3.1
		08-10 cm	0.3
		10 cm	3.1
		14-16 cm	1.5
		16-18 cm	1.4
		20-28 cm	13.9
		22-24 cm	0.7
		24 cm	1.4
		24-28 cm	1.4
Keli kao	*Trochus niloticus*	04-08 cm	4.5
		06 cm	4.5
		06-08 cm	14.7
		06-10 cm	4.5
		08 cm	1.2
		10 cm	15.3
		10-12 cm	53.7
		12 cm	1.6
Lobster	*Panulirus penicillatus, Panulirus* spp., *Panulirus versicolor*	16-18 cm	0.4
		18-22 cm	1.4
		18-26 cm	21.5
		20-22 cm	6.5
		20-24 cm	24.5
		20-28 cm	28.0
		22 cm	4.3
		26-28 cm	13.4
Mataalaala	*Cassis cornuta, Thais aculeata*	02-04 cm	26.3
		04 cm	26.3
		04-08 cm	19.7
		06 cm	19.7
		06-08 cm	7.9
Muli loa	*Cerithium nodulosum*	04-06 cm	100.0

2.2.4. Average invertebrate length-frequency distribution – Futuna (continued)
(% of total annual catch weight)

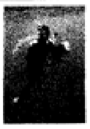
Vernacular name	Scientific name	Size class	% of total catch (weight)
Octopus	*Octopus* spp.	04-06 cm	18.9
		10 cm	15.8
		10-12 cm	18.9
		14 cm	28.3
		16 cm	18.1
Petit pule	*Cypraea* spp.	01 cm	71.9
		01-02 cm	17.3
		02 cm	10.8
Polu polu	*Carpilius maculatus*	08-10 cm	100.0
Pueki	-	01 cm	17.8
		02 cm	82.2
Pule uli (noir)	-	02 cm	3.4
		02-04 cm	25.8
		02-06 cm	17.9
		02-08 cm	43.9
		04-06 cm	4.3
		04-08 cm	1.4
		06 cm	2.4
		06-08 cm	0.9
Troca	*Trochus niloticus*	06-10 cm	100.0

2.2.5 Women's Federations on Futuna

Noms des villages D'ALO	Noms des Associations artisanales des femmes d'ALO	Noms des villages de SIGAVE	Noms des Associations des femmes artisanales et pêche de SIGAVE
1. TAOA	Fédérations des femmes artisanales D'ALO	1. LEAVA	Fédérations des femmes artisanales de SIGAVE
2. MALAE	Coopérative LAGAFENFUA	2. NUKU	VAIOFO SIGAVE
3. ONO	VAOFO ALO	3. VAISEI	FEMMES DE LEAVA (Pêche au 'Atule')
4. KOLIA		4. FIUA	
5. ALOFI		5. TOLOKE	
		6. TAVAI	

2.2.6 Governmental fisheries regulations in Wallis and Futuna

RÉGLEMENTATIONS RÉGISSANT LA PÊCHE À WALLIS ET FUTUNA



PÊCHE EN PLONGEE - Arrêté n° 94-202 du 1er juillet 1994

La pêche sous-marine se pratique en nageant en surface ou en plongée.

Il est interdit de pratiquer la pêche sous-marine à l'aide d'un équipement, autonome ou non, permettant à une personne immergée de respirer sans revenir à la surface.

Il est rappelé que le ramassage des coquillages constitue un acte de pêche.

La pêche sous-marine est interdite de nuit, entre le coucher et le lever du soleil.

Ne sont autorisés que les appareils destinés à tuer directement ou indirectement les animaux marins, ne faisant pas appel à l'utilisation du pouvoir détonant d'un mélange chimique ou à la détente d'un gaz comprimé.

Il est interdit de détenir simultanément à bord d'un bateau un engin de pêche sous-marine et un appareil permettant à une personne immergée de respirer sans revenir à la surface.

Il est interdit aux pêcheurs sous-marins :
- de s'approcher à moins de cent cinquante mètres (150 m) des établissements de culture marine et des filets et engins de pêche balisés;
- de capturer les animaux marins pris dans les filets posés par d'autres pêcheurs.

UTILISATION DES FILETS - Arrêté n° 94-199 du 1er juillet 1994

Quelle qu'en soit la nature, les parties en filets des engins de pêche, à l'exception des éperviers et nasses, ne doivent comporter aucun maillage inférieur à quarante cinq millimètres (45 mm).

La vente de filet de maillage inférieur à 45 mm est interdite.

La longueur totale installée des filets dormants (temporairement calés ou ancrés) ou dérivants ne peuvent excéder deux cent cinquante mètres (250 m).
Les filets dormants ou dérivants doivent être signalés au moyen de flotteurs à leurs deux extrémités.

Les arts traînants, c'est-à-dire les filets ou dragues qui sont traînés par un moyen mécanique sur le fond de la mer ou entre deux eaux ne peuvent être utilisées à l'intérieur du lagon.

Des dérogations à cette interdiction pourront être accordées pour des motifs scientifiques.

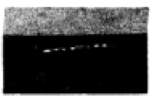
CRUSTACES - Arrêté n° 94-203 du 1er juillet 1994

Est interdite la pêche de spécimens de langoustes ("uo") (toutes espèces de la famille des Palinuridés) dont la dimension, mesurée du niveau des yeux (entre la base des épines supraorbitales) à l'arrière de la tête (à l'extrémité postérieure du céphalothorax), est inférieure à soixante quinze millimètres.

Est interdite la pêche de spécimens de langoustes ("uo") (toutes espèces de la famille des Palinuridés) porteuses d'oeufs (grainées).

Est interdite la capture de spécimens de crabe de cocotier ("uu") (*Birgus latro*) en période de mue (carapace molle), dont la longueur du thorax est inférieure à trente six millimètres (36 mm), ou porteurs d'oeufs, ou dont l'abdomen est de couleur orange.

PÊCHE AUTOUR DES DCP - Arrêté n° 94-201 du 1er juillet 1994



Il est interdit d'amarrer une embarcation ou une ligne à une bouée de DCP.

En cas de pêche à la palangre verticale ou horizontale, il est interdit de poser la ligne dans le sens du courant en amont du DCP.

Il est interdit de pêcher à la traîne à moins de cinquante mètres (50 m) d'un DCP.

EXPLOSIFS, NARCOTIQUES, BARRE A MINE... - Arrêté n° 94-200 du 1er juillet 1994

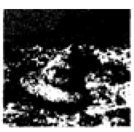
Il est interdit d'utiliser des substances explosives en vue de tuer, effrayer ou paralyser les animaux marins.

La détention à bord de toute embarcation de substance explosive est interdite.

Il est interdit l'usage de barre à mine, pioche ou tout outil ou engin susceptible de bouleverser l'habitat de la faune marine.

Il est interdit d'utiliser toute substance naturelle ou artificielle susceptible de détruire, enivrer, endormir, ou paralyser les animaux marins.

TROCAS - Arrêté n° 94-204 du 1er juillet 1994 (Service de la pêche)



Est interdite l'exploitation des trocas (*Trochus niloticus*) dont le plus grand diamètre est inférieur à neuf centimètres (9 cm) ou supérieur à douze centimètres (12 cm).

Toute personne pratiquant la pêche des Trocas doit disposer sur les lieux de pêche d'une jauge présentant deux anneaux rigides de neuf et douze centimètres de diamètre intérieur pour être en mesure d'appliquer la règle de l'article précédent. Les Trocas qui ne passent pas dans l'anneau de douze centimètres et ceux qui passent dans l'anneau de neuf centimètres doivent être immédiatement rejetés à la mer sur les lieux de pêche

L'exportation de coquilles de Trocas est soumise à autorisation délivrée annuellement par le chef du service de la pêche.

Délibération n° 31/AT/2003 du 8 juillet 2003 - Arrêté n° 2003-195 du 24 juillet 2003 (Service de l'Environnement)

Tout prélèvement d'organismes [...] destinés à l'exportation est soumise à autorisation administrative. La demande d'autorisation est examinée par le Service de l'Environnement qui émet alors tous avis, observations et recommandations jugés nécessaires.

SANCTIONS
Délibération n°38/CP/94 du 7 juin 1994

Les infractions aux dispositions de la présente réglementation relatives aux engins, équipements et moyens de pêche interdits sont punies des peines prévues pour les contraventions de quatrième catégorie (10 908 à 21 816 CFP) et, en cas de récidive, de cinquième catégorie (21 816 à 54 540 CFP).

Les produits pêchés, transportés, détenus ou commercialisés en infraction aux dispositions de la présente réglementation sont saisis et rejetés à la mer, détruits ou remis contre décharge à des établissements sociaux et de bienfaisance ou à des personnes nécessiteuses. Les produits pêchés à l'aide de substances interdites ne peuvent faire l'objet que d'un rejet à la mer ou d'une destruction.

En cas d'infraction aux disposition de la présente réglementation relative aux engins, équipements ou substances dont l'utilisation est interdite, lesdits engins, équipements et substances, les embarcations et tous les moyens ayant servi à transporter lesdits engins, équipements ou substances (bateau - remorque - véhicule), à se rendre sur les lieux de l'infraction ou à s'en éloigner sont confisqués.

APPENDIX 3: FINFISH SURVEY DATA

3.1 Vailala finfish survey data

3.1.1 Coordinates (WGS84) of the 22 D-UVC transects used to assess finfish resource status in Vailala

Station name	Habitat	Latitude	Longitude
TRA06	Outer reef	13º17'33.18 S	176º16'02.28 W
TRA07	Back-reef	13º16'23.4012 S	176º15'45.36 W
TRA08	Back-reef	13º17'13.74 S	176º15'39.8988 W
TRA09	Outer reef	13º12'45.18 S	176º14'47.76 W
TRA10	Outer reef	13º12'45.18 S	176º14'47.76 W
TRA11	Back-reef	13º14'45.3588 S	176º15'10.98 W
TRA12	Lagoon	13º15'43.8588 S	176º14'48.66 W
TRA17	Outer reef	13º16'11.82 S	176º07'41.7 W
TRA18	Outer reef	13º16'11.82 S	176º07'41.7 W
TRA19	Outer reef	13º11'13.4988 S	176º11'30.1812 W
TRA20	Coastal reef	13º15'40.5 S	176º14'04.4412 W
TRA21	Coastal reef	13º15'06.4188 S	176º14'18.5388 W
TRA22	Back-reef	13º11'27.24 S	176º12'50.6412 W
TRA23	Lagoon	13º12'15.3612 S	176º12'04.5 W
TRA24	Coastal reef	13º14'21.0012 S	176º14'00.7188 W
TRA25	Coastal reef	13º13'41.16 S	176º13'54.2388 W
TRA26	Lagoon	13º14'11.8212 S	176º14'32.0388 W
TRA27	Lagoon	13º12'25.8588 S	176º12'18.54 W
TRA35	Coastal reef	13º17'17.0412 S	176º10'14.0412 W
TRA41	Lagoon	13º14'45.06 S	176º09'29.16 W
TRA42	Back-reef	13º15'52.6212 S	176º08'14.9388 W
TRA48	Outer reef	13º11'13.4988 S	176º11'30.1812 W

3.1.2 Weighted average density and biomass of all finfish species recorded in Vailala (using distance-sampling underwater visual censuses (D-UVC))

Family	Species	Density (fish/m^2)	Biomass (g/m^2)
Acanthuridae	*Acanthurus blochii*	0.002	0.46
Acanthuridae	*Acanthurus dussumieri*	0.000	0.02
Acanthuridae	*Acanthurus guttatus*	0.002	0.19
Acanthuridae	*Acanthurus lineatus*	0.020	5.00
Acanthuridae	*Acanthurus nigricans*	0.019	1.67
Acanthuridae	*Acanthurus nigricauda*	0.003	1.21
Acanthuridae	*Acanthurus nigrofuscus*	0.000	0.02
Acanthuridae	*Acanthurus olivaceus*	0.001	0.18
Acanthuridae	*Acanthurus pyroferus*	0.001	0.07
Acanthuridae	*Acanthurus thompsoni*	0.000	0.03
Acanthuridae	*Acanthurus triostegus*	0.022	1.59
Acanthuridae	*Acanthurus xanthopterus*	0.000	0.05
Acanthuridae	*Ctenochaetus striatus*	0.137	21.36
Acanthuridae	*Naso annulatus*	0.001	0.19
Acanthuridae	*Naso lituratus*	0.003	0.41
Acanthuridae	*Naso unicornis*	0.000	0.20
Acanthuridae	*Zebrasoma scopas*	0.011	0.56

3.1.2 Weighted average density and biomass of all finfish species recorded in Vailala (continued)

(using distance-sampling underwater visual censuses (D-UVC))

Family	Species	Density (fish/m^2)	Biomass (g/m^2)
Acanthuridae	*Zebrasoma veliferum*	0.000	0.07
Balistidae	*Balistapus undulatus*	0.004	0.26
Balistidae	*Balistoides viridescens*	0.000	0.10
Balistidae	*Melichthys vidua*	0.005	0.62
Balistidae	*Rhinecanthus aculeatus*	0.001	0.03
Balistidae	*Sufflamen chrysopterum*	0.000	0.00
Chaetodontidae	*Chaetodon auriga*	0.001	0.06
Chaetodontidae	*Chaetodon citrinellus*	0.002	0.02
Chaetodontidae	*Chaetodon ephippium*	0.004	0.24
Chaetodontidae	*Chaetodon lineolatus*	0.000	0.01
Chaetodontidae	*Chaetodon lunula*	0.001	0.07
Chaetodontidae	*Chaetodon lunulatus*	0.007	0.19
Chaetodontidae	*Chaetodon melannotus*	0.001	0.03
Chaetodontidae	*Chaetodon ornatissimus*	0.000	0.03
Chaetodontidae	*Chaetodon pelewensis*	0.001	0.01
Chaetodontidae	*Chaetodon rafflesii*	0.000	0.01
Chaetodontidae	*Chaetodon reticulatus*	0.003	0.12
Chaetodontidae	*Chaetodon semeion*	0.002	0.15
Chaetodontidae	*Chaetodon trifascialis*	0.004	0.08
Chaetodontidae	*Chaetodon ulietensis*	0.003	0.08
Chaetodontidae	*Chaetodon vagabundus*	0.003	0.13
Chaetodontidae	*Forcipiger longirostris*	0.001	0.04
Chaetodontidae	*Hemitaurichthys polylepis*	0.002	0.08
Chaetodontidae	*Heniochus monoceros*	0.000	0.03
Chaetodontidae	*Heniochus singularius*	0.001	0.20
Chaetodontidae	*Heniochus varius*	0.001	0.06
Holocentridae	*Myripristis adusta*	0.004	0.96
Holocentridae	*Myripristis berndti*	0.004	0.70
Holocentridae	*Myripristis kuntee*	0.001	0.16
Holocentridae	*Myripristis* spp.	0.008	1.46
Holocentridae	*Neoniphon argenteus*	0.003	0.25
Holocentridae	*Neoniphon opercularis*	0.000	0.05
Holocentridae	*Neoniphon sammara*	0.007	0.62
Holocentridae	*Neoniphon* spp.	0.000	0.03
Holocentridae	*Sargocentron caudimaculatum*	0.003	0.40
Holocentridae	*Sargocentron* spp.	0.000	0.01
Holocentridae	*Sargocentron spiniferum*	0.001	0.28
Holocentridae	*Sargocentron tiere*	0.000	0.06
Kyphosidae	*Kyphosus vaigiensis*	0.000	0.12
Labridae	*Cheilinus chlorourus*	0.001	0.04
Labridae	*Cheilinus fasciatus*	0.001	0.04
Labridae	*Cheilinus trilobatus*	0.000	0.07
Labridae	*Cheilinus undulatus*	0.000	0.74
Labridae	*Coris aygula*	0.000	0.01
Labridae	*Coris gaimard*	0.000	0.02
Labridae	*Epibulus insidiator*	0.002	0.41
Labridae	*Hemigymnus fasciatus*	0.001	0.06

3.1.2 Weighted average density and biomass of all finfish species recorded in Vailala (continued)

(using distance-sampling underwater visual censuses (D-UVC))

Family	Species	Density (fish/m^2)	Biomass (fish/m^2)
Labridae	*Hemigymnus melapterus*	0.001	0.13
Labridae	*Oxycheilinus digramma*	0.000	0.02
Lethrinidae	*Gnathodentex aureolineatus*	0.049	8.97
Lethrinidae	*Lethrinus harak*	0.001	0.35
Lethrinidae	*Monotaxis grandoculis*	0.012	3.06
Lutjanidae	*Aphareus furca*	0.002	0.79
Lutjanidae	*Aprion virescens*	0.000	0.26
Lutjanidae	*Lutjanus bohar*	0.000	0.08
Lutjanidae	*Lutjanus fulviflamma*	0.013	4.37
Lutjanidae	*Lutjanus fulvus*	0.009	1.82
Lutjanidae	*Lutjanus gibbus*	0.005	2.05
Lutjanidae	*Lutjanus kasmira*	0.103	7.52
Lutjanidae	*Lutjanus monostigma*	0.005	1.49
Lutjanidae	*Macolor niger*	0.000	0.04
Mullidae	*Mulloidichthys flavolineatus*	0.013	2.38
Mullidae	*Mulloidichthys vanicolensis*	0.001	0.22
Mullidae	*Parupeneus barberinus*	0.000	0.11
Mullidae	*Parupeneus cyclostomus*	0.001	0.13
Mullidae	*Parupeneus multifasciatus*	0.005	0.36
Mullidae	*Parupeneus pleurostigma*	0.000	0.03
Mullidae	*Parupeneus trifasciatus*	0.001	0.25
Nemipteridae	*Scolopsis trilineata*	0.001	0.04
Pomacanthidae	*Pygoplites diacanthus*	0.004	0.48
Scaridae	*Calotomus carolinus*	0.001	0.13
Scaridae	*Chlorurus frontalis*	0.001	0.33
Scaridae	*Chlorurus japanensis*	0.000	0.04
Scaridae	*Chlorurus microrhinos*	0.000	0.30
Scaridae	*Chlorurus sordidus*	0.034	4.75
Scaridae	*Hipposcarus longiceps*	0.001	1.06
Scaridae	*Scarus altipinnis*	0.001	0.20
Scaridae	*Scarus chameleon*	0.000	0.03
Scaridae	*Scarus dimidiatus*	0.008	2.18
Scaridae	*Scarus forsteni*	0.000	0.04
Scaridae	*Scarus frenatus*	0.002	0.61
Scaridae	*Scarus ghobban*	0.002	0.21
Scaridae	*Scarus globiceps*	0.000	0.05
Scaridae	*Scarus niger*	0.002	1.37
Scaridae	*Scarus oviceps*	0.006	1.08
Scaridae	*Scarus psittacus*	0.007	0.75
Scaridae	*Scarus rubroviolaceus*	0.001	0.46
Scaridae	*Scarus schlegeli*	0.001	0.15
Scaridae	*Scarus* spp.	0.010	0.21
Scaridae	*Scarus spinus*	0.000	0.10
Serranidae	*Anyperodon leucogrammicus*	0.000	0.03
Serranidae	*Cephalopholis argus*	0.006	1.89
Serranidae	*Cephalopholis leopardus*	0.000	0.02

3.1.2 Weighted average density and biomass of all finfish species recorded in Vailala (continued)

(using distance-sampling underwater visual censuses (D-UVC))

Family	Species	Density (fish/m²)	Biomass (g/m²)
Serranidae	*Cephalopholis urodeta*	0.004	0.34
Serranidae	*Epinephelus merra*	0.002	0.12
Serranidae	*Epinephelus polyphekadion*	0.000	0.19
Serranidae	*Epinephelus* spp.	0.000	0.06
Serranidae	*Gracila albomarginata*	0.000	0.04
Siganidae	*Siganus argenteus*	0.006	0.78
Siganidae	*Siganus punctatus*	0.000	0.03
Siganidae	*Siganus spinus*	0.001	0.21
Zanclidae	*Zanclus cornutus*	0.002	0.17
Labridae	*Hemigymnus melapterus*	0.001	0.13
Labridae	*Oxycheilinus digramma*	0.000	0.02
Lethrinidae	*Gnathodentex aureolineatus*	0.049	8.97
Lethrinidae	*Lethrinus harak*	0.001	0.35
Lethrinidae	*Monotaxis grandoculis*	0.012	3.06
Lutjanidae	*Aphareus furca*	0.002	0.79
Lutjanidae	*Aprion virescens*	0.000	0.26
Lutjanidae	*Lutjanus bohar*	0.000	0.08
Lutjanidae	*Lutjanus fulviflamma*	0.013	4.37
Lutjanidae	*Lutjanus fulvus*	0.009	1.82
Lutjanidae	*Lutjanus gibbus*	0.005	2.05
Lutjanidae	*Lutjanus kasmira*	0.103	7.52
Lutjanidae	*Lutjanus monostigma*	0.005	1.49
Lutjanidae	*Macolor niger*	0.000	0.04
Mullidae	*Mulloidichthys flavolineatus*	0.013	2.38
Mullidae	*Mulloidichthys vanicolensis*	0.001	0.22
Mullidae	*Parupeneus barberinus*	0.000	0.11
Mullidae	*Parupeneus cyclostomus*	0.001	0.13
Mullidae	*Parupeneus multifasciatus*	0.005	0.36
Mullidae	*Parupeneus pleurostigma*	0.000	0.03
Mullidae	*Parupeneus trifasciatus*	0.001	0.25
Nemipteridae	*Scolopsis trilineata*	0.001	0.04
Pomacanthidae	*Pygoplites diacanthus*	0.004	0.48
Scaridae	*Calotomus carolinus*	0.001	0.13
Scaridae	*Chlorurus frontalis*	0.001	0.33
Scaridae	*Chlorurus japanensis*	0.000	0.04
Scaridae	*Chlorurus microrhinos*	0.000	0.30
Scaridae	*Chlorurus sordidus*	0.034	4.75
Scaridae	*Hipposcarus longiceps*	0.001	1.06
Scaridae	*Scarus altipinnis*	0.001	0.20
Scaridae	*Scarus chameleon*	0.000	0.03
Scaridae	*Scarus dimidiatus*	0.008	2.18
Scaridae	*Scarus forsteni*	0.000	0.04
Scaridae	*Scarus frenatus*	0.002	0.61
Scaridae	*Scarus ghobban*	0.002	0.21
Scaridae	*Scarus globiceps*	0.000	0.05
Scaridae	*Scarus niger*	0.002	1.37
Scaridae	*Scarus oviceps*	0.006	1.08

3.1.2 Weighted average density and biomass of all finfish species recorded in Vailala (continued)
(using distance-sampling underwater visual censuses (D-UVC))

Family	Species	Density (fish/m^2)	Biomass (g/m^2)
Scaridae	*Scarus psittacus*	0.007	0.75
Scaridae	*Scarus rubroviolaceus*	0.001	0.46
Scaridae	*Scarus schlegeli*	0.001	0.15
Scaridae	*Scarus spp.*	0.010	0.21
Scaridae	*Scarus spinus*	0.000	0.10
Serranidae	*Anyperodon leucogrammicus*	0.000	0.03
Serranidae	*Cephalopholis argus*	0.006	1.89
Serranidae	*Cephalopholis leopardus*	0.000	0.02
Serranidae	*Cephalopholis urodeta*	0.004	0.34
Serranidae	*Epinephelus merra*	0.002	0.12
Serranidae	*Epinephelus polyphekadion*	0.000	0.19
Serranidae	*Epinephelus spp.*	0.000	0.06
Serranidae	*Gracila albomarginata*	0.000	0.04
Siganidae	*Siganus argenteus*	0.006	0.78
Siganidae	*Siganus punctatus*	0.000	0.03
Siganidae	*Siganus spinus*	0.001	0.21
Zanclidae	*Zanclus cornutus*	0.002	0.17

3.2 Halalo finfish survey data

3.2.1 Coordinates (WGS84) of the 25 D-UVC transects used to assess finfish resource status in Halalo

Station name	Habitat	Latitude	Longitude
TRA01	Coastal reef	13º20'21.5412 S	176º13'34.4388 W
TRA02	Lagoon	13º20'46.68 S	176º14'02.58 W
TRA03	Lagoon	13º19'22.9188 S	176º15'47.2788 W
TRA04	Back-reef	13º19'14.7612 S	176º16'22.1988 W
TRA13	Outer reef	13º23'19.9212 S	176º13'45.5988 W
TRA14	Outer reef	13º23'19.9212 S	176º13'45.5988 W
TRA15	Lagoon	13º22'02.46 S	176º12'11.2212 W
TRA16	Lagoon	13º21'55.6812 S	176º11'07.6812 W
TRA28	Coastal reef	13º22'01.6788 S	176º13'01.92 W
TRA29	Coastal reef	13º22'10.6212 S	176º13'26.8788 W
TRA30	Lagoon	13º20'08.7612 S	176º10'13.5012 W
TRA31	Lagoon	13º19'41.9988 S	176º10'05.8188 W
TRA32	Coastal reef	13º19'59.6388 S	176º10'59.4588 W
TRA33	Coastal reef	13º19'19.8012 S	176º10'48.4788 W
TRA34	Coastal reef	13º18'04.0788 S	176º10'24.78 W
TRA36	Outer reef	13º23'40.4988 S	176º10'54.3612 W
TRA37	Outer reef	13º23'40.4988 S	176º10'54.3612 W
TRA38	Back-reef	13º23'26.16 S	176º12'27.9612 W
TRA39	Back-reef	13º23'18.96 S	176º10'54.3 W
TRA40	Lagoon	13º18'08.46 S	176º09'34.4412 W
TRA43	Back-reef	13º17'48.1812 S	176º07'40.7388 W
TRA44	Coastal reef	13º19'01.0812 S	176º15'06.7788 W
TRA45	Back-reef	13º22'04.3788 S	176º14'43.8 W
TRA46	Back-reef	13º19'51.96 S	176º08'26.7612 W
TRA47	Back-reef	13º20'24.6588 S	176º08'54.06 W

3.2.2 Weighted average density and biomass of all finfish species recorded in Halalo (using distance-sampling underwater visual censuses (D-UVC))

Family	Species	Density (fish/m^2)	Biomass (g/m^2)
Acanthuridae	*Acanthurus blochii*	0.006	2.23
Acanthuridae	*Acanthurus guttatus*	0.001	0.10
Acanthuridae	*Acanthurus lineatus*	0.023	6.14
Acanthuridae	*Acanthurus nigricans*	0.013	1.03
Acanthuridae	*Acanthurus nigricauda*	0.002	0.61
Acanthuridae	*Acanthurus olivaceus*	0.010	2.31
Acanthuridae	*Acanthurus pyroferus*	0.001	0.07
Acanthuridae	*Acanthurus* spp.	0.001	0.00
Acanthuridae	*Acanthurus triostegus*	0.016	1.04
Acanthuridae	*Acanthurus xanthopterus*	0.000	0.26
Acanthuridae	*Ctenochaetus striatus*	0.125	15.91
Acanthuridae	*Naso annulatus*	0.000	0.05
Acanthuridae	*Naso lituratus*	0.002	0.37
Acanthuridae	*Naso unicornis*	0.000	0.10
Acanthuridae	*Zebrasoma scopas*	0.016	0.81
Acanthuridae	*Zebrasoma veliferum*	0.001	0.25

3.2.2 Weighted average density and biomass of all finfish species recorded in Halalo (continued)

(using distance-sampling underwater visual censuses (D-UVC))

Family	Species	Density (fish/m^2)	Biomass (g/m^2)
Balistidae	*Balistapus undulatus*	0.001	0.08
Balistidae	*Balistoides viridescens*	0.000	0.37
Balistidae	*Melichthys vidua*	0.003	0.35
Balistidae	*Odonus niger*	0.000	0.02
Balistidae	*Pseudobalistes flavimarginatus*	0.000	0.02
Balistidae	*Rhinecanthus aculeatus*	0.001	0.03
Balistidae	*Sufflamen chrysopterum*	0.001	0.04
Balistidae	*Sufflamen fraenatum*	0.000	0.02
Chaetodontidae	*Chaetodon auriga*	0.002	0.09
Chaetodontidae	*Chaetodon citrinellus*	0.002	0.02
Chaetodontidae	*Chaetodon ephippium*	0.003	0.15
Chaetodontidae	*Chaetodon lunula*	0.001	0.08
Chaetodontidae	*Chaetodon lunulatus*	0.005	0.12
Chaetodontidae	*Chaetodon melannotus*	0.000	0.01
Chaetodontidae	*Chaetodon ornatissimus*	0.000	0.02
Chaetodontidae	*Chaetodon pelewensis*	0.000	0.00
Chaetodontidae	*Chaetodon reticulatus*	0.002	0.08
Chaetodontidae	*Chaetodon semeion*	0.001	0.06
Chaetodontidae	*Chaetodon trifascialis*	0.001	0.01
Chaetodontidae	*Chaetodon ulietensis*	0.003	0.08
Chaetodontidae	*Chaetodon unimaculatus*	0.000	0.02
Chaetodontidae	*Chaetodon vagabundus*	0.003	0.13
Chaetodontidae	*Forcipiger longirostris*	0.000	0.01
Chaetodontidae	*Heniochus acuminatus*	0.000	0.01
Chaetodontidae	*Heniochus chrysostomus*	0.001	0.05
Chaetodontidae	*Heniochus monoceros*	0.000	0.02
Holocentridae	*Myripristis adusta*	0.006	0.69
Holocentridae	*Myripristis berndti*	0.001	0.22
Holocentridae	*Myripristis kuntee*	0.002	0.23
Holocentridae	*Myripristis* spp.	0.004	0.68
Holocentridae	*Myripristis violacea*	0.000	0.02
Holocentridae	*Neoniphon sammara*	0.002	0.14
Holocentridae	*Sargocentron caudimaculatum*	0.003	0.37
Holocentridae	*Sargocentron diadema*	0.001	0.03
Holocentridae	*Sargocentron spiniferum*	0.002	0.57
Holocentridae	*Sargocentron tiere*	0.000	0.02
Kyphosidae	*Kyphosus cinerascens*	0.004	1.97
Labridae	*Bodianus loxozonus*	0.000	0.04
Labridae	*Cheilinus chlorourus*	0.001	0.06
Labridae	*Cheilinus fasciatus*	0.000	0.03
Labridae	*Cheilinus trilobatus*	0.000	0.06
Labridae	*Cheilinus undulatus*	0.000	0.01
Labridae	*Coris aygula*	0.000	0.01
Labridae	*Coris gaimard*	0.002	0.03
Labridae	*Epibulus insidiator*	0.001	0.18
Labridae	*Hemigymnus fasciatus*	0.000	0.03
Labridae	*Hemigymnus melapterus*	0.000	0.07

3.2.2 Weighted average density and biomass of all finfish species recorded in Halalo (continued)
(using distance-sampling underwater visual censuses (D-UVC))

Family	Species	Density (fish/m^2)	Biomass (g/m^2)
Lethrinidae	*Gnathodentex aureolineatus*	0.030	3.44
Lethrinidae	*Lethrinus harak*	0.001	0.37
Lethrinidae	*Lethrinus obsoletus*	0.000	0.08
Lethrinidae	*Lethrinus olivaceus*	0.000	0.01
Lethrinidae	*Lethrinus xanthochilus*	0.000	0.36
Lethrinidae	*Monotaxis grandoculis*	0.012	2.14
Lutjanidae	*Aphareus furca*	0.000	0.12
Lutjanidae	*Lutjanus biguttatus*	0.006	0.71
Lutjanidae	*Lutjanus bohar*	0.000	0.09
Lutjanidae	*Lutjanus fulviflamma*	0.002	0.63
Lutjanidae	*Lutjanus fulvus*	0.015	4.22
Lutjanidae	*Lutjanus gibbus*	0.005	2.04
Lutjanidae	*Lutjanus kasmira*	0.009	0.80
Lutjanidae	*Lutjanus monostigma*	0.004	1.23
Mullidae	*Mulloidichthys flavolineatus*	0.000	0.00
Mullidae	*Mulloidichthys vanicolensis*	0.007	2.13
Mullidae	*Parupeneus barberinus*	0.002	0.24
Mullidae	*Parupeneus cyclostomus*	0.001	0.29
Mullidae	*Parupeneus multifasciatus*	0.004	0.23
Mullidae	*Parupeneus pleurostigma*	0.000	0.00
Mullidae	*Parupeneus trifasciatus*	0.000	0.06
Nemipteridae	*Scolopsis trilineata*	0.001	0.04
Pomacanthidae	*Pygoplites diacanthus*	0.002	0.33
Scaridae	*Calotomus carolinus*	0.000	0.07
Scaridae	*Cetoscarus bicolor*	0.000	0.15
Scaridae	*Chlorurus microrhinos*	0.000	0.23
Scaridae	*Chlorurus sordidus*	0.017	2.23
Scaridae	*Hipposcarus longiceps*	0.001	0.15
Scaridae	*Scarus altipinnis*	0.001	0.51
Scaridae	*Scarus dimidiatus*	0.002	0.36
Scaridae	*Scarus frenatus*	0.000	0.15
Scaridae	*Scarus ghobban*	0.005	1.38
Scaridae	*Scarus globiceps*	0.001	0.13
Scaridae	*Scarus niger*	0.000	0.00
Scaridae	*Scarus oviceps*	0.002	0.29
Scaridae	*Scarus psittacus*	0.003	0.74
Scaridae	*Scarus rivulatus*	0.000	0.01
Scaridae	*Scarus schlegeli*	0.000	0.05
Scaridae	*Scarus* spp.	0.003	0.07
Scaridae	*Scarus spinus*	0.000	0.02
Serranidae	*Cephalopholis argus*	0.003	0.86
Serranidae	*Cephalopholis urodeta*	0.001	0.09
Serranidae	*Epinephelus howlandi*	0.000	0.05
Serranidae	*Epinephelus merra*	0.001	0.05
Serranidae	*Variola louti*	0.000	0.08
Siganidae	*Siganus argenteus*	0.000	0.03
Siganidae	*Siganus punctatus*	0.000	0.02

3.2.2 Weighted average density and biomass of all finfish species recorded in Halalo (continued)

(using distance-sampling underwater visual censuses (D-UVC))

Family	Species	Density (fish/m^2)	Biomass (g/m^2)
Siganidae	*Siganus spinus*	0.001	0.23
Zanclidae	*Zanclus cornutus*	0.001	0.10

3.3 Futuna finfish survey data

3.3.1 Coordinates (WGS84) of the 45 D-UVC transects used to assess finfish resource status in Futuna

Station name	Habitat	Latitude	Longitude
TRA01	Outer reef	14º18'47.7612 S	178º03'36.9 W
TRA02	Outer reef	14º18'50.4 S	178º04'16.2588 W
TRA03	Outer reef	14º18'50.8212 S	178º04'40.9188 W
TRA04	Outer reef	14º18'51.2388 S	178º05'06.9 W
TRA05	Outer reef	14º18'36.7812 S	178º05'42.7812 W
TRA06	Outer reef	14º18'44.3412 S	178º06'04.0788 W
TRA07	Outer reef	14º18'52.9812 S	178º06'27.72 W
TRA08	Outer reef	14º19'20.1612 S	178º02'00.3012 W
TRA09	Outer reef	14º19'19.56 S	178º03'29.9988 W
TRA10	Outer reef	14º20'05.1 S	178º04'20.3988 W
TRA11	Outer reef	14º14'54.4812 S	178º11'04.3188 W
TRA12	Outer reef	14º15'36.36 S	178º10'58.0188 W
TRA13	Outer reef	14º16'04.7388 S	178º10'49.62 W
TRA14	Outer reef	14º16'36.5412 S	178º10'33.24 W
TRA15	Outer reef	14º15'05.1588 S	178º08'51.72 W
TRA16	Outer reef	14º14'45.06 S	178º09'24.48 W
TRA17	Outer reef	14º14'42.4788 S	178º09'51.0588 W
TRA18	Outer reef	14º14'32.7588 S	178º10'05.88 W
TRA19	Outer reef	14º18'21.8988 S	178º09'16.74 W
TRA20	Outer reef	14º18'01.7388 S	178º09'36.72 W
TRA21	Outer reef	14º17'13.6788 S	178º10'20.64 W
TRA22	Outer reef	14º17'39.1812 S	178º10'04.0188 W
TRA23	Outer reef	14º21'05.04 S	178º03'54.18 W
TRA24	Outer reef	14º21'23.58 S	178º02'59.9388 W
TRA25	Outer reef	14º21'17.3412 S	178º01'49.8612 W
TRA26	Outer reef	14º20'36.1212 S	178º00'36.7812 W
TRA27	Outer reef	14º16'48.6588 S	178º06'17.1 W
TRA28	Outer reef	14º16'15.6612 S	178º07'00.5988 W
TRA29	Outer reef	14º15'46.3212 S	178º07'34.32 W
TRA30	Outer reef	14º15'25.74 S	178º08'04.8012 W
TRA31	Outer reef	14º17'24.6012 S	178º05'40.56 W
TRA32	Outer reef	14º17'44.5812 S	178º04'52.9788 W
TRA33	Outer reef	14º18'06.48 S	178º04'02.8812 W
TRA34	Outer reef	14º18'17.7588 S	178º03'45.4788 W
TRA35	Outer reef	14º16'38.46 S	178º06'31.9788 W
TRA36	Outer reef	14º17'08.0412 S	178º06'00.18 W
TRA37	Outer reef	14º17'38.1588 S	178º05'22.1388 W
TRA38	Outer reef	14º17'52.3788 S	178º04'27.9588 W
TRA39	Outer reef	14º14'45.6612 S	178º09'16.6212 W
TRA40	Outer reef	14º15'14.5188 S	178º08'29.3388 W
TRA41	Outer reef	14º16'03.36 S	178º07'14.4012 W
TRA42	Outer reef	14º15'33.7788 S	178º07'46.8588 W
TRA43	Outer reef	14º19'50.2212 S	178º01'09.7212 W
TRA44	Outer reef	14º18'48.3012 S	178º07'30.0612 W
TRA45	Outer reef	14º18'34.9812 S	178º08'39.66 W

3.3.2 Weighted average density and biomass of all finfish species recorded in Futuna (using distance-sampling underwater visual censuses (D-UVC))

Family	Species	Density (fish/m^2)	Biomass (g/m^2)
Acanthuridae	*Acanthurus albipectoralis*	0.000	0.04
Acanthuridae	*Acanthurus blochii*	0.001	0.42
Acanthuridae	*Acanthurus guttatus*	0.001	0.05
Acanthuridae	*Acanthurus lineatus*	0.039	11.76
Acanthuridae	*Acanthurus nigricans*	0.030	2.39
Acanthuridae	*Acanthurus nigricauda*	0.002	0.78
Acanthuridae	*Acanthurus nigrofuscus*	0.003	0.06
Acanthuridae	*Acanthurus nigroris*	0.000	0.00
Acanthuridae	*Acanthurus olivaceus*	0.002	0.23
Acanthuridae	*Acanthurus pyroferus*	0.000	0.01
Acanthuridae	*Acanthurus* spp.	0.001	0.01
Acanthuridae	*Acanthurus triostegus*	0.002	0.13
Acanthuridae	*Ctenochaetus striatus*	0.099	12.13
Acanthuridae	*Ctenochaetus strigosus*	0.002	0.05
Acanthuridae	*Naso annulatus*	0.000	0.07
Acanthuridae	*Naso brevirostris*	0.000	0.14
Acanthuridae	*Naso lituratus*	0.004	0.96
Acanthuridae	*Naso unicornis*	0.001	0.34
Acanthuridae	*Zebrasoma scopas*	0.001	0.10
Acanthuridae	*Zebrasoma veliferum*	0.002	0.15
Balistidae	*Balistapus undulatus*	0.006	0.39
Balistidae	*Balistoides conspicillum*	0.000	0.03
Balistidae	*Balistoides viridescens*	0.000	0.41
Balistidae	*Melichthys vidua*	0.008	0.92
Balistidae	*Odonus niger*	0.000	0.02
Balistidae	*Rhinecanthus rectangulus*	0.001	0.11
Balistidae	*Sufflamen bursa*	0.002	0.11
Balistidae	*Sufflamen chrysopterum*	0.000	0.03
Balistidae	*Sufflamen fraenatum*	0.000	0.02
Caesionidae	*Pterocaesio tile*	0.000	0.01
Carangidae	*Carangoides ferdau*	0.000	0.12
Carangidae	*Caranx melampygus*	0.000	0.08
Carangidae	*Decapterus russelli*	0.001	0.09
Chaetodontidae	*Chaetodon auriga*	0.000	0.01
Chaetodontidae	*Chaetodon baronessa*	0.000	0.00
Chaetodontidae	*Chaetodon bennetti*	0.000	0.02
Chaetodontidae	*Chaetodon citrinellus*	0.003	0.03
Chaetodontidae	*Chaetodon ephippium*	0.001	0.11
Chaetodontidae	*Chaetodon lunula*	0.004	0.22
Chaetodontidae	*Chaetodon lunulatus*	0.001	0.04
Chaetodontidae	*Chaetodon ornatissimus*	0.000	0.03
Chaetodontidae	*Chaetodon pelewensis*	0.000	0.00
Chaetodontidae	*Chaetodon quadrimaculatus*	0.000	0.00
Chaetodontidae	*Chaetodon rafflesii*	0.000	0.01
Chaetodontidae	*Chaetodon reticulatus*	0.006	0.27
Chaetodontidae	*Chaetodon semeion*	0.001	0.05
Chaetodontidae	*Chaetodon trifascialis*	0.001	0.01

3.3.2 Weighted average density and biomass of all finfish species recorded in Futuna (continued)

(using distance-sampling underwater visual censuses (D-UVC))

Family	Species	Density (fish/m^2)	Biomass (g/m^2)
Chaetodontidae	*Chaetodon ulietensis*	0.001	0.04
Chaetodontidae	*Chaetodon unimaculatus*	0.000	0.00
Chaetodontidae	*Chaetodon vagabundus*	0.002	0.11
Chaetodontidae	*Forcipiger longirostris*	0.002	0.08
Chaetodontidae	*Heniochus acuminatus*	0.000	0.01
Chaetodontidae	*Heniochus chrysostomus*	0.000	0.00
Chaetodontidae	*Heniochus monoceros*	0.001	0.11
Chaetodontidae	*Heniochus singularius*	0.000	0.02
Chaetodontidae	*Heniochus varius*	0.000	0.01
Diodontidae	*Diodon hystrix*	0.000	0.13
Diodontidae	*Diodon* spp.	0.000	0.00
Haemulidae	*Plectorhinchus orientalis*	0.000	0.07
Haemulidae	*Plectorhinchus* spp.	0.000	0.01
Holocentridae	*Myripristis kuntee*	0.000	0.06
Holocentridae	*Myripristis murdjan*	0.000	0.01
Holocentridae	*Myripristis* spp.	0.000	0.05
Holocentridae	*Neoniphon argenteus*	0.000	0.00
Holocentridae	*Neoniphon sammara*	0.002	0.19
Holocentridae	*Neoniphon* spp.	0.000	0.01
Holocentridae	*Sargocentron caudimaculatum*	0.001	0.07
Holocentridae	*Sargocentron spiniferum*	0.001	0.10
Holocentridae	*Sargocentron tiere*	0.000	0.04
Kyphosidae	*Kyphosus cinerascens*	0.000	0.03
Labridae	*Bodianus loxozonus*	0.000	0.02
Labridae	*Cheilinus chlorourus*	0.000	0.04
Labridae	*Cheilinus trilobatus*	0.000	0.03
Labridae	*Cheilinus undulatus*	0.000	0.11
Labridae	*Coris aygula*	0.000	0.04
Labridae	*Coris gaimard*	0.000	0.02
Labridae	*Hemigymnus fasciatus*	0.001	0.15
Labridae	*Oxycheilinus digramma*	0.000	0.01
Labridae	*Oxycheilinus unifasciatus*	0.000	0.02
Lethrinidae	*Gnathodentex aureolineatus*	0.004	0.59
Lethrinidae	*Lethrinus obsoletus*	0.000	0.01
Lethrinidae	*Lethrinus olivaceus*	0.000	0.45
Lethrinidae	*Monotaxis grandoculis*	0.000	0.28
Lutjanidae	*Aphareus furca*	0.001	0.54
Lutjanidae	*Lutjanus bohar*	0.001	0.68
Lutjanidae	*Lutjanus fulviflamma*	0.001	0.14
Lutjanidae	*Lutjanus fulvus*	0.002	0.64
Lutjanidae	*Lutjanus gibbus*	0.001	0.06
Lutjanidae	*Lutjanus kasmira*	0.003	0.52
Lutjanidae	*Lutjanus monostigma*	0.001	0.29
Lutjanidae	*Macolor macularis*	0.000	0.02
Lutjanidae	*Macolor niger*	0.000	0.11
Monacanthidae	*Cantherhines pardalis*	0.000	0.00
Mugilidae	*Crenimugil crenilabis*	0.000	0.04

3.3.2 Weighted average density and biomass of all finfish species recorded in Futuna (continued)

(using distance-sampling underwater visual censuses (D-UVC))

Family	Species	Density (fish/m^2)	Biomass (g/m^2)
Mullidae	*Mulloidichthys flavolineatus*	0.000	0.03
Mullidae	*Mulloidichthys vanicolensis*	0.000	0.01
Mullidae	*Parupeneus cyclostomus*	0.002	0.34
Mullidae	*Parupeneus multifasciatus*	0.002	0.21
Mullidae	*Parupeneus trifasciatus*	0.002	0.30
Muraenidae	*Gymnothorax javanicus*	0.000	0.02
Muraenidae	*Gymnothorax* spp.	0.000	0.09
Pomacanthidae	*Pomacanthus imperator*	0.000	0.03
Pomacanthidae	*Pygoplites diacanthus*	0.001	0.23
Scaridae	*Calotomus carolinus*	0.001	0.26
Scaridae	*Chlorurus frontalis*	0.004	1.13
Scaridae	*Chlorurus japanensis*	0.001	0.28
Scaridae	*Chlorurus microrhinos*	0.000	0.02
Scaridae	*Chlorurus sordidus*	0.002	0.35
Scaridae	*Scarus forsteni*	0.001	0.25
Scaridae	*Scarus frenatus*	0.000	0.08
Scaridae	*Scarus globiceps*	0.001	0.14
Scaridae	*Scarus niger*	0.000	0.22
Scaridae	*Scarus oviceps*	0.001	0.16
Scaridae	*Scarus psittacus*	0.003	0.61
Scaridae	*Scarus rubroviolaceus*	0.003	2.13
Scaridae	*Scarus schlegeli*	0.000	0.01
Scaridae	*Scarus spinus*	0.000	0.03
Serranidae	*Anyperodon leucogrammicus*	0.000	0.01
Serranidae	*Cephalopholis argus*	0.002	0.44
Serranidae	*Cephalopholis urodeta*	0.014	1.01
Serranidae	*Epinephelus hexagonatus*	0.000	0.00
Serranidae	*Epinephelus macrospilos*	0.000	0.03
Serranidae	*Epinephelus* spp.	0.000	0.01
Serranidae	*Variola louti*	0.000	0.15
Siganidae	*Siganus argenteus*	0.000	0.04
Zanclidae	*Zanclus cornutus*	0.001	0.06

APPENDIX 4: INVERTEBRATE SURVEY DATA

4.1 All Wallis invertebrate survey data

4.1.1 Invertebrate species recorded in different assessments in all Wallis

Group	Species	Broad scale	Reef benthos	Soft benthos	Others
Bêche-de-mer	*Actinopyga mauritiana*		+		+
Bêche-de-mer	*Actinopyga miliaris*	+	+		+
Bêche-de-mer	*Bohadschia argus*	+	+		+
Bêche-de-mer	*Bohadschia graeffei*	+			+
Bêche-de-mer	*Bohadschia vitiensis*	+	+	+	+
Bêche-de-mer	*Holothuria atra*	+	+	+	+
Bêche-de-mer	*Holothuria fuscogilva*				+
Bêche-de-mer	*Holothuria fuscopunctata*	+	+		+
Bêche-de-mer	*Holothuria hilla*		+		
Bêche-de-mer	*Holothuria nobilis*	+	+		+
Bêche-de-mer	*Holothuria scabra*	+			
Bêche-de-mer	*Stichopus chloronotus*	+	+	+	+
Bêche-de-mer	*Stichopus hermanni*	+	+		+
Bêche-de-mer	*Stichopus horrens*	+		+	+
Bêche-de-mer	*Synapta* spp.	+	+		
Bêche-de-mer	*Thelenota ananas*	+	+		+
Bêche-de-mer	*Thelenota anax*				+
Bivalve	*Anadara* spp.	+	+	+	+
Bivalve	*Barbatia* spp.		+		
Bivalve	*Chama* spp.	+	+	+	
Bivalve	*Codakia* spp.			+	
Bivalve	*Fragum unedo*		+	+	
Bivalve	*Gafrarium pectinatum*			+	
Bivalve	*Gafrarium* spp.			+	
Bivalve	*Gafrarium tumidum*			+	
Bivalve	*Hyotissa* spp.	+			
Bivalve	*Lima* spp.		+		
Bivalve	*Modiolus* spp.			+	
Bivalve	*Pinna* spp.	+		+	
Bivalve	*Spondylus* spp.	+	+	+	+
Bivalve	*Tellina palatum*			+	
Bivalve	*Tridacna maxima*	+	+		+
Cnidarians	*Stichodactyla* spp.	+	+		+
Crustacean	*Etisus splendidus*				+
Crustacean	*Lysiosquillina maculata*	+	+		
Crustacean	*Panulirus* spp.	+			
Crustacean	*Panulirus versicolor*	+			+
Crustacean	*Stenopus hispidus*		+		
Gastropod	*Astralium* spp.		+		+
Gastropod	*Bursa granularis*		+		
Gastropod	*Cassis cornuta*				+
Gastropod	*Cerithium aluco*		+		
Gastropod	*Cerithium nodulosum*	+	+		
Gastropod	*Cerithium* spp.			+	

+ = presence of the species.

4.1.1 Invertebrate species recorded in different assessments in all Wallis (continued)

Group	Species	Broad scale	Reef benthos	Soft benthos	Others
Gastropod	*Chicoreus brunneus*		+		+
Gastropod	*Chicoreus ramosus*		+		+
Gastropod	*Chicoreus* spp.		+		
Gastropod	*Conus bandanus*		+		
Gastropod	*Conus catus*		+		
Gastropod	*Conus coronatus*		+		
Gastropod	*Conus distans*		+		+
Gastropod	*Conus flavidus*		+		
Gastropod	*Conus frigidus*		+		
Gastropod	*Conus lividus*		+		
Gastropod	*Conus imperialis*		+		
Gastropod	*Conus leopardus*		+		
Gastropod	*Conus marmoreus*		+		+
Gastropod	*Conus miles*		+		+
Gastropod	*Conus pulicarius*		+	+	
Gastropod	*Conus rattus*		+		
Gastropod	*Conus* spp.	+	+		
Gastropod	*Conus striatus*		+		
Gastropod	*Conus vexillum*		+		+
Gastropod	*Coralliophila* spp.				+
Gastropod	*Cymatium rubeculum*		+		
Gastropod	*Cypraea annulus*		+	+	
Gastropod	*Cypraea arabica*		+		
Gastropod	*Cypraea caputserpensis*				+
Gastropod	*Cypraea erosa*		+		
Gastropod	*Cypraea mappa mappa*		+		
Gastropod	*Cypraea moneta*		+	+	
Gastropod	*Cypraea tigris*	+	+		
Gastropod	*Drupa ricinus*		+		
Gastropod	*Drupa* spp.		+		
Gastropod	*Drupella cornus*		+		
Gastropod	*Drupella* spp.		+		
Gastropod	*Lambis truncata*	+	+		+
Gastropod	*Latirolagena smaragdula*		+		+
Gastropod	*Nassarius* spp.			+	
Gastropod	*Peristernia* spp.		+		
Gastropod	*Pleuroploca filamentosa*				+
Gastropod	*Pleuroploca* spp.		+		
Gastropod	*Pleuroploca trapezium*		+		
Gastropod	*Polinices* spp.			+	
Gastropod	*Rhinoclavis aspera*			+	
Gastropod	*Strombus gibberulus gibbosus*	+		+	
Gastropod	*Strombus lentiginosus*	+			
Gastropod	*Strombus luhuanus*	+	+		+
Gastropod	*Strombus* spp.		+		
Gastropod	*Tectus conus*				+
Gastropod	*Tectus pyramis*	+			+
Gastropod	*Thais* spp.				+

+ = presence of the species.

4.1.1 Invertebrate species recorded in different assessments in all Wallis (continued)

Group	Species	Broad scale	Reef benthos	Soft benthos	Others
Gastropod	*Trochus maculata*				+
Gastropod	*Trochus niloticus*	+	+		+
Gastropod	*Trochus niloticus*	+	+		+
Gastropod	*Turbo argyrostomus*				+
Gastropod	*Turbo setosus*				+
Gastropod	*Turbo* spp.		+		+
Gastropod	*Vasum* spp.				+
Star	*Acanthaster planci*	+			
Star	*Archaster typicus*			+	
Star	*Culcita novaeguineae*	+	+		+
Star	*Linckia laevigata*	+	+		+
Urchin	*Diadema* spp.	+	+		+
Urchin	*Echinometra mathaei*		+		+
Urchin	*Echinothrix calamaris*		+		
Urchin	*Echinothrix diadema*	+	+		+
Urchin	*Echinothrix* spp.	+	+		+
Urchin	*Heterocentrotus mammillatus*				+

+ = presence of the species.

4.1.2 All Wallis broad-scale assessment data review

Station: Six 2 m x 300 m transects.

Species	Transects			Transects _P			Stations			Stations _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Acanthaster planci	0.4	0.4	151	66.7		1	0.4	0.4	25	11.1		1
Actinopyga miliaris	0.2	0.2	151	16.7	0	2	0.2	0.2	25	2.8	0	2
Anadara spp.	0.9	0.3	151	19.0	2.4	7	0.9	0.4	25	5.6	1.1	4
Bohadschia argus	29.6	4.9	151	75.7	9.8	59	29.2	9.3	25	44.3	13.9	14
Bohadschia graeffei	0.1	0.1	151	16.7		1	0.1	0.1	25	2.8		1
Bohadschia vitiensis	654.2	265.0	151	1619.5	639.2	61	656.8	509.1	25	861.7	634.2	20
Cerithium nodulosum	1.2	0.6	151	36.4	9.9	5	1.2	0.7	25	9.8	2.6	3
Chama spp.	69.9	55.7	151	458.7	361.5	23	70.3	55.8	25	175.8	136.9	10
Conus spp.	3.4	0.7	151	21.5	2.1	24	3.4	0.7	25	5.2	0.8	17
Culcita novaeguineae	35.1	4.8	151	73.5	7.9	72	35.3	7.9	25	42.4	8.7	21
Cypraea tigris	2.3	0.6	151	21.9	2.5	16	2.3	0.8	25	6.2	1.3	10
Diadema spp.	0.3	0.2	151	16.7	0.0	3	0.3	0.2	25	2.8	1.4	2
Echinothrix diadema	1.4	0.6	151	24.1	5.6	9	1.4	0.9	25	9.0	3.7	4
Echinothrix spp.	0.1	0.1	151	16.7		1	0.1	0.1	25	2.8		1
Holothuria atra	1450.3	655.5	151	2670.7	1193.8	82	1458.7	789.7	25	1919.3	1022.3	19
Holothuria fuscopunctata	4.5	1.5	151	48.7	11.0	14	4.5	2.2	25	19.0	6.2	6
Holothuria nobilis	1.6	0.5	151	20.7	3.0	12	1.6	0.5	25	4.4	0.9	9
Holothuria scabra	1.1	0.8	151	83.3	16.7	2	1.1	0.8	25	13.9	2.8	2
Hyotissa spp.	0.1	0.1	151	16.7		1	0.1	0.1	25	2.8		1
Lambis truncata	0.2	0.2	151	16.7	0.0	2	0.2	0.2	25	2.8	0.0	2
Linckia laevigata	84.7	15.6	151	161.9	27.2	79	84.2	30.3	25	84.2	39.8	18
Lysiosquillina maculata	0.3	0.2	151	25.0	8.3	2	0.3	0.2	25	4.2	1.4	2
Panulirus spp.	0.2	0.2	151	16.7	0.0	2	0.2	0.2	25	2.8	0.0	2
Panulirus versicolor	0.1	0.1	151	16.7		1	0.1	0.1	25	2.8		1
Pinna spp.	0.1	0.1	151	16.7		1	0.1	0.1	25	2.8		1
Spondylus spp.	2.4	0.6	151	21.5	2.4	17	2.4	0.7	25	5.5	1.1	11
Stichodactyla spp.	3.6	1.0	151	32.4	5.2	17	3.7	1.5	25	10.2	3.2	9

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

4.1.2 All Wallis broad-scale assessment data review (continued)

Station: Six 2 m x 300 m transects.

Species	Transects			Transects _P			Stations			Stations _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Stichopus chloronotus	277.0	171.6	151	1162.0	707.1	36	278.1	190.7	25	579.4	386.5	12
Stichopus hermanni	7.9	2.1	151	49.8	9.8	24	8.0	2.8	25	19.9	5.2	10
Stichopus horrens	340.4	233.3	151	6425.0	4053.5	8	342.7	335.1	25	4283.3	4100.0	2
Strombus gibberulus gibbosus	242.6	156.8	151	12,211.1	4438.9	3	241.0	153.7	25	1625.6	766.3	3
Strombus lentiginosus	0.9	0.6	151	44.4	14.7	3	0.8	0.8	25	19.0		1
Strombus luhuanus	17.7	7.6	151	126.9	49.3	21	16.2	9.8	25	33.6	19.5	12
Synapta spp.	0.3	0.2	151	16.7	0.0	3	0.3	0.2	25	4.2	1.4	2
Tectus pyramis	0.2	0.2	151	16.7	0.0	2	0.2	0.2	25	2.8	0.0	2
Thelenota ananas	0.6	0.3	151	20.8	4.1	4	0.6	0.4	25	4.6	1.8	3
Tridacna maxima	1.9	0.7	151	28.3	6.6	10	1.9	0.9	25	7.9	2.5	6
Trochus niloticus	0.2	0.2	151	16.7	0.0	2	0.2	0.2	25	2.8	0.0	2

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

4.1.3 All Wallis reef-benthos transect (RBt) assessment data review

Station: Six 1 m x 40 m transects.

Species	Transects			Transects _P			Stations			Stations _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinopyga mauritiana	1.2	1.2	210	250		1	1.2	1.2	35	41.7		1
Actinopyga miliaris	1.2	1.2	210	250		1	1.2	1.2	35	41.7		1
Anadara spp.	2.4	2.4	210	500		1	2.4	2.4	35	83.3		1
Astralium spp.	1.2	1.2	210	250		1	1.2	1.2	35	41.7		1
Barbatia spp.	2.4	2.4	210	500		1	2.4	2.4	35	83.3		1
Bohadschia argus	140.5	16.7	210	409.7	29.0	72	140.5	32.0	35	196.7	39.6	25
Bohadschia vitiensis	6.0	2.6	210	250.0	0.0	5	6.0	3.9	35	69.4	27.8	3
Bursa granularis	1.2	1.2	210	250.0		1	1.2	1.2	35	41.7		1
Cerithium aluco	4.8	3.8	210	500.0	250.0	2	4.8	4.8	35	166.7		1
Cerithium nodulosum	26.2	10.0	210	550.0	128.0	10	26.2	19.1	35	152.8	103.0	6
Chama spp.	63.1	15.6	210	473.2	83.7	28	63.1	17.5	35	138.0	28.9	16
Chicoreus brunneus	11.9	3.7	210	250.0	0.0	10	11.9	4.0	35	52.1	6.8	8
Chicoreus ramosus	1.2	1.2	210	250.0		1	1.2	1.2	35	41.7		1
Chicoreus spp.	4.8	2.4	210	250.0	0.0	4	4.8	2.3	35	41.7	0.0	4
Conus bandanus	6.0	3.1	210	312.5	62.5	4	6.0	3.5	35	69.4	13.9	3
Conus catus	16.7	6.0	210	388.9	60.5	9	16.7	6.9	35	97.2	17.6	6
Conus coronatus	4.8	3.8	210	500.0	250.0	2	4.8	3.7	35	83.3	41.7	2
Conus distans	2.4	1.7	210	250.0	0.0	2	2.4	2.4	35	83.3		1
Conus flavidus	6.0	3.1	210	312.5	62.5	4	6.0	3.0	35	52.1	10.4	4
Conus frigidus	1.2	1.2	210	250.0		1	1.2	1.2	35	41.7		1
Conus imperialis	2.4	1.7	210	250.0	0.0	2	2.4	1.7	35	41.7	0.0	2
Conus leopardus	1.2	1.2	210	250.0		1	1.2	1.2	35	41.7		1
Conus lividus	4.8	3.4	210	500.0	0.0	2	4.8	4.8	35	166.7		1
Conus marmoreus	13.1	5.9	210	392.9	107.1	7	13.1	5.9	35	76.4	19.9	6
Conus miles	2.4	1.7	210	250.0	0.0	2	2.4	1.7	35	41.7	0.0	2
Conus pulicarius	1.2	1.2	210	250.0		1	1.2	1.2	35	41.7		1
Conus rattus	21.4	7.8	210	409.1	90.9	11	21.4	8.4	35	93.8	23.3	8

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

4.1.3 All Wallis reef-benthos transect (RBt) assessment data review (continued)

Station: Six 1 m x 40 m transects.

Species	Transects			Transects _P			Stations			Stations _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Conus spp.	8.3	3.1	210	250.0	0.0	7	8.3	3.3	35	48.6	6.9	6
Conus striatus	1.2	1.2	210	250.0		1	1.2	1.2	35	41.7		1
Conus vexillum	8.3	3.1	210	250.0	0.0	7	8.3	4.1	35	58.3	16.7	5
Culcita novaeguineae	141.7	22.3	210	472.2	55.5	63	141.7	45.0	35	215.6	63.5	23
Cymatium rubeculum	1.2	1.2	210	250.0		1	1.2	1.2	35	41.7		1
Cypraea annulus	10.7	3.5	210	250.0	0.0	9	10.7	3.6	35	46.9	5.2	8
Cypraea arabica	4.8	2.4	210	250.0	0.0	4	4.8	3.3	35	83.3	0.0	2
Cypraea erosa	1.2	1.2	210	250.0		1	1.2	1.2	35	41.7		1
Cypraea mappa mappa	3.6	3.6	210	750.0		1	3.6	3.6	35	125.0		1
Cypraea moneta	14.3	4.7	210	300.0	33.3	10	14.3	5.1	35	62.5	11.1	8
Cypraea tigris	59.5	12.1	210	357.1	47.3	35	59.5	15.2	35	99.2	21.4	21
Diadema spp.	10.7	7.4	210	562.5	312.5	4	10.7	7.3	35	93.8	52.1	4
Drupa ricinus	2.4	1.7	210	250.0	0.0	2	2.4	1.7	35	41.7	0.0	2
Drupa spp.	2.4	2.4	210	500.0		1	2.4	2.4	35	83.3		1
Drupella cornus	1.2	1.2	210	250.0		1	1.2	1.2	35	41.7		1
Drupella spp.	19.0	7.0	210	400.0	85.0	10	19.0	6.7	35	74.1	15.2	9
Echinometra mathaei	26.2	6.3	210	305.6	25.2	18	26.2	6.9	35	70.5	9.9	13
Echinothrix calamaris	3.6	2.7	210	375.0	125.0	2	3.6	2.6	35	62.5	20.8	2
Echinothrix diadema	60.7	14.0	210	510.0	69.9	25	60.7	26.7	35	177.1	67.5	12
Echinothrix spp.	15.5	6.3	210	406.3	93.8	8	15.5	6.9	35	90.3	22.6	6
Fragum unedo	1.2	1.2	210	250.0		1	1.2	1.2	35	41.7		1
Holothuria atra	3659.5	1015.3	210	10,527.4	2757.4	73	3659.5	2317.7	35	5822.0	3638.2	22
Holothuria fuscopunctata	1.2	1.2	210	250.0		1	1.2	1.2	35	41.7		1
Holothuria hilla	3.6	2.7	210	375.0	125.0	2	3.6	3.6	35	125.0		1
Holothuria nobilis	7.1	4.1	210	375.0	125.0	4	7.1	5.0	35	83.3	41.7	3
Lambis truncata	1.2	1.2	210	250.0		1	1.2	1.2	35	41.7		1
Latirolagena smaragdula	11.9	6.3	210	500.0	158.1	5	11.9	7.0	35	138.9	27.8	3

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

4.1.3 All Wallis reef-benthos transect (RBt) assessment data review (continued)

Station: Six 1 m x 40 m transects.

Species	Transects			Transects _P			Stations			Stations _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Lima spp.	9.5	7.5	210	1000.0	500.0	2	9.5	9.5	35	333.3		1
Linckia laevigata	492.9	43.9	210	790.1	56.3	131	492.9	90.9	35	575.0	98.4	30
Lysiosquillina maculata	2.4	1.7	210	250.0	0.0	2	2.4	1.7	35	41.7	0.0	2
Peristernia spp.	10.7	4.2	210	321.4	46.1	7	10.7	5.8	35	93.8	26.2	4
Pleuroploca spp.	3.6	2.1	210	250.0	0.0	3	3.6	2.0	35	41.7	0.0	3
Pleuroploca trapezium	6.0	3.6	210	416.7	83.3	3	6.0	4.9	35	104.2	62.5	2
Spondylus spp.	4.8	2.4	210	250.0	0.0	4	4.8	2.3	35	41.7	0.0	4
Stenopus hispidus	1.2	1.2	210	250.0		1	1.2	1.2	35	41.7		1
Stichodactyla spp.	2.4	1.7	210	250.0	0.0	2	2.4	1.7	35	41.7	0.0	2
Stichopus chloronotus	148.8	31.1	210	762.2	119.1	41	148.8	66.0	35	372.0	148.7	14
Stichopus hermanni	2.4	1.7	210	250.0	0.0	2	2.4	1.7	35	41.7	0.0	2
Strombus luhuanus	732.1	261.0	210	8541.7	2418.0	18	732.1	601.4	35	4270.8	3365.0	6
Strombus spp.	1.2	1.2	210	250.0		1	1.2	1.2	35	41.7		1
Synapta spp.	1.2	1.2	210	250.0		1	1.2	1.2	35	41.7		1
Thelenota ananas	1.2	1.2	210	250.0		1	1.2	1.2	35	41.7		1
Tridacna maxima	33.3	6.6	210	280.0	16.6	25	33.3	9.8	35	77.8	17.2	15
Trochus niloticus	4.8	2.9	210	333.3	83.3	3	4.8	2.8	35	55.6	13.9	3
Turbo spp.	1.2	1.2	210	250.0		1	1.2	1.2	35	41.7		1

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

4.1.4 All Wallis soft-benthos quadrat (SBq) assessment data review

Station: 8 quadrat groups (4 quadrats/group).

Species	Quadrat groups			Quadrat groups _P			Stations			Stations _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Anadara spp.	1.1	0.3	184	17.3	1.3	12	1.1	0.4	23	2.9	0.7	9
Archaster typicus	1.4	0.4	184	19.7	2.7	13	1.4	0.5	23	4.6	1.0	7
Bohadschia vitiensis	0.3	0.1	184	16.0	0.0	3	0.3	0.1	23	2.0	0.0	3
Cerithium spp.	7.7	2.1	184	44.5	9.5	32	7.7	3.4	23	19.8	7.1	9
Chama spp.	1.3	0.5	184	26.7	5.3	9	1.3	1.0	23	10.0	6.0	3
Codakia spp.	0.2	0.1	184	16.0	0.0	2	0.2	0.1	23	2.0	0.0	2
Conus pulicarius	0.1	0.1	184	16.0		1	0.1	0.1	23	2.0		1
Cypraea annulus	0.3	0.2	184	24.0	8.0	2	0.3	0.2	23	3.0	1.0	2
Cypraea moneta	0.3	0.3	184	48.0		1	0.3	0.3	23	6.0		1
Fragum unedo	0.6	0.3	184	28.0	4.0	4	0.6	0.3	23	4.7	0.7	3
Gafrarium pectinatum	0.4	0.4	184	80.0		1	0.4	0.4	23	10.0		1
Gafrarium spp.	2.5	0.7	184	25.8	3.7	18	2.5	1.2	23	7.3	3.0	8
Gafrarium tumidum	0.3	0.1	184	16.0	0.0	3	0.3	0.3	23	6.0		1
Holothuria atra	11.1	2.3	184	58.5	8.6	35	11.1	5.5	23	25.6	11.2	10
Modiolus spp.	1.8	0.6	184	28.0	5.3	12	1.8	0.7	23	6.0	1.4	7
Nassarius spp.	0.2	0.2	184	32.0		1	0.2	0.2	23	4.0		1
Pinna spp.	0.3	0.2	184	21.3	5.3	3	0.3	0.3	23	4.0	2.0	2
Polinices spp.	0.1	0.1	184	16.0		1	0.1	0.1	23	2.0		1
Rhinoclavis aspera	0.7	0.2	184	16.0	0.0	8	0.7	0.3	23	4.0	0.8	4
Spondylus spp.	0.1	0.1	184	16.0		1	0.1	0.1	23	2.0		1
Stichopus chloronotus	2.3	1.4	184	108.0	39.9	4	2.3	2.3	23	54.0		1
Stichopus horrens	65.2	9.2	184	196.7	18.5	61	65.2	22.0	23	187.5	33.2	8
Strombus gibberulus	0.2	0.2	184	32.0		1	0.2	0.2	23	4.0		1
Tellina palatum	0.2	0.1	184	16.0	0.0	2	0.2	0.1	23	2.0	0.0	2

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

4.1.5 All Wallis reef-front search (RFs) assessment data review

Station: Six 5-min search periods.

Species	Transects			Transects _P			Stations			Stations _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinopyga mauritiana	2.1	1.1	66	35.3	6.8	4	2.1	1.1	11	7.8	0	3
Astralium spp.	0.4	0.4	66	23.5		1	0.4	0.4	11	3.9		1
Bohadschia argus	0.7	0.5	66	23.5	0.0	2	0.7	0.7	11	7.8		1
Culcita novaeguineae	0.4	0.4	66	23.5		1	0.4	0.4	11	3.9		1
Cypraea caputserpensis	3.2	1.2	66	30.3	4.3	7	3.2	1.0	11	5.9	0.9	6
Echinothrix diadema	1.1	0.8	66	35.3	11.8	2	1.1	0.8	11	5.9	2.0	2
Holothuria nobilis	0.7	0.5	66	23.5	0.0	2	0.7	0.7	11	7.8		1
Stichodactyla spp.	0.4	0.4	66	23.5		1	0.4	0.4	11	3.9		1
Stichopus chloronotus	5.3	2.5	66	70.6	14.9	5	5.3	5.3	11	58.8		1
Tectus conus	1.1	1.1	66	70.6		1	1.1	1.1	11	11.8		1
Tectus pyramis	0.4	0.4	66	23.5		1	0.4	0.4	11	3.9		1
Thais spp.	1.4	0.7	66	23.5	0.0	4	1.4	0.6	11	3.9	0	4
Tridacna maxima	5.3	1.9	66	35.3	7.2	10	5.3	2.8	11	9.8	4.5	6
Trochus maculata	1.1	1.1	66	70.6		1	1.1	1.1	11	11.8		1
Trochus niloticus	13.9	3.4	66	48.3	7.1	19	13.9	4.5	11	21.8	4.9	7
Turbo argyrostomus	0.7	0.5	66	23.5	0.0	2	0.7	0.7	11	7.8		1
Turbo setosus	0.4	0.4	66	23.5		1	0.4	0.4	11	3.9		1
Vasum spp.	0.7	0.5	66	23.5	0.0	2	0.7	0.5	11	3.9	0	2

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

4.1.6 All Wallis reef-front search by walking (RFs_w) assessment data review

Station: Six 5-min search periods.

Species	Transects			Transects _P			Stations			Stations _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinopyga mauritiana	7.8	3.1	66	57.2	14.8	9	5.6	3.5	7	9.8	5.3	4
Cypraea caputserpensis	2.1	1.2	66	45.9	9.6	3	2.4	1.8	7	8.4	4.0	2
Echinothrix diadema	15.4	5.3	66	84.4	19.3	12	8.3	7.3	7	29.0	22.8	2
Echinothrix spp.	152.7	36.7	66	314.9	64.7	32	226.6	98.0	7	264.4	107.0	6
Holothuria atra	47.1	9.5	66	100.4	15.5	31	44.1	14.3	7	51.5	14.4	6
Thais spp.	1.2	0.9	66	41.1	14.4	2	1.5	1.0	7	5.3	0.9	2
Tridacna maxima	6.4	5.1	66	84.5	62.2	5	5.3	5.3	7	37.0		1
Trochus niloticus	63.7	7.6	66	97.8	7.5	43	75.3	9.3	7	75.3	9.3	7
Turbo setosus	1.8	1.1	66	38.7	8.9	3	0.8	0.8	7	5.3		1
Turbo spp.	2.4	1.6	66	52.0	25.3	3	3.7	2.6	7	13.0	4.1	2

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

4.1.7 All Wallis mother-of-pearl search (MOPs) assessment data review

Station: Six 5-min search periods.

Species	Transects			Transects _P			Stations			Stations _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinopyga mauritiana	1.5	1.5	30	45.5		1	1.5	1.5	5	7.6		1
Conus distans	1.5	1.5	30	45.5		1	1.5	1.5	5	7.6		1
Conus marmoreus	1.5	1.5	30	45.5		1	1.5	1.5	5	7.6		1
Conus miles	1.5	1.5	30	45.5		1	1.5	1.5	5	7.6		1
Cypraea caputserpensis	1.5	1.5	30	45.5		1	1.5	1.5	5	7.6		1
Panulirus versicolor	1.5	1.5	30	45.5		1	1.5	1.5	5	7.6		1
Stichodactyla spp.	1.5	1.5	30	45.5		1	1.5	1.5	5	7.6		1
Tectus pyramis	3.0	3.0	30	90.9		1	3.0	3.0	5	15.2		1
Thais spp.	7.6	3.8	30	56.8	11.4	4	7.6	3.4	5	12.6	2.5	3
Tridacna maxima	16.7	4.6	30	50.0	4.5	10	16.7	6.9	5	27.8	2.5	3
Trochus niloticus	18.2	6.4	30	68.2	12.1	8	18.2	9.5	5	22.7	10.7	4
Turbo argyrostomus	3.0	2.1	30	45.5	0.0	2	3.0	3.0	5	15.2		1
Turbo spp.	1.5	1.5	30	45.5		1	1.5	1.5	5	7.6		1
Vasum spp.	1.5	1.5	30	45.5		1	1.5	1.5	5	7.6		1

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

4.1.8 All Wallis mother-of-pearl transect (MOPt) assessment data review

Station: Six 1 m x 40 m transects.

Species	Transects			Transects _P			Stations			Stations _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinopyga mauritiana	14.6	6.0	60	145.8	20.8	6	14.6	5.4	10	29.2	5.1	5
Astralium spp.	12.5	5.7	60	150.0	25.0	5	12.5	8.9	10	62.5	20.8	2
Bohadschia argus	10.4	5.4	60	156.3	31.3	4	10.4	5.6	10	34.7	6.9	3
Bohadschia graeffei	2.1	2.1	60	125.0		1	2.1	2.1	10	20.8		1
Conus miles	2.1	2.1	60	125.0		1	2.1	2.1	10	20.8		1
Coralliophila spp.	2.1	2.1	60	125.0		1	2.1	2.1	10	20.8		1
Cypraea caputserpensis	4.2	4.2	60	250.0		1	4.2	4.2	10	41.7		1
Echinometra mathaei	2.1	2.1	60	125.0		1	2.1	2.1	10	20.8		1
Holothuria atra	2.1	2.1	60	125.0		1	2.1	2.1	10	20.8		1
Holothuria nobilis	6.3	3.5	60	125.0	0.0	3	6.3	4.4	10	31.3	10.4	2
Latirolagena smaragdula	2.1	2.1	60	125.0		1	2.1	2.1	10	20.8		1
Panulirus versicolor	2.1	2.1	60	125.0		1	2.1	2.1	10	20.8		1
Pleuroploca filamentosa	4.2	2.9	60	125.0	0.0	2	4.2	4.2	10	41.7		1
Stichodactyla spp.	2.1	2.1	60	125.0		1	2.1	2.1	10	20.8		1
Stichopus chloronotus	4.2	4.2	60	250.0		1	4.2	4.2	10	41.7		1
Tectus conus	6.3	3.5	60	125.0	0.0	3	6.3	3.2	10	20.8	0.0	3
Tectus pyramis	10.4	4.5	60	125.0	0.0	5	10.4	3.5	10	20.8	0.0	5
Thais spp.	10.4	8.6	60	312.5	187.5	2	10.4	8.4	10	52.1	31.3	2
Tridacna maxima	37.5	11.2	60	173.1	30.2	13	37.5	17.0	10	62.5	23.4	6
Trochus niloticus	185.4	39.1	60	278.1	53.0	40	185.4	60.5	10	185.4	60.5	10
Turbo argyrostomus	6.3	3.5	60	125.0	0.0	3	6.3	4.4	10	31.3	10.4	2
Turbo spp.	4.2	2.9	60	125.0	0.0	2	4.2	2.8	10	20.8	0.0	2

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

4.1.9 All Wallis sea cucumber day search (Ds) assessment data review

Station: Six 5-min search periods.

Species	Transects			Transects _P			Stations			Stations _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinopyga miliaris	1.0	0.5	44	14.3	0.0	3	0.9	0.4	7	2.2	0.2	3
Anadara spp.	0.3	0.3	44	14.3		1	0.3	0.3	7	2.4		1
Bohadschia argus	2.6	1.3	44	22.9	5.7	5	2.3	1.3	7	5.4	1.9	3
Bohadschia vitiensis	0.3	0.3	44	14.3		1	0.3	0.3	7	2.4		1
Cassis cornuta	0.3	0.3	44	14.3		1	0.3	0.3	7	2.4		1
Chicoreus brunneus	0.3	0.3	44	14.3		1	0.3	0.3	7	2.4		1
Chicoreus ramosus	0.6	0.5	44	14.3	0.0	2	0.7	0.4	7	2.4	0.0	2
Conus marmoreus	1.0	1.0	44	42.9		1	0.8	0.8	7	5.4		1
Conus vexillum	0.6	0.6	44	28.6		1	0.7	0.7	7	4.8		1
Culcita novaeguineae	14.6	3.6	44	33.8	6.0	19	14.7	6.4	7	17.2	7.0	6
Holothuria fuscogilva	12.7	5.1	44	39.8	13.6	14	11.4	5.3	7	16.0	6.4	5
Holothuria fuscopunctata	4.2	2.9	44	61.9	29.0	3	4.4	4.0	7	15.5	13.1	2
Holothuria nobilis	0.3	0.3	44	14.3		1	0.3	0.3	7	1.8		1
Lambis truncata	1.0	0.7	44	21.4	7.1	2	1.0	1.0	7	7.1		1
Linckia laevigata	0.3	0.3	44	14.3		1	0.3	0.3	7	2.4		1
Spondylus spp.	0.3	0.3	44	14.3		1	0.3	0.3	7	2.4		1
Stichodactyla spp.	0.3	0.3	44	14.3		1	0.3	0.3	7	1.8		1
Stichopus chloronotus	1.0	0.5	44	14.3	0.0	3	0.8	0.8	7	5.4		1
Stichopus hermanni	0.3	0.3	44	14.3		1	0.3	0.3	7	2.4		1
Thelenota ananas	1.0	0.5	44	14.3	0.0	3	1.0	1.0	7	7.1		1
Thelenota anax	7.5	3.6	44	46.9	16.1	7	7.7	7.4	7	27.1	25.3	2

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

4.1.10 All Wallis sea cucumber night search (Ns) assessment data review

Station: Six 5-min search periods.

Species	Transects			Transects _P			Stations			Stations _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Bohadschia argus	35.6	16.2	30	152.4	50.0	7	30.4	15.1	4	40.5	15.9	3
Bohadschia vitiensis	417.8	117.4	30	596.8	152.4	21	371.1	258.2	4	371.1	258.2	4
Culcita novaeguineae	28.4	10.5	30	94.8	23.1	9	25.2	10.6	4	25.2	10.6	4
Diadema spp.	24.9	8.0	30	83.0	12.9	9	20.7	15.4	4	41.5	23.7	2
Echinometra mathaei	247.1	127.2	30	529.5	256.6	14	302.2	278.7	4	302.2	278.7	4
Echinothrix spp.	21.3	10.1	30	106.7	33.7	6	17.8	17.8	4	71.1		1
Etisus splendidus	3.6	2.5	30	53.3	0.0	2	3.0	3.0	4	11.9		1
Heterocentrotus mammillatus	1.8	1.8	30	53.3		1	1.5	1.5	4	5.9		1
Holothuria atra	247.1	93.6	30	436.1	151.3	17	272.6	146.9	4	363.5	163.2	3
Holothuria fuscopunctata	3.6	3.6	30	106.7		1	3.0	3.0	4	11.9		1
Panulirus versicolor	1.8	1.8	30	53.3		1	1.5	1.5	4	5.9		1
Stichopus chloronotus	104.9	35.7	30	185.1	56.0	17	123.0	64.9	4	164.0	71.2	3
Stichopus hermanni	26.7	11.4	30	100.0	31.0	8	27.4	9.3	4	27.4	9.3	4
Stichopus horrens	3.6	2.5	30	53.3	0.0	2	3.0	3.0	4	11.9		1
Strombus luhuanus	1.8	1.8	30	53.3		1	1.5	1.5	4	5.9		1
Thelenota ananas	3.6	2.5	30	53.3	0.0	2	3.0	3.0	4	11.9		1

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

4.1.11 All Wallis species size review – all survey methods

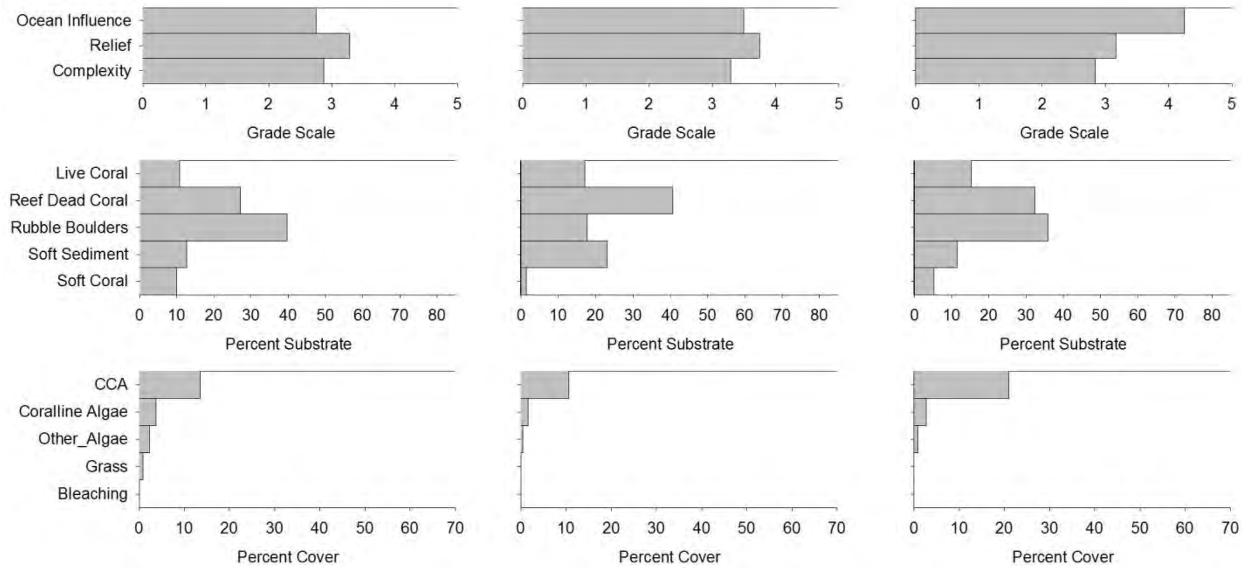
Species	Mean length (cm)	SE	n
Holothuria atra	17.55	0.47	288
Trochus niloticus	9.38	0.14	259
Bohadschia argus	31.65	0.35	213
Stichopus chloronotus	18.66	0.4	158
Tridacna maxima	20.81	0.63	86
Stichopus hermanni	31.90	0.59	49
Cypraea tigris	7.72	0.08	46
Holothuria fuscopunctata	37.64	0.74	36
Conus spp.	8.62	0.47	31
Gafrarium spp.	3.09	0.13	29
Holothuria nobilis	30.52	0.82	25
Holothuria fuscogilva	34.00	0.55	24
Cerithium nodulosum	7.75	0.11	22
Anadara spp.	5.41	0.46	14
Conus marmoreus	6.44	0.25	14
Modiolus spp.	2.82	0.24	13
Conus catus	3.58	0.19	12
Conus rattus	3.42	0.13	12
Holothuria scabra	20.50	1.79	10
Strombus luhuanus	4.51	0.2	10
Cerithium spp.	2.78	0.17	10
Thelenota ananas	45.56	3.23	9
Rhinoclavis aspera	3.23	0.3	8
Conus vexillum	7.49	1.14	7
Bohadschia vitiensis	15.71	1.06	7
Thais spp.	4.8	0.25	7
Tectus pyramis	6.54	0.23	7
Fragum unedo	1.04	0.09	7
Actinopyga miliaris	27.6	1.44	5
Conus bandanus	5.94	0.46	5
Gafrarium pectinatum	3.12	0.13	5
Conus flavidus	3.78	0.13	5
Peristernia spp.	3.4	0.07	5
Latirolagena smaragdula	3.86	0.04	5
Thelenota anax	59.5	5.11	4
Turbo spp.	5.53	1.15	4
Conus lividus	3.18	0.61	4
Chicoreus spp.	4.5	0.32	4
Turbo argyrostomus	6.7	0.3	4
Cerithium aluco	7.48	0.13	4
Cypraea arabica	5.45	0.09	4
Lambis truncata	23.33	4.26	3
Pleuroploca spp.	6.27	1.03	3
Conus miles	3.97	0.79	3
Tectus conus	6.13	0.58	3
Chicoreus brunneus	4.53	0.41	3
Drupella spp.	3.17	0.33	3

4.1.11 All Wallis species size review – all survey methods (continued)

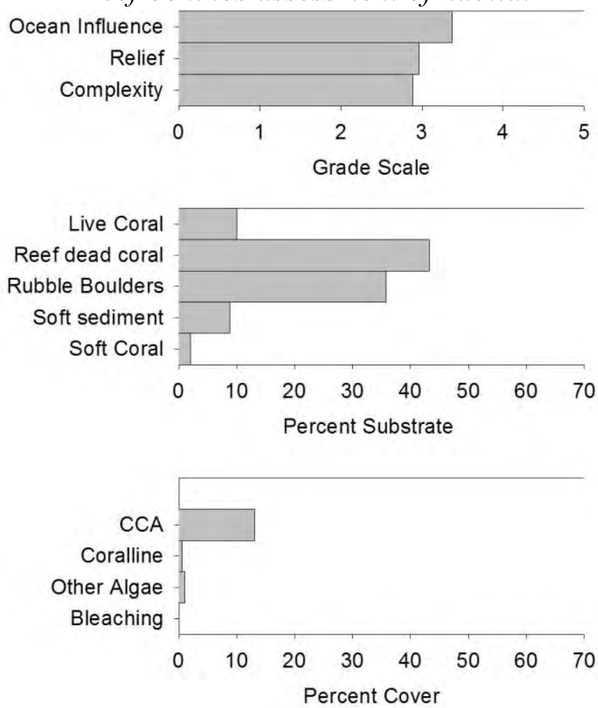
Species	Mean length (cm)	SE	n
Cypraea moneta	1.57	0.23	3
Gafrarium tumidum	2.73	0.07	3
Actinopyga mauritiana	24.5	1.5	2
Conus distans	7	1.5	2
Pleuroploca filamentosa	6	1.5	2
Conus imperialis	5.7	1.2	2
Pleuroploca trapezium	4.45	0.95	2
Conus pulicarius	3.3	0.6	2
Chicoreus ramosus	17	0.5	2
Cypraea annulus	1.75	0.25	2
Chama spp.	11.8	0.2	2
Astralium spp.	3	0.2	2
Tellina palatum	3.55	0.15	2
Strombus gibberulus gibbosus	3.45	0.15	2
Stichopus horrens	27	0	1
Stichodactyla spp.	28	0	1
Cassis cornuta	6.5	0	1
Conus frigidus	4.3	0	1
Conus leopardus	7.5	0	1
Conus striatus	8	0	1
Cymatium rubeculum	2.5	0	1
Drupella cornus	3.4	0	1
Polinices spp.	2.8	0	1
Turbo setosus	6	0	1
Vasum spp.	8	0	1

4.1.12 Habitat descriptors for independent assessments – All Wallis

Broad-scale inner, middle and outer assessments of habitat



Reef-benthos assessment of habitat



4.2 Vailala invertebrate survey data

4.2.1 Invertebrate species recorded in different assessments in Vailala

Group	Species	Broad scale	Reef benthos	Soft benthos	Others
Bêche-de-mer	*Actinopyga mauritiana*		+		+
Bêche-de-mer	*Actinopyga miliaris*	+	+		+
Bêche-de-mer	*Bohadschia argus*	+	+		+
Bêche-de-mer	*Bohadschia graeffei*				+
Bêche-de-mer	*Bohadschia vitiensis*	+	+	+	+
Bêche-de-mer	*Holothuria atra*	+	+	+	+
Bêche-de-mer	*Holothuria fuscogilva*				+
Bêche-de-mer	*Holothuria fuscopunctata*	+	+		+
Bêche-de-mer	*Holothuria hilla*		+		
Bêche-de-mer	*Holothuria nobilis*	+	+		+
Bêche-de-mer	*Holothuria scabra*	+			
Bêche-de-mer	*Stichopus chloronotus*	+	+	+	+
Bêche-de-mer	*Stichopus hermanni*	+	+		+
Bêche-de-mer	*Stichopus horrens*	+		+	+
Bêche-de-mer	*Synapta* spp.	+			
Bêche-de-mer	*Thelenota ananas*	+	+		+
Bêche-de-mer	*Thelenota anax*				+
Bivalve	*Anadara* spp.	+	+	+	
Bivalve	*Barbatia sp*		+		
Bivalve	*Chama* spp.	+	+	+	
Bivalve	*Codakia* spp.			+	
Bivalve	*Fragum unedo*		+	+	
Bivalve	*Gafrarium pectinatum*			+	
Bivalve	*Gafrarium* spp.			+	
Bivalve	*Gafrarium tumidum*			+	
Bivalve	*Lima* spp.		+		
Bivalve	*Modiolus* spp.			+	
Bivalve	*Pinna* spp.	+		+	
Bivalve	*Spondylus* spp.	+	+	+	+
Bivalve	*Tellina palatum*			+	
Bivalve	*Tridacna maxima*	+	+		+
Cnidarians	*Stichodactyla* spp.	+			+
Crustacean	*Etisus splendidus*				+
Crustacean	*Lysiosquillina maculata*		+		
Crustacean	*Panulirus versicolor*				+
Gastropod	*Astralium* spp.		+		+
Gastropod	*Bursa granularis*		+		
Gastropod	*Cerithium nodulosum*	+	+		
Gastropod	*Cerithium* spp.			+	
Gastropod	*Chicoreus brunneus*		+		
Gastropod	*Chicoreus ramosus*		+		
Gastropod	*Chicoreus* spp.		+		
Gastropod	*Conus bandanus*		+		
Gastropod	*Conus catus*		+		
Gastropod	*Conus coronatus*		+		
Gastropod	*Conus distans*		+		

+ = presence of the species.

Appendix 4: Invertebrate survey data
Vailala

4.2.1 Invertebrate species recorded in different assessments in Vailala (continued)

Group	Species	Broad scale	Reef benthos	Soft benthos	Others
Gastropod	*Conus flavidus*		+		
Gastropod	*Conus imperialis*		+		
Gastropod	*Conus leopardus*		+		
Gastropod	*Conus marmoreus*		+		+
Gastropod	*Conus miles*		+		+
Gastropod	*Conus pulicarius*		+	+	
Gastropod	*Conus rattus*		+		
Gastropod	*Conus* spp.	+	+		
Gastropod	*Conus striatus*		+		
Gastropod	*Conus vexillum*		+		
Gastropod	*Coralliophila* spp.				+
Gastropod	*Cypraea annulus*		+	+	
Gastropod	*Cypraea arabica*		+		
Gastropod	*Cypraea caputserpensis*				+
Gastropod	*Cypraea erosa*		+		
Gastropod	*Cypraea moneta*		+	+	
Gastropod	*Cypraea tigris*	+	+		
Gastropod	*Drupella* spp.		+		
Gastropod	*Latirolagena smaragdula*		+		+
Gastropod	*Nassarius* spp.			+	
Gastropod	*Peristernia* spp.		+		
Gastropod	*Pleuroploca* spp.		+		
Gastropod	*Pleuroploca trapezium*		+		
Gastropod	*Polinices* spp.			+	
Gastropod	*Rhinoclavis aspera*			+	
Gastropod	*Strombus gibberulus gibbosus*	+		+	
Gastropod	*Strombus lentiginosus*	+			
Gastropod	*Strombus luhuanus*	+	+		+
Gastropod	*Strombus* spp.		+		
Gastropod	*Tectus conus*				+
Gastropod	*Tectus pyramis*	+			+
Gastropod	*Thais* spp.				+
Gastropod	*Trochus niloticus*	+	+		+
Gastropod	*Turbo argyrostomus*				+
Gastropod	*Turbo setosus*				+
Gastropod	*Turbo* spp.				+
Gastropod	*Vasum* spp.				+
Star	*Archaster typicus*			+	
Star	*Culcita novaeguineae*	+	+		+
Star	*Linckia laevigata*	+	+		
Urchin	*Diadema* spp.	+	+		+
Urchin	*Echinometra mathaei*		+		+
Urchin	*Echinothrix calamaris*		+		
Urchin	*Echinothrix diadema*	+	+		+
Urchin	*Echinothrix* spp.		+		+
Urchin	*Heterocentrotus mammillatus*				+

+ = presence of the species.

4.2.2 Vailala broad-scale assessment data review

Station: Six 2 m x 300 m transects.

Species	Transect			Transect _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinopyga miliaris	0.2	0.2	73	16.7		1	0.2	0.2	12	2.8		1
Anadara spp.	0.5	0.3	73	16.7	0.0	2	0.5	0.5	12	5.6		1
Bohadschia argus	46.1	9.1	73	99.0	15.2	34	45.5	17.8	12	78.0	24.0	7
Bohadschia vitiensis	1312.2	539.3	73	2902.7	1141.6	33	1208.5	931.9	12	1318.3	1013.7	11
Cerithium nodulosum	1.4	1.0	73	50.0	16.7	2	1.3	1.0	12	7.9	3.2	2
Chama spp.	140.0	115.0	73	928.8	747.5	11	117.9	98.0	12	282.9	227.4	5
Conus spp.	4.3	1.2	73	22.5	2.8	14	4.3	1.2	12	5.8	1.3	9
Culcita novaeguineae	39.4	7.5	73	82.2	12.2	35	39.7	14.2	12	52.9	16.7	9
Cypraea tigris	1.6	0.7	73	19.4	2.8	6	1.6	0.7	12	3.9	1.1	5
Diadema spp.	0.7	0.4	73	16.7	0.0	3	0.7	0.5	12	4.2	1.4	2
Echinothrix diadema	1.1	0.6	73	20.8	4.2	4	1.2	1.2	12	13.9		1
Holothuria atra	1385.8	895.2	73	2529.1	1620.5	40	1155.3	1054.4	12	1732.9	1574.0	8
Holothuria fuscopunctata	1.1	0.8	73	41.3	7.9	2	1.1	1.1	12	13.7		1
Holothuria nobilis	2.1	0.7	73	18.8	2.1	8	2.0	0.7	12	4.0	0.6	6
Holothuria scabra	2.3	1.6	73	83.3	16.7	2	2.3	1.6	12	13.8	2.7	2
Linckia laevigata	120.8	30.5	73	244.9	54.8	36	120.3	60.5	12	180.4	84.1	8
Pinna spp.	0.2	0.2	73	16.7		1	0.2	0.2	12	2.8		1
Spondylus spp.	1.8	0.8	73	22.0	3.4	6	1.7	0.8	12	4.1	1.3	5
Stichodactyla spp.	3.0	1.5	73	43.3	13.5	5	3.0	1.9	12	12.0	4.6	3
Stichopus chloronotus	561.9	353.2	73	1709.0	1049.9	24	582.6	392.3	12	998.7	643.7	7
Stichopus hermanni	8.4	3.6	73	55.7	18.7	11	8.5	4.9	12	34.1	9.8	3
Stichopus horrens	704.1	480.6	73	6425.0	4053.5	8	715.3	697.3	12	4291.7	4091.7	2
Strombus gibberulus gibbosus	501.8	322.7	73	12,211.1	4438.9	3	502.2	309.0	12	2008.7	766.3	3
Strombus lentiginosus	1.8	1.2	73	44.4	14.7	3	1.6	1.6	12	19.0		1
Strombus luhuanus	28.5	15.3	73	189.4	90.2	11	25.6	19.9	12	51.1	38.5	6
Synapta spp.	0.2	0.2	73	16.7		1	0.2	0.2	12	2.8		1

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

4.2.2 Vailala broad-scale manta assessment data review (continued)
Station: Six 2 m x 300 m transects.

Species	Transect			Transect _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Tectus pyramis	0.2	0.2	73	16.7		1	0.2	0.2	12	2.8		1
Thelenota ananas	0.5	0.3	73	16.7	0.0	2	0.5	0.3	12	2.8	0.0	2
Tridacna maxima	0.5	0.3	73	16.7	0.0	2	0.5	0.3	12	2.8	0.0	2
Trochus niloticus	0.2	0.2	73	16.7		1	0.2	0.2	12	2.8		1

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

4.2.3 Vailala reef-benthos transect (RBt) assessment data review
Station: Six 1 m x 40 m transects.

Species	Transect			Transect _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinopyga mauritiana	2.5	2.5	102	250.0		1	2.5	2.5	17	41.7		1
Actinopyga miliaris	2.5	2.5	102	250.0		1	2.5	2.5	17	41.7		1
Anadara spp.	4.9	4.9	102	500.0		1	4.9	4.9	17	83.3		1
Astralium spp.	2.5	2.5	102	250.0		1	2.5	2.5	17	41.7		1
Barbatia spp.	4.9	4.9	102	500.0		1	4.9	4.9	17	83.3		1
Bohadschia argus	147.1	25.2	102	428.6	44.2	35	147.1	47.3	17	192.3	56.3	13
Bohadschia vitiensis	12.3	5.4	102	250.0	0.0	5	12.3	7.8	17	69.4	27.8	3
Bursa granularis	2.5	2.5	102	250.0		1	2.5	2.5	17	41.7		1
Cerithium nodulosum	53.9	20.2	102	550.0	128.0	10	53.9	38.8	17	152.8	103.0	6
Chama spp.	105.4	30.1	102	511.9	108.4	21	105.4	31.6	17	162.9	39.1	11
Chicoreus brunneus	19.6	6.7	102	250.0	0.0	8	19.6	7.3	17	55.6	8.8	6
Chicoreus ramosus	2.5	2.5	102	250.0		1	2.5	2.5	17	41.7		1
Chicoreus spp.	7.4	4.2	102	250.0	0.0	3	7.4	4.0	17	41.7	0.0	3
Conus bandanus	7.4	5.5	102	375.0	125.0	2	7.4	5.3	17	62.5	20.8	2
Conus catus	14.7	7.7	102	375.0	72.2	4	14.7	10.7	17	125.0	41.7	2
Conus coronatus	7.4	7.4	102	750.0		1	7.4	7.4	17	125.0		1
Conus distans	4.9	3.4	102	250.0	0.0	2	4.9	4.9	17	83.3		1

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

4.2.3 Vailala reef-benthos transect (RBt) assessment data review (continued)

Station: Six 1 m x 40 m transects.

Species	Transect			Transect _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Conus flavidus	7.4	5.5	102	375.0	125.0	2	7.4	5.3	17	62.5	20.8	2
Conus imperialis	4.9	3.4	102	250.0	0.0	2	4.9	3.4	17	41.7	0.0	2
Conus leopardus	2.5	2.5	102	250.0		1	2.5	2.5	17	41.7		1
Conus marmoreus	24.5	11.8	102	416.7	123.6	6	24.5	11.3	17	83.3	22.8	5
Conus miles	4.9	3.4	102	250.0	0.0	2	4.9	3.4	17	41.7	0.0	2
Conus pulicarius	2.5	2.5	102	250.0		1	2.5	2.5	17	41.7		1
Conus rattus	44.1	15.7	102	409.1	90.9	11	44.1	15.8	17	93.8	23.3	8
Conus spp.	7.4	4.2	102	250.0	0.0	3	7.4	4.0	17	41.7	0.0	3
Conus striatus	2.5	2.5	102	250.0		1	2.5	2.5	17	41.7		1
Conus vexillum	4.9	3.4	102	250.0	0.0	2	4.9	3.4	17	41.7	0.0	2
Culcita novaeguineae	208.3	42.2	102	574.3	89.2	37	208.3	87.2	17	295.1	115.4	12
Cypraea annulus	14.7	5.9	102	250.0	0.0	6	14.7	6.1	17	50.0	8.3	5
Cypraea arabica	4.9	3.4	102	250.0	0.0	2	4.9	4.9	17	83.3		1
Cypraea erosa	2.5	2.5	102	250.0		1	2.5	2.5	17	41.7		1
Cypraea moneta	7.4	5.5	102	375.0	125.0	2	7.4	5.3	17	62.5	20.8	2
Cypraea tigris	98.0	23.1	102	400.0	64.5	25	98.0	28.1	17	138.9	33.4	12
Diadema spp.	22.1	15.2	102	562.5	312.5	4	22.1	14.8	17	93.8	52.1	4
Drupella spp.	27.0	13.0	102	458.3	135.7	6	27.0	11.8	17	76.4	22.6	6
Echinometra mathaei	46.6	11.9	102	316.7	29.5	15	46.6	11.2	17	72.0	11.4	11
Echinothrix calamaris	2.5	2.5	102	250.0		1	2.5	2.5	17	41.7		1
Echinothrix diadema	56.4	16.7	102	410.7	67.4	14	56.4	22.6	17	159.7	36.4	6
Echinothrix spp.	29.4	12.7	102	428.6	105.1	7	29.4	13.3	17	100.0	25.0	5
Fragum unedo	2.5	2.5	102	250.0		1	2.5	2.5	17	41.7		1
Holothuria atra	7210.8	2034.7	102	14,710.0	3893.3	50	7210.8	4682.5	17	9429.5	6040.3	13
Holothuria fuscopunctata	2.5	2.5	102	250.0		1	2.5	2.5	17	41.7		1
Holothuria hilla	7.4	5.5	102	375.0	125.0	2	7.4	7.4	17	125.0		1
Holothuria nobilis	12.3	8.1	102	416.7	166.7	3	12.3	10.0	17	104.2	62.5	2

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

4.2.3 Vailala reef-benthos transect (RBt) assessment data review (continued)

Station: Six 1 m x 40 m transects.

Species	Transect			Transect _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Latirolagena smaragdula	14.7	8.4	102	375.0	125.0	4	14.7	10.7	17	125.0	41.7	2
Lima spp.	19.6	15.5	102	1000.0	500.0	2	19.6	19.6	17	333.3		1
Linckia laevigata	671.6	79.2	102	1037.9	96.0	66	671.6	166.5	17	761.1	176.2	15
Lysiosquillina maculata	4.9	3.4	102	250.0	0.0	2	4.9	3.4	17	41.7	0.0	2
Peristernia spp.	9.8	6.0	102	333.3	83.3	3	9.8	6.7	17	83.3	0.0	2
Pleuroploca spp.	4.9	3.4	102	250.0	0.0	2	4.9	3.4	17	41.7	0.0	2
Pleuroploca trapezium	12.3	7.3	102	416.7	83.3	3	12.3	10.0	17	104.2	62.5	2
Spondylus spp.	4.9	3.4	102	250.0	0.0	2	4.9	3.4	17	41.7	0.0	2
Stichopus chloronotus	90.7	20.5	102	420.5	53.0	22	90.7	33.2	17	192.7	50.4	8
Stichopus hermanni	2.5	2.5	102	250.0		1	2.5	2.5	17	41.7		1
Strombus luhuanus	1487.7	528.3	102	10,839.3	2828.7	14	1487.7	1229.9	17	8430.6	6269.9	3
Strombus spp.	2.5	2.5	102	250.0		1	2.5	2.5	17	41.7		1
Thelenota ananas	2.5	2.5	102	250.0		1	2.5	2.5	17	41.7		1
Tridacna maxima	31.9	9.0	102	270.8	20.8	12	31.9	12.6	17	67.7	20.7	8
Trochus niloticus	9.8	6.0	102	333.3	83.3	3	9.8	5.7	17	55.6	13.9	3

4.2.4 Vailala soft-benthos quadrats (SBq) assessment data review

Station: 8 quadrat groups (4 quadrats/group).

Species	Quadrat group			Quadrat group _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Anadara spp.	1.1	0.3	184	17.3	1.3	12	1.1	0.4	23	2.9	0.7	9
Archaster typicus	1.4	0.4	184	19.7	2.7	13	1.4	0.5	23	4.6	1.0	7
Bohadschia vitiensis	0.3	0.1	184	16.0	0.0	3	0.3	0.1	23	2.0	0.0	3
Cerithium spp.	7.7	2.1	184	44.5	9.5	32	7.7	3.4	23	19.8	7.1	9
Chama spp.	1.3	0.5	184	26.7	5.3	9	1.3	1.0	23	10.0	6.0	3
Codakia spp.	0.2	0.1	184	16.0	0.0	2	0.2	0.1	23	2.0	0.0	2
Conus pulicarius	0.1	0.1	184	16.0		1	0.1	0.1	23	2.0		1
Cypraea annulus	0.3	0.2	184	24.0	8.0	2	0.3	0.2	23	3.0	1.0	2
Cypraea moneta	0.3	0.3	184	48.0		1	0.3	0.3	23	6.0		1
Fragum unedo	0.6	0.3	184	28.0	4.0	4	0.6	0.3	23	4.7	0.7	3
Gafrarium pectinatum	0.4	0.4	184	80.0		1	0.4	0.4	23	10.0		1
Gafrarium spp.	2.5	0.7	184	25.8	3.7	18	2.5	1.2	23	7.3	3.0	8
Gafrarium tumidum	0.3	0.1	184	16.0	0.0	3	0.3	0.3	23	6.0		1
Holothuria atra	11.1	2.3	184	58.5	8.6	35	11.1	5.5	23	25.6	11.2	10
Modiolus spp.	1.8	0.6	184	28.0	5.3	12	1.8	0.7	23	6.0	1.4	7
Nassarius spp.	0.2	0.2	184	32.0		1	0.2	0.2	23	4.0		1
Pinna spp.	0.3	0.2	184	21.3	5.3	3	0.3	0.3	23	4.0	2.0	2
Polinices spp.	0.1	0.1	184	16.0		1	0.1	0.1	23	2.0		1
Rhinoclavis aspera	0.7	0.2	184	16.0	0.0	8	0.7	0.3	23	4.0	0.8	4
Spondylus spp.	0.1	0.1	184	16.0		1	0.1	0.1	23	2.0		1
Stichopus chloronotus	2.3	1.4	184	108.0	39.9	4	2.3	2.3	23	54.0		1
Stichopus horrens	65.2	9.2	184	196.7	18.5	61	65.2	22.0	23	187.5	33.2	8
Strombus gibberulus	0.2	0.2	184	32.0		1	0.2	0.2	23	4.0		1
Tellina palatum	0.2	0.1	184	16.0	0.0	2	0.2	0.1	23	2.0	0.0	2

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

4.2.5 Vailala reef-front search (RFs) assessment data review

Station: Six 5-min search periods.

Species	Search period			Search period _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinopyga mauritiana	2.6	1.6	36	31.4	7.8	3	2.6	1.7	6	7.8	0	2
Bohadschia argus	1.3	0.9	36	23.5	0.0	2	1.3	1.3	6	7.8		1
Culcita novaeguineae	0.7	0.7	36	23.5		1	0.7	0.7	6	3.9		1
Cypraea caputserpensis	4.6	2.1	36	32.9	5.8	5	4.6	1.2	6	5.5	1.0	5
Echinothrix diadema	2.0	1.4	36	35.3	11.8	2	2.0	1.3	6	5.9	2.0	2
Holothuria nobilis	1.3	0.9	36	23.5	0.0	2	1.3	1.3	6	7.8		1
Stichodactyla spp.	0.7	0.7	36	23.5		1	0.7	0.7	6	3.9		1
Stichopus chloronotus	9.8	4.5	36	70.6	14.9	5	9.8	9.8	6	58.8		1
Thais spp.	0.7	0.7	36	23.5		1	0.7	0.7	6	3.9		1
Tridacna maxima	7.8	3.2	36	40.3	9.9	7	7.8	5.1	6	15.7	8.2	3
Trochus niloticus	17.6	4.7	36	45.4	7.6	14	17.6	6.8	6	21.2	7.1	5
Turbo setosus	0.7	0.7	36	23.5		1	0.7	0.7	6	3.9		1
Vasum spp.	1.3	0.9	36	23.5	0.0	2	1.3	0.8	6	3.9	0.0	2

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

4.2.6 Vailala reef-front search_walking (RFs_w) assessment data review

Station: Six 5-min search periods.

Species	Search period			Search period _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinopyga mauritiana	21.1	9.6	12	50.6	15.3	5	21.1	17.1	2	21.1	17.1	2
Echinothrix diadema	40.9	14.3	12	70.2	17.4	7	40.9	25.0	2	40.9	25.0	2
Holothuria atra	53.1	26.2	12	106.2	43.6	6	53.1	18.4	2	53.1	18.4	2
Tridacna maxima	7.4	3.2	12	22.3	0.9	4	7.4	0.5	2	7.4	0.5	2
Trochus niloticus	5.7	4.2	12	34.2	13.4	2	5.7	2.2	2	5.7	2.2	2
Turbo setosus	5.7	4.2	12	34.2	13.4	2	5.7	2.2	2	5.7	2.2	2

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

4.2.7 Vailala mother-of-pearl search (MOPs) assessment data review

Station: Six 5-min search periods.

Species	Search period			Search period _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinopyga mauritiana	3.8	3.8	12	45.5		1	3.8	3.8	2	7.6		1
Tridacna maxima	26.5	8.8	12	53.0	7.6	6	26.5	3.8	2	26.5	3.8	2
Trochus niloticus	15.2	8.5	12	60.6	15.2	3	15.2	7.6	2	15.2	7.6	2

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

4.2.8 Vailala mother-of-pearl transect (MOPt) assessment data review

Station: Six 1 m x 40 m transects.

Species	Transect			Transect _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinopyga mauritiana	17.4	8.8	36	156.3	31.3	4	26.0	10.0	4	34.7	6.9	3
Astralium spp.	20.8	9.3	36	150.0	25.0	5	20.8	20.8	4	83.3		1
Bohadschia argus	17.4	8.8	36	156.3	31.3	4	15.6	10.0	4	31.3	10.4	2
Bohadschia graeffei	3.5	3.5	36	125.0		1	5.2	5.2	4	20.8		1
Conus miles	3.5	3.5	36	125.0		1	5.2	5.2	4	20.8		1
Coralliophila spp.	3.5	3.5	36	125.0		1	5.2	5.2	4	20.8		1
Cypraea caputserpensis	6.9	6.9	36	250.0		1	10.4	10.4	4	41.7		1
Echinometra mathaei	3.5	3.5	36	125.0		1	5.2	5.2	4	20.8		1
Holothuria atra	3.5	3.5	36	125.0		1	5.2	5.2	4	20.8		1
Holothuria nobilis	10.4	5.8	36	125.0	0.0	3	0.0	0.0	4			0
Latirolagena smaragdula	3.5	3.5	36	125.0		1	5.2	5.2	4	20.8		1
Panulirus versicolor	3.5	3.5	36	125.0		1	5.2	5.2	4	20.8		1
Stichopus chloronotus	6.9	6.9	36	250.0		1	10.4	10.4	4	41.7		1
Tectus conus	3.5	3.5	36	125.0		1	5.2	5.2	4	20.8		1
Tectus pyramis	10.4	5.8	36	125.0	0.0	3	10.4	6.0	4	20.8	0.0	2
Thais spp.	13.9	13.9	36	500.0		1	20.8	20.8	4	83.3		1
Tridacna maxima	48.6	16.7	36	175.0	38.2	10	52.1	38.5	4	69.4	48.6	3
Trochus niloticus	111.1	24.8	36	210.5	33.2	19	93.8	45.4	4	93.8	45.4	4
Turbo argyrostomus	3.5	3.5	36	125.0		1	5.2	5.2	4	20.8		1
Turbo spp.	3.5	3.5	36	125.0		1	5.2	5.2	4	20.8		1

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

4.2.9 Vailala sea cucumber night search (Ns) assessment data review

Station: Six 5-min search periods.

Species	Search period			Search period _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Bohadschia argus	56.3	26.0	18	168.9	55.8	6	56.3	3.0	2	56.3	3.0	2
Bohadschia vitiensis	604.4	178.9	18	836.9	215.8	13	604.4	539.3	2	604.4	539.3	2
Culcita novaeguineae	41.5	16.5	18	106.7	28.5	7	41.5	11.9	2	41.5	11.9	2
Diadema spp.	41.5	11.9	18	83.0	12.9	9	41.5	23.7	2	41.5	23.7	2
Echinometra mathaei	26.7	8.9	18	68.6	9.8	7	26.7	20.7	2	26.7	20.7	2
Echinothrix spp.	35.6	16.1	18	106.7	33.7	6	35.6	35.6	2	71.1		1
Etisus splendidus	5.9	4.1	18	53.3	0.0	2	5.9	5.9	2	11.9		1
Heterocentrotus mammillatus	3.0	3.0	18	53.3		1	3.0	3.0	2	5.9		1
Holothuria atra	145.2	50.2	18	290.4	73.9	9	145.2	145.2	2	290.4		1
Holothuria fuscopunctata	5.9	5.9	18	106.7		1	5.9	5.9	2	11.9		1
Panulirus versicolor	3.0	3.0	18	53.3		1	3.0	3.0	2	5.9		1
Stichopus chloronotus	32.6	9.8	18	73.3	9.8	8	32.6	32.6	2	65.2		1
Stichopus hermanni	23.7	15.1	18	106.7	53.3	4	23.7	17.8	2	23.7	17.8	2
Stichopus horrens	5.9	4.1	18	53.3	0.0	2	5.9	5.9	2	11.9		1
Strombus luhuanus	3.0	3.0	18	53.3		1	3.0	3.0	2	5.9		1
Thelenota ananas	5.9	4.1	18	53.3	0.0	2	5.9	5.9	2	11.9		1

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

4.2.10 Vailala sea cucumber day search (Ds) assessment data review

Station: Six 5-min search periods.

Species	Search period			Search period _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinopyga miliaris	0.7	0.7	20	14.3		1	0.9	0.5	4	1.8		1
Bohadschia argus	5.0	2.6	20	25.0	6.8	4	5.5	1.7	5	6.8	2.1	2
Conus marmoreus	2.1	2.1	20	42.9		1	2.7	1.5	4	5.4		1
Culcita novaeguineae	12.9	2.9	20	21.4	2.8	12	12.9	3.0	6	12.9	4.8	3
Holothuria fuscogilva	18.6	10.5	20	53.1	26.4	7	16.3	7.3	6	16.3	11.6	3
Holothuria fuscopunctata	8.6	6.3	20	85.7	28.6	2	14.3	8.2	4	28.6		1
Holothuria nobilis	0.7	0.7	20	14.3		1	0.9	0.5	4	1.8		1
Spondylus spp.	0.7	0.7	20	14.3		1	1.2	0.7	4	2.4		1
Stichodactyla spp.	0.7	0.7	20	14.3		1	0.9	0.5	4	1.8		1
Stichopus chloronotus	2.1	1.2	20	14.3	0.0	3	2.7	1.5	4	5.4		1
Stichopus hermanni	0.7	0.7	20	14.3		1	1.2	0.7	4	2.4		1
Thelenota anax	0.7	0.7	20	14.3		1	0.9	0.5	4	1.8		1

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

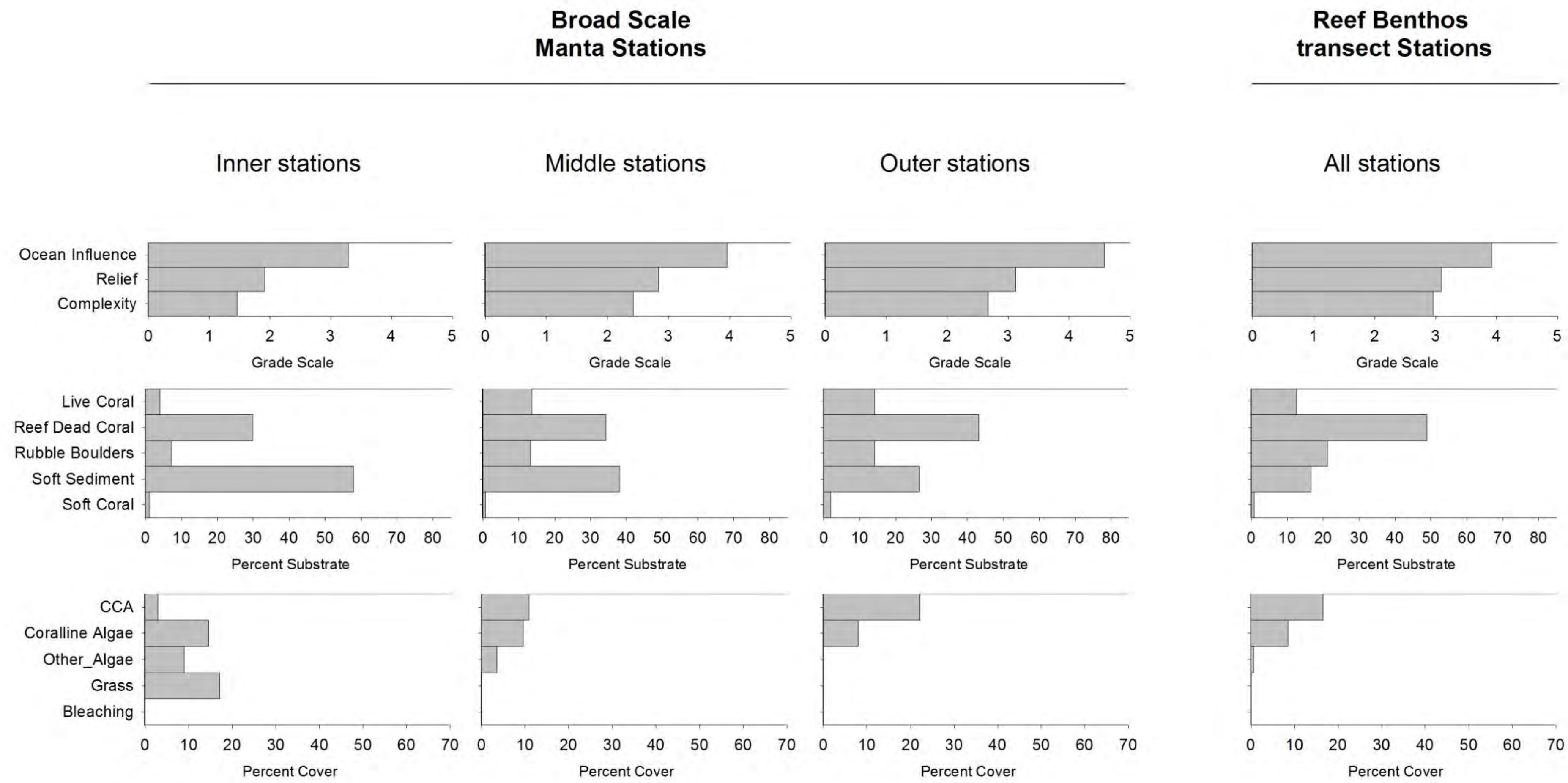
4.2.11 Vailala species size review — all survey methods

Species	Mean length (cm)	SE	n
Holothuria atra	17.6	0.6	7744
Bohadschia vitiensis	15.7	1.1	3767
Stichopus chloronotus	18.1	0.6	2555
Strombus gibberulus gibbosus	3.5	0.2	2200
Strombus luhuanus	4.8	0.1	733
Bohadschia argus	32.9	0.5	295
Cerithium spp.	2.8	0.2	89
Trochus niloticus	11.0	0.2	71
Tridacna maxima	21.6	0.8	52
Stichopus hermanni	31.5	0.9	47
Cypraea tigris	7.6	0.1	47
Gafrarium spp.	3.1	0.1	29
Cerithium nodulosum	7.7	0.1	28
Holothuria fuscogilva	33.9	0.6	26
Actinopyga mauritiana	24.5	1.5	23
Conus spp.	9.2	0.5	21
Modiolus spp.	2.7	0.2	21
Holothuria nobilis	31.5	1.0	20
Holothuria fuscopunctata	39.8	0.9	20
Conus rattus	3.4	0.1	18
Anadara spp.	5.4	0.5	17
Conus marmoreus	6.4	0.3	13
Holothuria scabra	20.5	1.8	10
Rhinoclavis aspera	3.2	0.3	8
Fragum unedo	1.0	0.1	8
Astralium spp.	3.0	0.2	7
Latirolagena smaragdula	3.9	0.0	7
Conus catus	3.9	0.1	6
Thelenota ananas	45.8	5.8	5
Pleuroploca trapezium	4.8	0.6	5
Thais spp.	4.6	0.2	5
Gafrarium pectinatum	3.1	0.1	5
Tectus pyramis	6.2	0.4	4
Actinopyga miliaris	29.0	2.1	3
Conus miles	4.0	0.8	3
Conus bandanus	5.4	0.6	3
Chicoreus spp.	4.7	0.4	3
Conus flavidus	3.8	0.2	3
Gafrarium tumidum	2.7	0.1	3
Conus vexillum	9.4	1.6	2
Conus distans	7.0	1.5	2
Conus imperialis	5.7	1.2	2
Conus pulicarius	3.3	0.6	2
Pleuroploca spp.	5.3	0.3	2
Tellina palatum	3.6	0.2	2
Cypraea arabica	5.4	0.2	2
Stichopus horrens	27.0		3836
Cypraea annulus	1.5		9

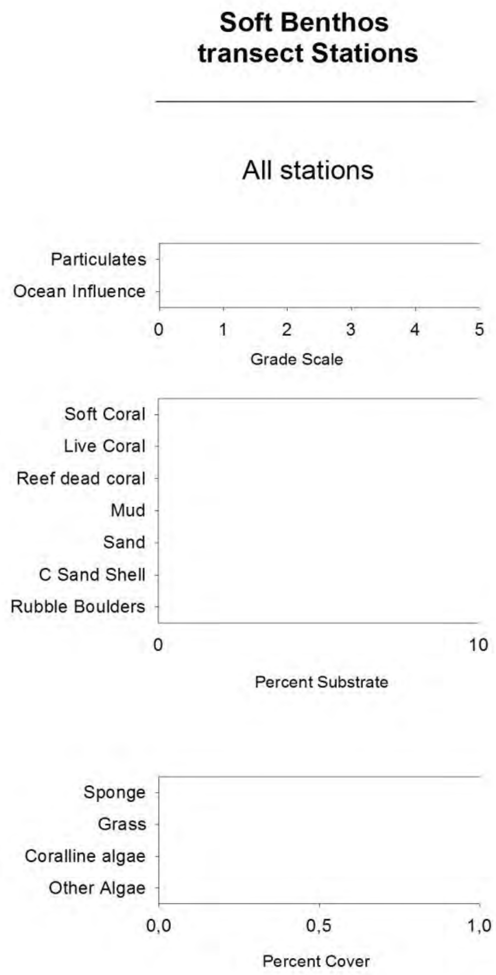
4.2.11 Vailala species size review — all techniques (continued)

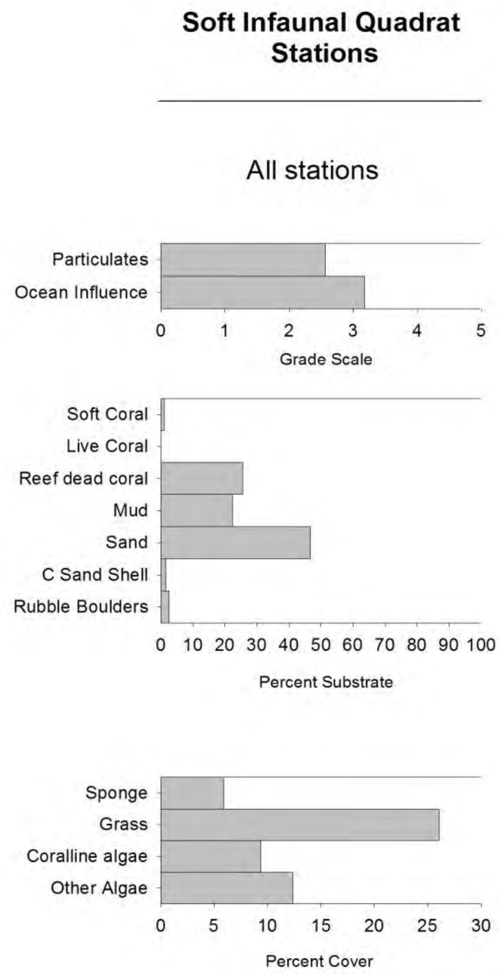
Species	Mean length (cm)	SE	n
Chicoreus ramosus	16.5		1
Conus leopardus	7.5		1
Conus striatus	8.0		1
Polinices spp.	2.8		1
Tectus conus	6.5		1
Turbo argyrostomus	6.8		1
Turbo spp.	6.5		1
Thelenota anax	45.0		1
Linckia laevigata			803
Chama spp.			386
Culcita novaeguineae			286
Echinothrix diadema			54
Echinometra mathaei			29
Diadema spp.			26
Echinothrix spp.			24
Archaster typicus			16
Stichodactyla spp.			15
Drupella spp.			11
Spondylus spp.			10
Cypraea caputserpensis			9
Chicoreus brunneus			8
Lima spp.			8
Strombus lentiginosus			8
Cypraea moneta			6
Pinna spp.			5
Peristernia spp.			4
Turbo setosus			4
Conus coronatus			3
Holothuria hilla			3
Lysiosquillina maculata			2
Etisus splendidus			2
Vasum spp.			2
Codakia spp.			2
Panulirus versicolor			2
Nassarius spp.			2
Barbatia spp.			2
Heterocentrotus mammillatus			1
Echinothrix calamaris			1
Bursa granularis			1
Coralliophila spp.			1
Synapta spp.			1
Cypraea erosa			1
Bohadschia graeffei			1
Strombus spp.			1

4.2.12 Habitat descriptors for independent assessment – Vailala



4.2.12 Habitat descriptors for independent assessment – Vailala (continued)





4.3 Halalo invertebrate survey data

4.3.1 Invertebrate species recorded in different assessments in Halalo

Group	Species	Broad scale	Reef benthos	Soft benthos	Others
Bêche-de-mer	*Actinopyga mauritiana*				+
Bêche-de-mer	*Actinopyga miliaris*	+			+
Bêche-de-mer	*Bohadschia argus*	+	+		+
Bêche-de-mer	*Bohadschia graeffei*	+			
Bêche-de-mer	*Bohadschia vitiensis*	+			+
Bêche-de-mer	*Holothuria atra*	+	+		+
Bêche-de-mer	*Holothuria fuscogilva*				+
Bêche-de-mer	*Holothuria fuscopunctata*	+			+
Bêche-de-mer	*Holothuria nobilis*	+	+		
Bêche-de-mer	*Stichopus chloronotus*	+	+		+
Bêche-de-mer	*Stichopus hermanni*	+	+		+
Bêche-de-mer	*Synapta* spp.	+	+		
Bêche-de-mer	*Thelenota ananas*	+			+
Bêche-de-mer	*Thelenota anax*				+
Bivalve	*Anadara* spp.	+			+
Bivalve	*Chama* spp.	+	+		
Bivalve	*Hyotissa* spp.	+			
Bivalve	*Spondylus* spp.	+	+		
Bivalve	*Tridacna maxima*	+	+		+
Cnidarians	*Stichodactyla* spp.	+	+		+
Crustacean	*Lysiosquillina maculata*	+			
Crustacean	*Panulirus* spp.	+			
Crustacean	*Panulirus versicolor*	+			+
Crustacean	*Stenopus hispidus*		+		
Gastropod	*Astralium* spp.				+
Gastropod	*Cassis cornuta*				+
Gastropod	*Cerithium aluco*		+		
Gastropod	*Cerithium nodulosum*	+			
Gastropod	*Chicoreus brunneus*		+		+
Gastropod	*Chicoreus ramosus*				+
Gastropod	*Chicoreus* spp.		+		
Gastropod	*Conus bandanus*		+		
Gastropod	*Conus catus*		+		
Gastropod	*Conus coronatus*		+		
Gastropod	*Conus distans*				+
Gastropod	*Conus flavidus*		+		
Gastropod	*Conus frigidus*		+		
Gastropod	*Conus lividus*		+		
Gastropod	*Conus marmoreus*		+		+
Gastropod	*Conus miles*				+
Gastropod	*Conus* spp.	+	+		
Gastropod	*Conus vexillum*		+		+
Gastropod	*Cymatium rubeculum*		+		
Gastropod	*Cypraea annulus*		+		
Gastropod	*Cypraea arabica*		+		

+ = presence of the species.

4.3.1 Invertebrate species recorded in different assessments in Halalo (continued)

Group	Species	Broad scale	Reef benthos	Soft benthos	Others
Gastropod	*Cypraea caputserpensis*				+
Gastropod	*Cypraea mappa*		+		
Gastropod	*Cypraea moneta*		+		
Gastropod	*Cypraea tigris*	+	+		
Gastropod	*Drupa ricinus*		+		
Gastropod	*Drupa* spp.		+		
Gastropod	*Drupella cornus*		+		
Gastropod	*Drupella* spp.		+		
Gastropod	*Lambis truncata*	+	+		+
Gastropod	*Latirolagena smaragdula*		+		
Gastropod	*Peristernia* spp.		+		
Gastropod	*Pleuroploca filamentosa*				+
Gastropod	*Pleuroploca* spp.		+		
Gastropod	*Strombus luhuanus*	+	+		
Gastropod	*Tectus conus*				+
Gastropod	*Tectus pyramis*	+			+
Gastropod	*Thais* spp.				+
Gastropod	*Trochus maculata*				+
Gastropod	*Trochus niloticus*	+			+
Gastropod	*Turbo argyrostomus*				+
Gastropod	*Turbo setosus*				+
Gastropod	*Turbo* spp.		+		+
Gastropod	*Vasum* spp.				+
Star	*Acanthaster planci*	+			
Star	*Culcita novaeguineae*	+	+		+
Star	*Linckia laevigata*	+	+		+
Urchin	*Echinometra mathaei*		+		+
Urchin	*Echinothrix calamaris*		+		
Urchin	*Echinothrix diadema*	+	+		+
Urchin	*Echinothrix* spp.	+	+		+

+ = presence of the species.

4.3.2 Halalo broad-scale assessment data review

Station: Six 2 m x 300 m transects.

Species	Transect			Transect _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Acanthaster planci	0.9	0.9	78	66.7		1	0.9	0.9	13	11.1		1
Actinopyga miliaris	0.2	0.2	78	16.7		1	0.2	0.2	13	2.8		1
Anadara spp.	1.3	0.6	78	20.0	3.3	5	1.3	0.8	13	5.7	1.6	3
Bohadschia argus	14.1	3.2	78	43.9	6.8	25	14.1	5.0	13	26.3	6.3	7
Bohadschia graeffei	0.2	0.2	78	16.7		1	0.2	0.2	13	2.8		1
Bohadschia vitiensis	38.5	12.3	78	107.1	30.6	28	39.9	16.6	13	57.7	21.6	9
Cerithium nodulosum	1.1	0.7	78	27.3	11.4	3	1.1	1.1	13	13.7		1
Chama spp.	4.3	1.3	78	27.8	3.7	12	4.3	2.2	13	11.1	4.2	5
Conus spp.	2.6	0.9	78	20.0	3.3	10	2.6	0.7	13	4.2	0.8	8
Culcita novaeguineae	31.0	6.1	78	65.3	10.1	37	31.6	8.6	13	34.3	8.9	12
Cypraea tigris	3.0	1.0	78	23.3	3.7	10	2.8	1.3	13	7.3	2.2	5
Echinothrix diadema	1.7	0.9	78	26.7	10.0	5	1.7	1.3	13	7.3	4.5	3
Echinothrix spp.	0.2	0.2	78	16.7		1	0.2	0.2	13	2.8		1
Holothuria atra	1510.7	958.7	78	2805.5	1765.6	42	1020.1	600.0	13	1205.6	698.7	11
Holothuria fuscopunctata	7.7	2.8	78	50.0	12.8	12	7.7	3.9	13	20.0	7.5	5
Holothuria nobilis	1.3	0.7	78	24.6	8.5	4	1.3	0.9	13	5.6	2.7	3
Hyotissa spp.	0.2	0.2	78	16.7		1	0.2	0.2	13	2.8		1
Lambis truncata	0.4	0.3	78	16.7	0.0	2	0.4	0.3	13	2.8	0.0	2
Linckia laevigata	51.0	8.8	78	92.4	12.9	43	51.3	16.1	13	66.6	18.4	10
Lysiosquillina maculata	0.6	0.5	78	25.0	8.3	2	0.4	0.3	13	2.9	0.1	2
Panulirus spp.	0.4	0.3	78	16.7	0.0	2	0.4	0.3	13	2.9	0.1	2
Panulirus versicolor	0.2	0.2	78	16.7		1	0.2	0.2	13	2.7		1
Spondylus spp.	3.0	0.9	78	21.2	3.2	11	3.0	1.2	13	6.5	1.5	6
Stichodactyla spp.	4.3	1.3	78	27.8	4.7	12	4.3	2.3	13	9.3	4.4	6
Stichopus chloronotus	10.5	3.8	78	68.1	16.8	12	10.3	4.5	13	26.8	6.9	5
Stichopus hermanni	7.5	2.4	78	44.9	9.5	13	7.7	3.3	13	14.3	5.0	7
Strombus luhuanus	7.5	3.3	78	58.2	19.8	10	7.4	4.1	13	16.1	7.8	6
Synapta spp.	0.4	0.3	78	16.7	0.0	2	0.4	0.4	13	5.6		1

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

4.3.2 Halalo broad-scale assessment data review (continued)

Station: Six 2 m x 300 m transects.

Species	Transect			Transect _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Tectus pyramis	0.2	0.2	78	16.7		1	0.2	0.2	13	2.7		1
Thelenota ananas	0.6	0.5	78	24.9	8.2	2	0.6	0.6	13	8.3		1
Tridacna maxima	3.2	1.3	78	31.3	8.0	8	3.2	1.6	13	10.4	3.1	4
Trochus niloticus	0.2	0.2	78	16.7		1	0.2	0.2	13	2.8		1

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

4.3.3 Halalo reef-benthos transect (RBt) assessment data review
Station: Six 1 m x 40 m transects.

Species	Transect			Transect _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Bohadschia argus	134.3	22.2	108	391.9	38.2	37	134.3	44.6	18	201.4	58.2	12
Cerithium aluco	9.3	7.3	108	500.0	250.0	2	9.3	9.3	18	166.7		1
Chama spp.	23.1	9.6	108	357.1	74.3	7	23.1	10.8	18	83.3	22.8	5
Chicoreus brunneus	4.6	3.3	108	250.0	0.0	2	4.6	3.2	18	41.7	0.0	2
Chicoreus spp.	2.3	2.3	108	250.0		1	2.3	2.3	18	41.7		1
Conus bandanus	4.6	3.3	108	250.0	0.0	2	4.6	4.6	18	83.3		1
Conus catus	18.5	9.1	108	400.0	100.0	5	18.5	9.1	18	83.3	17.0	4
Conus coronatus	2.3	2.3	108	250.0		1	2.3	2.3	18	41.7		1
Conus flavidus	4.6	3.3	108	250.0	0.0	2	4.6	3.2	18	41.7	0.0	2
Conus frigidus	2.3	2.3	108	250.0		1	2.3	2.3	18	41.7		1
Conus lividus	9.3	6.5	108	500.0	0.0	2	9.3	9.3	18	166.7		1
Conus marmoreus	2.3	2.3	108	250.0		1	2.3	2.3	18	41.7		1
Conus spp.	9.3	4.6	108	250.0	0.0	4	9.3	5.4	18	55.6	13.9	3
Conus vexillum	11.6	5.1	108	250.0	0.0	5	11.6	7.4	18	69.4	27.8	3
Culcita novaeguineae	78.7	14.9	108	326.9	26.9	26	78.7	25.2	18	128.8	33.5	11
Cymatium rubeculum	2.3	2.3	108	250.0		1	2.3	2.3	18	41.7		1
Cypraea annulus	6.9	4.0	108	250.0	0.0	3	6.9	3.8	18	41.7	0.0	3
Cypraea arabica	4.6	3.3	108	250.0	0.0	2	4.6	4.6	18	83.3		1
Cypraea mappa	6.9	6.9	108	750.0		1	6.9	6.9	18	125.0		1
Cypraea moneta	20.8	7.4	108	281.3	31.3	8	20.8	8.4	18	62.5	14.2	6
Cypraea tigris	23.1	7.0	108	250.0	0.0	10	23.1	6.0	18	46.3	4.6	9
Drupa ricinus	4.6	3.3	108	250.0	0.0	2	4.6	3.2	18	41.7	0.0	2
Drupa spp.	4.6	4.6	108	500.0		1	4.6	4.6	18	83.3		1
Drupella cornus	2.3	2.3	108	250.0		1	2.3	2.3	18	41.7		1
Drupella spp.	11.6	6.1	108	312.5	62.5	4	11.6	6.6	18	69.4	13.9	3
Echinometra mathaei	6.9	4.0	108	250.0	0.0	3	6.9	5.1	18	62.5	20.8	2
Echinothrix calamaris	4.6	4.6	108	500.0		1	4.6	4.6	18	83.3		1
Echinothrix diadema	64.8	22.4	108	636.4	127.8	11	64.8	48.1	18	194.4	136.4	6

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

4.3.3 Halalo reef-benthos transect (RBt) assessment data review (continued)

Station: Six 1 m x 40 m transects.

Species	Transect			Transect _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Echinothrix spp.	2.3	2.3	108	250.0		1	2.3	2.3	18	41.7		1
Holothuria atra	305.6	87.0	108	1434.8	314.8	23	305.6	195.5	18	611.1	373.0	9
Holothuria nobilis	2.3	2.3	108	250.0		1	2.3	2.3	18	41.7		1
Lambis truncata	2.3	2.3	108	250.0		1	2.3	2.3	18	41.7		1
Latirolagena smaragdula	9.3	9.3	108	1000.0		1	9.3	9.3	18	166.7		1
Linckia laevigata	324.1	34.5	108	538.5	38.9	65	324.1	63.8	18	388.9	64.3	15
Peristernia spp.	11.6	6.1	108	312.5	62.5	4	11.6	9.4	18	104.2	62.5	2
Pleuroploca spp.	2.3	2.3	108	250.0		1	2.3	2.3	18	41.7		1
Spondylus spp.	4.6	3.3	108	250.0	0.0	2	4.6	3.2	18	41.7	0.0	2
Stenopus hispidus	2.3	2.3	108	250.0		1	2.3	2.3	18	41.7		1
Stichodactyla spp.	4.6	3.3	108	250.0	0.0	2	4.6	3.2	18	41.7	0.0	2
Stichopus chloronotus	203.7	56.9	108	1157.9	219.0	19	203.7	124.9	18	611.1	330.8	6
Stichopus hermanni	2.3	2.3	108	250.0		1	2.3	2.3	18	41.7		1
Strombus luhuanus	18.5	10.2	108	500.0	144.3	4	18.5	11.3	18	111.1	36.7	3
Synapta spp.	2.3	2.3	108	250.0		1	2.3	2.3	18	41.7		1
Tridacna maxima	34.7	9.6	108	288.5	26.0	13	34.7	15.2	18	89.3	29.4	7
Turbo spp.	2.3	2.3	108	250.0		1	2.3	2.3	18	41.7		1

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

4.3.4 Halalo reef-front search (RFs) assessment data review
Station: Six 5-min search periods.

Species	Search period			Search period _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinopyga mauritiana	1.6	1.6	30	47.1		1	1.6	1.6	5	7.8		1
Astralium spp.	0.8	0.8	30	23.5		1	0.8	0.8	5	3.9		1
Cypraea caputserpensis	1.6	1.1	30	23.5	0.0	2	1.6	1.6	5	7.8		1
Tectus conus	2.4	2.4	30	70.6		1	2.4	2.4	5	11.8		1
Tectus pyramis	0.8	0.8	30	23.5		1	0.8	0.8	5	3.9		1
Thais spp.	2.4	1.3	30	23.5	0.0	3	2.4	1.0	5	3.9	0.0	3
Tridacna maxima	2.4	1.3	30	23.5	0.0	3	2.4	1.0	5	3.9	0.0	3
Trochus maculata	2.4	2.4	30	70.6		1	2.4	2.4	5	11.8		1
Trochus niloticus	9.4	4.7	30	56.5	17.6	5	9.4	5.8	5	23.5	0.0	2
Turbo argyrostomus	1.6	1.1	30	23.5	0.0	2	1.6	1.6	5	7.8		1

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

4.3.5 Halalo reef-front search by walking (RFs_w) assessment data review
Station: Six 5-min search periods.

Species	Search period			Search period _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinopyga mauritiana	4.8	3.0	54	65.4	29.8	4	5.6	3.5	7	9.8	5.3	4
Cypraea caputserpensis	2.6	1.5	54	45.9	9.6	3	2.4	1.8	7	8.4	4.0	2
Echinothrix diadema	9.7	5.4	54	104.4	40.6	5	8.3	7.3	7	29.0	22.8	2
Echinothrix spp.	186.6	43.6	54	314.9	64.7	32	226.6	98.0	7	264.4	107.0	6
Holothuria atra	45.8	10.2	54	99.0	16.7	25	44.1	14.3	7	51.5	14.4	6
Thais spp.	1.5	1.1	54	41.1	14.4	2	1.5	1.0	7	5.3	0.9	2
Tridacna maxima	6.2	6.2	54	333.3		1	5.3	5.3	7	37.0		1
Trochus niloticus	76.6	8.2	54	100.9	7.6	41	75.3	9.3	7	75.3	9.3	7
Turbo setosus	0.9	0.9	54	47.6		1	0.8	0.8	7	5.3		1
Turbo spp.	2.9	2.0	54	52.0	25.3	3	3.7	2.6	7	13.0	4.1	2

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

4.3.6 Halalo mother-of-pearl search (MOPs) assessment data review

Station: Six 5-min search periods.

Species	Search period			Search period _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Conus distans	2.5	2.5	18	45.5		1	2.5	2.5	3	7.6		1
Conus marmoreus	2.5	2.5	18	45.5		1	2.5	2.5	3	7.6		1
Conus miles	2.5	2.5	18	45.5		1	2.5	2.5	3	7.6		1
Cypraea caputserpensis	2.5	2.5	18	45.5		1	2.5	2.5	3	7.6		1
Panulirus versicolor	2.5	2.5	18	45.5		1	2.5	2.5	3	7.6		1
Stichodactyla spp.	2.5	2.5	18	45.5		1	2.5	2.5	3	7.6		1
Tectus pyramis	5.1	5.1	18	90.9		1	5.1	5.1	3	15.2		1
Thais spp.	12.6	6.2	18	56.8	11.4	4	12.6	2.5	3	12.6	2.5	3
Tridacna maxima	10.1	4.6	18	45.5	0.0	4	10.1	10.1	3	30.3		1
Trochus niloticus	20.2	9.2	18	72.7	18.2	5	20.2	16.6	3	30.3	22.7	2
Turbo argyrostomus	5.1	3.5	18	45.5	0.0	2	5.1	5.1	3	15.2		1
Turbo spp.	2.5	2.5	18	45.5		1	2.5	2.5	3	7.6		1
Vasum spp.	2.5	2.5	18	45.5		1	2.5	2.5	3	7.6		1

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

4.3.7 Halalo mother-of-pearl transect (MOPt) assessment data review
Station: Six 1 m x 40 m transects.

Species	Transect			Transect _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinopyga mauritiana	10.4	7.2	24	125.0	0.0	2	10.4	6.0	4	20.8	0.0	2
Pleuroploca filamentosa	10.4	7.2	24	125.0	0.0	2	10.4	10.4	4	41.7		1
Stichodactyla spp.	5.2	5.2	24	125.0		1	5.2	5.2	4	20.8		1
Tectus conus	10.4	7.2	24	125.0	0.0	2	10.4	6.0	4	20.8	0.0	2
Tectus pyramis	10.4	7.2	24	125.0	0.0	2	10.4	6.0	4	20.8	0.0	2
Thais spp.	5.2	5.2	24	125.0		1	5.2	5.2	4	20.8		1
Tridacna maxima	20.8	12.3	24	166.7	41.7	3	20.8	14.7	4	41.7	20.8	2
Trochus niloticus	296.9	86.7	24	339.3	95.7	21	296.9	128.0	4	296.9	128.0	4
Turbo argyrostomus	10.4	7.2	24	125.0	0.0	2	10.4	10.4	4	41.7		1
Turbo spp.	5.2	5.2	24	125.0		1	5.2	5.2	4	20.8		1

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

4.3.8 Halalo sea cucumber night search (Ns) assessment data review
Station: Six 5-min search periods.

Species	Search period			Search period _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Bohadschia argus	4.4	4.4	12	53.3		1	4.4	4.4	2	8.9		1
Bohadschia vitiensis	137.8	69.0	12	206.7	95.9	8	137.8	13.3	2	137.8	13.3	2
Culcita novaeguineae	8.9	6.0	12	53.3	0.0	2	8.9	0.0	2	8.9	0.0	2
Echinometra mathaei	577.8	299.8	12	990.5	463.0	7	577.8	560.0	2	577.8	560.0	2
Holothuria atra	400.0	219.9	12	600.0	311.3	8	400.0	275.6	2	400.0	275.6	2
Stichopus chloronotus	213.3	79.9	12	284.4	95.7	9	213.3	88.9	2	213.3	88.9	2
Stichopus hermanni	31.1	17.9	12	93.3	40.0	4	31.1	13.3	2	31.1	13.3	2

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

4.3.9 Halalo sea cucumber day search (Ds) assessment data review

Station: Six 5-min search periods.

Species	Search period			Search period _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinopyga miliaris	1.2	0.8	24	14.3	0.0	2	1.2	0.7	4	2.4	0.0	2
Anadara spp.	0.6	0.6	24	14.3		1	0.6	0.6	4	2.4		1
Bohadschia argus	0.6	0.6	24	14.3		1	0.6	0.6	4	2.4		1
Bohadschia vitiensis	0.6	0.6	24	14.3		1	0.6	0.6	4	2.4		1
Cassis cornuta	0.6	0.6	24	14.3		1	0.6	0.6	4	2.4		1
Chicoreus brunneus	0.6	0.6	24	14.3		1	0.6	0.6	4	2.4		1
Chicoreus ramosus	1.2	0.8	24	14.3	0.0	2	1.2	0.7	4	2.4	0.0	2
Conus vexillum	1.2	1.2	24	28.6		1	1.2	1.2	4	4.8		1
Culcita novaeguineae	16.1	6.2	24	55.1	12.2	7	16.1	11.5	4	21.4	14.4	3
Holothuria fuscogilva	7.7	3.1	24	26.5	6.6	7	7.7	4.5	4	15.5	1.2	2
Holothuria fuscopunctata	0.6	0.6	24	14.3		1	0.6	0.6	4	2.4		1
Lambis truncata	1.8	1.3	24	21.4	7.1	2	1.8	1.8	4	7.1		1
Linckia laevigata	0.6	0.6	24	14.3		1	0.6	0.6	4	2.4		1
Thelenota ananas	1.8	1.0	24	14.3	0.0	3	1.8	1.8	4	7.1		1
Thelenota anax	13.1	6.3	24	52.4	17.9							

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error.

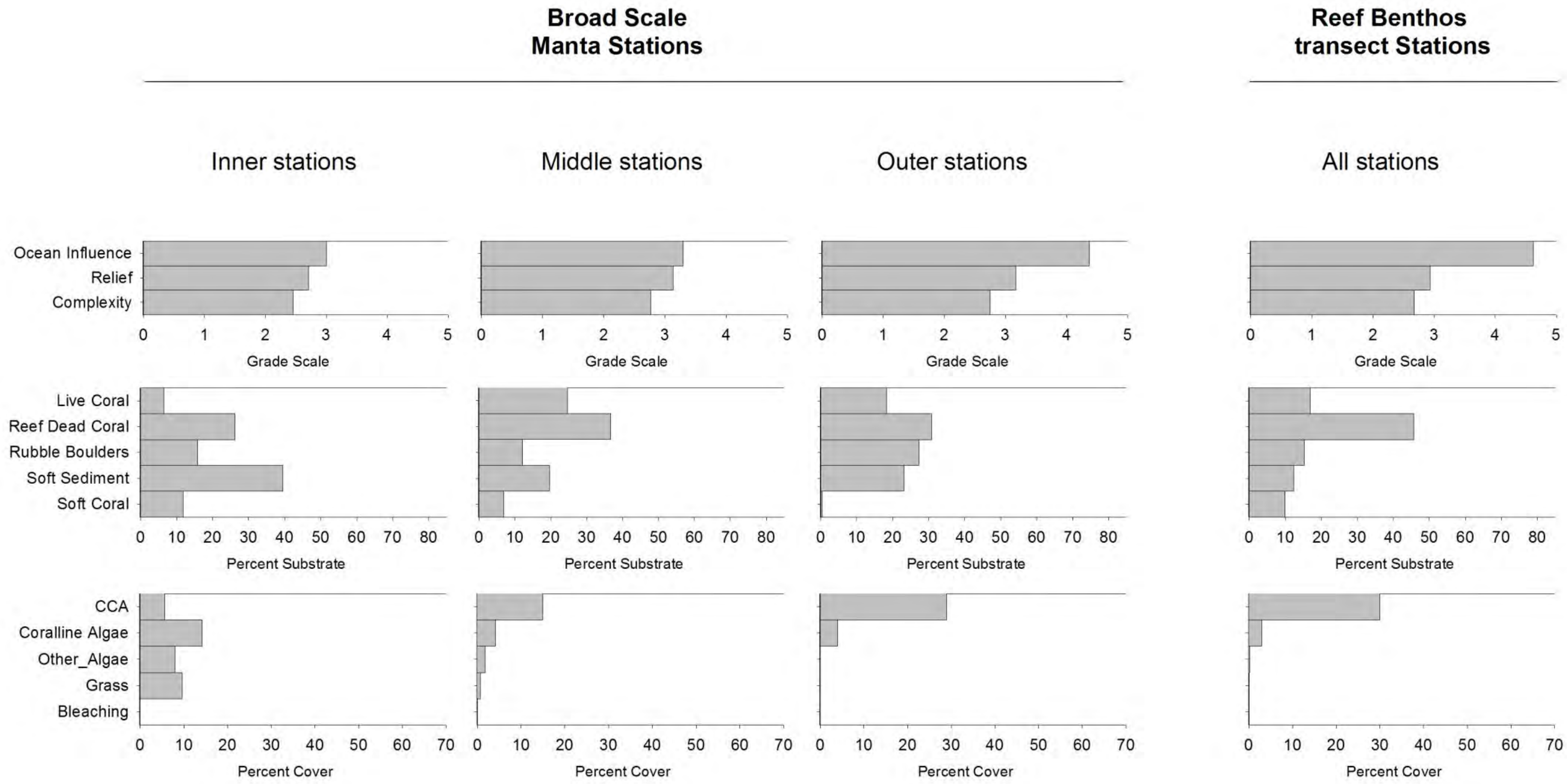
4.3.10 Halalo species size review – all survey methods

Species	Mean length (cm)	SE	N
Holothuria atra	17.5	0.7	4705
Trochus niloticus	8.8	0.2	189
Stichopus chloronotus	18.9	0.5	183
Bohadschia argus	30.1	0.4	126
Tridacna maxima	20.2	1.0	51
Stichopus hermanni	32.3	0.8	43
Strombus luhuanus	4.2	0.3	43
Holothuria fuscopunctata	37.0	0.9	37
Chama spp.	11.8	0.2	30
Cypraea tigris	8.0	0.2	23
Thelenota anax	64.3	2.3	22
Conus spp.	8.4	0.7	16
Holothuria fuscogilva	34.3	1.4	13
Thais spp.	5.1	0.5	11
Cypraea moneta	1.6	0.2	9
Conus catus	3.3	0.3	8
Lambis truncata	23.3	4.3	7
Turbo spp.	5.2	1.6	7
Conus vexillum	6.7	1.4	7
Holothuria nobilis	28.7	0.7	7
Thelenota ananas	45.4	4.2	6
Turbo argyrostomus	6.7	0.4	6
Tectus pyramis	6.8	0.2	6
Tectus conus	6.0	1.0	5
Drupella spp.	3.2	0.3	5
Peristernia spp.	3.4	0.1	5
Conus lividus	3.2	0.6	4
Cerithium aluco	7.5	0.1	4
Actinopyga miliaris	25.5	0.5	3
Chicoreus brunneus	4.5	0.4	3
Pleuroploca filamentosa	6.0	1.5	2
Conus bandanus	6.8	0.3	2
Conus flavidus	3.7	0.2	2
Cypraea arabica	5.6	0.1	2
Stichodactyla spp.	28.0		24
Cypraea annulus	2.0		3
Conus marmoreus	7.0		2
Chicoreus ramosus	17.5		2
Cymatium rubeculum	2.5		1
Pleuroploca spp.	8.3		1
Chicoreus spp.	4.0		1
Turbo setosus	6.0		1
Vasum spp.	8.0		1
Cassis cornuta	6.5		1
Drupella cornus	3.4		1
Conus frigidus	4.3		1
Linckia laevigata			382
Echinothrix spp.			328

4.3.10 Halalo species size review - all survey methods (continued)

Species	Mean length (cm)	SE	n
Bohadschia vitiensis			209
Culcita novaeguineae			208
Echinometra mathaei			133
Echinothrix diadema			51
Spondylus spp.			16
Actinopyga mauritiana			10
Anadara spp.			7
Cypraea caputserpensis			6
Cerithium nodulosum			5
Latirolagena smaragdula			4
Acanthaster planci			4
Synapta spp.			3
Trochus maculata			3
Cypraea mappa			3
Drupa ricinus			2
Drupa spp.			2
Panulirus versicolor			2
Echinothrix calamaris			2
Lysiosquillina maculata			2
Panulirus spp.			2
Bohadschia graeffei			1
Astralium spp.			1
Conus miles			1
Hyotissa spp.			1
Stenopus hispidus			1
Conus coronatus			1
Conus distans			1

4.3.11 Habitat descriptors for independent assessment – Halalo



4.4 All Futuna invertebrate survey data

4.1.1 Invertebrate species recorded in different assessments in All Futuna

Group	Species	Broad scale	Reef benthos	Soft benthos	Others
Bêche-de-mer	*Actinopyga mauritiana*	+	+		+
Bêche-de-mer	*Bohadschia argus*	+	+		+
Bêche-de-mer	*Bohadschia vitiensis*	+			+
Bêche-de-mer	*Holothuria atra*	+	+		+
Bêche-de-mer	*Holothuria coluber*				+
Bêche-de-mer	*Holothuria fuscopunctata*		+		+
Bêche-de-mer	*Holothuria nobilis*	+	+		+
Bêche-de-mer	*Stichopus horrens*				+
Bêche-de-mer	*Thelenota ananas*	+			+
Bêche-de-mer	*Thelenota anax*				+
Bivalve	*Anadara* spp.		+		
Bivalve	*Asaphis violascens*				+
Bivalve	*Tridacna maxima*	+	+		+
Bivalve	*Tridacna squamosa*				+
Cnidarians	*Actinodendron* spp.		+		
Cnidarians	*Stichodactyla* spp.	+	+		+
Crustacean	*Eriphia sebana*				+
Crustacean	*Etisus splendidus*				+
Crustacean	*Gonodactylus* spp.				+
Crustacean	*Panulirus femoristriga albiflagellum*				+
Crustacean	*Panulirus penicillatus*				+
Crustacean	*Panulirus versicolor*				+
Crustacean	*Parribacus caledonicus*				+
Crustacean	*Penaeus* spp.				+
Gastropod	*Astralium* spp.		+		+
Gastropod	*Cerithium nodulosum*				+
Gastropod	*Conus ebraeus*				+
Gastropod	*Conus flavidus*		+		+
Gastropod	*Conus imperialis*		+		+
Gastropod	*Conus litteratus*		+		
Gastropod	*Conus marmoreus*		+		
Gastropod	*Conus* spp.	+	+		+
Gastropod	*Conus vexillum*		+		+
Gastropod	*Cypraea annulus*				+
Gastropod	*Cypraea caputserpensis*		+		+
Gastropod	*Cypraea moneta*		+		+
Gastropod	*Cypraea tigris*		+		+
Gastropod	*Distorsio anus*				+
Gastropod	*Dolabella* spp.				+
Gastropod	*Drupa morum*		+		+
Gastropod	*Lambis truncata*	+	+		
Gastropod	*Latirolagena smaragdula*		+		+
Gastropod	*Mitra stictica*				+
Gastropod	*Morula* spp.		+		
Gastropod	*Oliva* spp.		+		

+ = presence of the species.

4.1.1 Invertebrate species recorded in different assessments in All Futuna (continued)

Group	Species	Broad scale	Reef benthos	Soft benthos	Others
Gastropod	*Pleuroploca filamentosa*				+
Gastropod	*Pleuroploca* spp.		+		
Gastropod	*Pleuroploca trapezium*		+		
Gastropod	*Strombus luhuanus*		+		
Gastropod	*Tectus conus*		+		
Gastropod	*Tectus pyramis*	+	+		+
Gastropod	*Thais aculeata*		+		+
Gastropod	*Thais armigera*				+
Gastropod	*Thais* spp.	+	+		+
Gastropod	*Trochus maculata*				+
Gastropod	*Trochus niloticus*	+	+		+
Gastropod	*Turbo argyrostomus*		+		+
Gastropod	*Turbo chrysostomus*		+		
Gastropod	*Turbo crassus*		+		+
Gastropod	*Turbo setosus*		+		+
Gastropod	*Turbo* spp.		+		
Gastropod	*Vasum ceramicum*		+		+
Gastropod	*Vasum* spp.		+		+
Octopus	*Octopus* spp.	+	+		
Star	*Acanthaster planci*				+
Star	*Culcita novaeguineae*	+			+
Star	*Culcita* spp.				+
Star	*Linckia laevigata*	+	+		+
Urchin	*Echinometra mathaei*	+	+		+
Urchin	*Echinothrix calamaris*		+		+
Urchin	*Echinothrix diadema*	+	+		+
Urchin	*Heterocentrotus mammillatus*				+
Urchin	*Toxopneustes pileolus*		+		

+ = presence of the species.

4.1.2 All Futuna broad-scale assessment data review

Station: Six 2 m x 300 m transects.

Species	Transect			Transect _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinopyga mauritiana	3.5	0.8	119	21.8	2.2	19	3.5	1.2	20	6.5	1.8	11
Bohadschia argus	2.2	0.9	119	32.8	7.9	8	2.3	2.0	20	22.7	17.2	2
Bohadschia vitiensis	0.3	0.2	119	16.7	0.0	2	0.3	0.2	20	2.7	0.0	2
Conus spp.	0.5	0.3	119	19.0	2.4	3	0.4	0.3	20	4.1	1.4	2
Culcita novaeguineae	0.4	0.2	119	16.6	0.0	3	0.4	0.3	20	4.2	1.4	2
Echinometra mathaei	3.7	3.4	119	144.9	127.5	3	3.6	3.5	20	36.3	33.6	2
Echinothrix diadema	10.2	6.9	119	152.3	94.6	8	10.2	7.6	20	40.8	28.0	5
Holothuria atra	0.4	0.2	119	16.6	0.0	3	0.4	0.3	20	4.0	1.3	2
Holothuria nobilis	7.6	2.1	119	53.4	8.5	17	7.7	3.6	20	30.7	8.7	5
Lambis truncata	1.1	0.4	119	16.5	0.5	8	1.1	0.4	20	3.1	0.4	7
Linckia laevigata	0.3	0.2	119	20.2	3.6	2	0.3	0.2	20	2.7	0.1	2
Octopus spp.	0.1	0.1	119	16.7		1	0.1	0.1	20	2.7		1
Stichodactyla spp.	0.3	0.2	119	15.9	0.8	2	0.3	0.2	20	2.8	0.0	2
Tectus pyramis	0.6	0.3	119	16.7	0.0	4	0.5	0.3	20	2.7	0.0	4
Thais spp.	0.3	0.2	119	15.9	0.8	2	0.3	0.2	20	2.7	0.0	2
Thelenota ananas	0.6	0.3	119	22.2	5.6	3	0.5	0.4	20	5.4	0.1	2
Tridacna maxima	39.8	5.2	119	70.6	7.4	67	39.3	8.6	20	41.4	8.8	19
Trochus niloticus	4.6	1.3	119	32.0	5.3	17	4.6	2.3	20	18.6	5.7	5

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error present.

4.1.3 *All Futuna reef-benthos transect (RBt) assessment data review*

Station: Six 1 m x 40 m transects.

Species	Transect			Transect _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinodendron spp.	3.3	2.3	150	250.0	0.0	2	3.3	2.3	25	41.7	0.0	2
Actinopyga mauritiana	83.3	31.0	150	520.8	170.2	24	83.3	44.7	25	148.8	76.5	14
Anadara spp.	1.7	1.7	150	250.0		1	1.7	1.7	25	41.7		1
Astralium spp.	5.0	2.9	150	250.0	0.0	3	5.0	2.8	25	41.7	0.0	3
Bohadschia argus	45.0	13.6	150	421.9	81.4	16	45.0	17.8	25	125.0	37.4	9
Conus flavidus	13.3	5.2	150	285.7	35.7	7	13.3	5.8	25	66.7	10.2	5
Conus imperialis	11.7	4.3	150	250.0	0.0	7	11.7	6.1	25	72.9	19.9	4
Conus litteratus	8.3	4.4	150	312.5	62.5	4	8.3	4.8	25	69.4	13.9	3
Conus marmoreus	1.7	1.7	150	250.0		1	1.7	1.7	25	41.7		1
Conus spp.	75.0	14.7	150	401.8	39.3	28	75.0	24.4	25	144.2	38.2	13
Conus vexillum	5.0	3.7	150	375.0	125.0	2	5.0	5.0	25	125.0		1
Cypraea caputserpensis	13.3	5.2	150	285.7	35.7	7	13.3	4.6	25	47.6	6.0	7
Cypraea moneta	3.3	2.3	150	250.0	0.0	2	3.3	2.3	25	41.7	0.0	2
Cypraea tigris	8.3	4.4	150	312.5	62.5	4	8.3	5.4	25	69.4	27.8	3
Drupa morum	3.3	2.3	150	250.0	0.0	2	3.3	2.3	25	41.7	0.0	2
Echinometra mathaei	50.0	12.5	150	416.7	49.5	18	50.0	18.8	25	138.9	37.4	9
Echinothrix calamaris	5.0	2.9	150	250.0	0.0	3	5.0	2.8	25	41.7	0.0	3
Echinothrix diadema	56.7	14.6	150	447.4	65.1	19	56.7	23.7	25	202.4	55.6	7
Holothuria atra	53.3	22.0	150	727.3	222.2	11	53.3	35.8	25	266.7	155.7	5
Holothuria fuscopunctata	3.3	3.3	150	500.0		1	3.3	3.3	25	83.3		1
Holothuria nobilis	121.7	41.1	150	869.0	240.1	21	121.7	74.9	25	338.0	194.0	9
Lambis truncata	5.0	2.9	150	250.0	0.0	3	5.0	2.8	25	41.7	0.0	3
Latirolagena smaragdula	15.0	7.2	150	450.0	93.5	5	15.0	7.6	25	93.8	19.9	4
Linckia laevigata	46.7	13.2	150	411.8	70.9	17	46.7	18.2	25	145.8	38.6	8
Morula spp.	6.7	3.3	150	250.0	0.0	4	6.7	3.1	25	41.7	0.0	4
Octopus spp.	1.7	1.7	150	250.0		1	1.7	1.7	25	41.7		1

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error present.

4.1.3 All Futuna reef-benthos transect (RBt) assessment data review (continued)

Station: Six 1 m x 40 m transects.

Species	Transect			Transect _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Oliva spp.	1.7	1.7	150	250.0		1	1.7	1.7	25	41.7		1
Pleuroploca spp.	1.7	1.7	150	250.0		1	1.7	1.7	25	41.7		1
Pleuroploca trapezium	3.3	2.3	150	250.0	0.0	2	3.3	2.3	25	41.7	0.0	2
Stichodactyla spp.	1.7	1.7	150	250.0		1	1.7	1.7	25	41.7		1
Strombus luhuanus	1.7	1.7	150	250.0		1	1.7	1.7	25	41.7		1
Tectus conus	13.3	7.8	150	500.0	176.8	4	13.3	8.2	25	111.1	36.7	3
Tectus pyramis	35.0	9.2	150	328.1	37.6	16	35.0	10.1	25	79.5	14.3	11
Thais aculeata	20.0	8.0	150	333.3	83.3	9	20.0	7.7	25	62.5	15.7	8
Thais spp.	16.7	7.4	150	416.7	83.3	6	16.7	7.6	25	83.3	18.6	5
Toxopneustes pileolus	1.7	1.7	150	250.0		1	1.7	1.7	25	41.7		1
Tridacna maxima	75.0	14.7	150	375.0	41.1	30	75.0	25.0	25	104.2	32.4	18
Trochus niloticus	86.7	15.9	150	382.4	39.8	34	86.7	21.1	25	144.4	26.0	15
Turbo argyrostomus	3.3	2.3	150	250.0	0.0	2	3.3	2.3	25	41.7	0.0	2
Turbo chrysostomus	6.7	3.3	150	250.0	0.0	4	6.7	3.9	25	55.6	13.9	3
Turbo crassus	13.3	5.2	150	285.7	35.7	7	13.3	10.1	25	111.1	69.4	3
Turbo setosus	16.7	8.7	150	500.0	158.1	5	16.7	12.0	25	138.9	77.3	3
Turbo spp.	5.0	2.9	150	250.0	0.0	3	5.0	2.8	25	41.7	0.0	3
Vasum ceramicum	41.7	9.3	150	297.6	27.9	21	41.7	9.6	25	69.4	11.3	15
Vasum spp.	13.3	6.6	150	400.0	100.0	5	13.3	10.1	25	111.1	69.4	3

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error present.

4.1.4 All Futuna reef-front search (RFs) assessment data review

Station: Six 5-min search periods.

Species	Search period			Search period _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinopyga mauritiana	7.8	2.2	60	33.6	5.4	14	7.8	3.3	10	11.2	4.1	7
Conus flavidus	1.2	0.7	60	23.5	0.0	3	1.2	0.8	10	5.9	2.0	2
Conus vexillum	1.2	0.7	60	23.5	0.0	3	1.2	0.6	10	3.9	0.0	3
Cypraea caputserpensis	0.4	0.4	60	23.5		1	0.4	0.4	10	3.9		1
Cypraea tigris	0.4	0.4	60	23.5		1	0.4	0.4	10	3.9		1
Drupa morum	0.8	0.8	60	47.1		1	0.8	0.8	10	7.8		1
Echinometra mathaei	4.7	3.3	60	94.1	47.1	3	4.7	3.9	10	23.5	15.7	2
Echinothrix diadema	8.6	4.1	60	73.9	24.3	7	8.6	6.2	10	43.1	15.7	2
Holothuria nobilis	0.8	0.5	60	23.5	0.0	2	0.8	0.5	10	3.9	0.0	2
Latirolagena smaragdula	0.4	0.4	60	23.5		1	0.4	0.4	10	3.9		1
Panulirus femoristriga albiflagellum	0.4	0.4	60	23.5		1	0.4	0.4	10	3.9		1
Panulirus penicillatus	0.4	0.4	60	23.5		1	0.4	0.4	10	3.9		1
Tectus pyramis	2.0	1.0	60	29.4	5.9	4	2.0	1.3	10	9.8	2.0	2
Thais aculeata	7.8	2.0	60	33.6	3.2	14	7.8	2.7	10	13.1	2.8	6
Tridacna maxima	5.5	1.7	60	29.9	4.6	11	5.5	1.3	10	6.9	1.2	8
Trochus niloticus	12.2	5.7	60	91.2	32.2	8	12.2	11.3	10	40.5	36.6	3
Turbo crassus	0.4	0.4	60	23.5		1	0.4	0.4	10	3.9		1
Turbo setosus	1.2	1.2	60	70.6		1	1.2	1.2	10	11.8		1
Vasum ceramicum	0.4	0.4	60	23.5		1	0.4	0.4	10	3.9		1

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error present.

4.1.5 All Futuna reef-front search by walking (RFs_w) assessment data review

Station: Six 5-min search periods.

Species	Search period			Search period _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinopyga mauritiana	2.4	1.4	30	23.8	4.8	3.0	2.4	1.8	5	6.0	3.6	2
Cerithium nodulosum	1.0	1.0	30	28.6		1.0	1.0	1.0	5	4.8		1
Conus ebraeus	27.1	10.0	30	74.0	20.9	11.0	27.1	16.0	5	33.9	18.7	4
Conus spp.	21.4	6.5	30	53.6	11.0	12.0	21.4	9.3	5	35.7	5.5	3
Cypraea annulus	3.8	2.6	30	38.1	17.2	3.0	3.8	2.2	5	6.3	2.9	3
Cypraea moneta	3.3	2.3	30	50.0	7.1	2.0	3.3	2.1	5	8.3	1.2	2
Dolabella spp.	0.5	0.5	30	14.3		1.0	0.5	0.5	5	2.4		1
Drupa morum	6.2	2.7	30	37.1	5.7	5.0	6.2	2.8	5	10.3	2.1	3
Echinometra mathaei	19.5	9.0	30	97.6	29.1	6.0	19.5	17.2	5	48.8	39.3	2
Echinothrix calamaris	0.5	0.5	30	14.3		1.0	0.5	0.5	5	2.4		1
Eriphia sebana	9.0	3.3	30	30.2	7.3	9.0	9.0	4.5	5	15.1	4.8	3
Gonodactylus spp.	1.4	1.1	30	21.4	7.1	2.0	1.4	1.0	5	3.6	1.2	2
Holothuria atra	3.3	1.3	30	16.7	2.4	6.0	3.3	2.2	5	5.6	3.2	3
Linckia laevigata	2.9	1.4	30	21.4	4.1	4.0	2.9	2.3	5	7.1	4.8	2
Pleuroploca filamentosa	0.5	0.5	30	14.3		1.0	0.5	0.5	5	2.4		1
Rhinoclavis aspera	0.5	0.5	30	14.3		1.0	0.5	0.5	5	2.4		1
Thais aculeata	4.8	2.1	30	28.6	4.5	5.0	4.8	2.6	5	7.9	3.2	3
Thais armigera	2.4	1.7	30	35.7	7.1	2.0	2.4	2.4	5	11.9		1
Thais spp.	18.1	6.9	30	67.9	15.9	8.0	18.1	12.0	5	45.2	14.3	2
Trochus niloticus	1.0	1.0	30	28.6		1.0	1.0	1.0	5	4.8		1
Turbo crassus	1.0	0.7	30	14.3	0.0	2.0	1.0	0.6	5	2.4	0.0	2
Vasum ceramicum	0.0	0.0	30	0.0		1.0	0.0	0.0	5			0

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error present.

4.1.6 All Futuna mother-of-pearl transect (MOPt) assessment data review

Station: Six 1 m x 40 m transects.

Species	Transect			Transect _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Acanthaster planci	1.6	1.6	78	125.0		1	1.6	1.6	13	20.8		1
Actinopyga mauritiana	38.5	11.5	78	230.8	37.0	13	38.5	17.3	13	100.0	28.3	5
Astralium spp.	9.6	5.0	78	187.5	36.1	4	9.6	5.6	13	41.7	12.0	3
Bohadschia argus	1.6	1.6	78	125.0		1	1.6	1.6	13	20.8		1
Conus imperialis	1.6	1.6	78	125.0		1	1.6	1.6	13	20.8		1
Culcita novaeguineae	4.8	2.7	78	125.0	0.0	3	4.8	2.5	13	20.8	0.0	3
Culcita spp.	1.6	1.6	78	125.0		1	1.6	1.6	13	20.8		1
Holothuria atra	3.2	2.3	78	125.0	0.0	2	3.2	2.2	13	20.8	0.0	2
Holothuria nobilis	20.8	9.2	78	270.8	59.7	6	20.8	19.2	13	135.4	114.6	2
Panulirus penicillatus	1.6	1.6	78	125.0		1	1.6	1.6	13	20.8		1
Tectus pyramis	60.9	15.3	78	226.2	38.2	21	60.9	25.1	13	88.0	32.7	9
Thais aculeata	1.6	1.6	78	125.0		1	1.6	1.6	13	20.8		1
Thelenota ananas	4.8	3.6	78	187.5	62.5	2	4.8	4.8	13	62.5		1
Tridacna maxima	89.7	15.5	78	233.3	22.2	30	89.7	23.6	13	129.6	23.7	9
Trochus maculata	3.2	2.3	78	125.0	0.0	2	3.2	2.2	13	20.8	0.0	2
Trochus niloticus	259.6	40.9	78	413.3	54.2	49	259.6	70.9	13	259.6	70.9	13
Turbo argyrostomus	1.6	1.6	78	125.0		1	1.6	1.6	13	20.8		1
Turbo setosus	1.6	1.6	78	125.0		1	1.6	1.6	13	20.8		1
Vasum ceramicum	8.0	4.2	78	156.3	31.3	4	8.0	5.0	13	34.7	13.9	3

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error present.

4.1.7 All Futuna sea cucumber night search (Ns) assessment data review

Station: Six 5-min search periods.

Species	Search period			Search period _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinopyga mauritiana	58.7	11.2	30	92.6	12.1	19	58.7	13.9	5	58.7	13.9	5
Bohadschia argus	1.8	1.8	30	53.3		1	1.8	1.8	5	8.9		1
Bohadschia vitiensis	1.8	1.8	30	53.3		1	1.8	1.8	5	8.9		1
Cypraea tigris	3.6	3.6	30	106.7		1	3.6	3.6	5	17.8		1
Echinometra mathaei	12.4	5.5	30	74.7	13.1	5	12.4	6.0	5	20.7	5.9	3
Echinothrix calamaris	1.8	1.8	30	53.3		1	1.8	1.8	5	8.9		1
Echinothrix diadema	8.9	4.5	30	66.7	13.3	4	8.9	4.9	5	14.8	5.9	3
Etisus splendidus	5.3	3.0	30	53.3	0.0	3	5.3	2.2	5	8.9	0.0	3
H. mammillatus	14.2	7.6	30	85.3	32.0	5	14.2	10.0	5	23.7	14.8	3
Holothuria nobilis	3.6	2.5	30	53.3	0.0	2	3.6	2.2	5	8.9	0.0	2
Panulirus penicillatus	5.3	3.9	30	80.0	26.7	2	5.3	3.6	5	13.3	4.4	2
Panulirus versicolor	1.8	1.8	30	53.3		1	1.8	1.8	5	8.9		1
Parribacus caledonicus	24.9	7.1	30	74.7	8.7	10	24.9	11.0	5	31.1	11.8	4

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error present.

4.1.8 All Futuna sea cucumber day search (Ds) assessment data review

Station: Six 5-min search periods.

Species	Search period			Search period _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Bohadschia argus	8.3	2.2	48	25.0	4.4	16	8.3	3.9	8	11.1	4.8	6
Cassiopea spp.	0.3	0.3	48	14.3		1	0.3	0.3	8	2.4		1
Culcita novaeguineae	1.2	0.7	48	19.0	4.8	3	1.2	0.9	8	4.8	2.4	2
Holothuria atra	1.5	0.8	48	17.9	3.6	4	1.5	0.8	8	4.0	0.8	3
Holothuria fuscopunctata	0.6	0.4	48	14.3	0.0	2	0.6	0.4	8	2.4	0.0	2
Holothuria nobilis	11.9	3.2	48	38.1	6.3	15	11.9	6.4	8	23.8	9.9	4
Thelenota ananas	6.3	2.5	48	33.3	9.5	9	6.3	3.0	8	8.3	3.7	6
Thelenota anax	4.5	1.7	48	26.8	5.7	8	4.5	2.0	8	8.9	2.3	4
Tridacna maxima	4.8	2.1	48	28.6	9.0	8	4.8	2.2	8	9.5	2.9	4
Tridacna squamosa	0.3	0.3	48	14.3		1	0.3	0.3	8	2.4		1
Trochus niloticus	0.3	0.3	48	14.3		1	0.3	0.3	8	2.4		1

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error present.

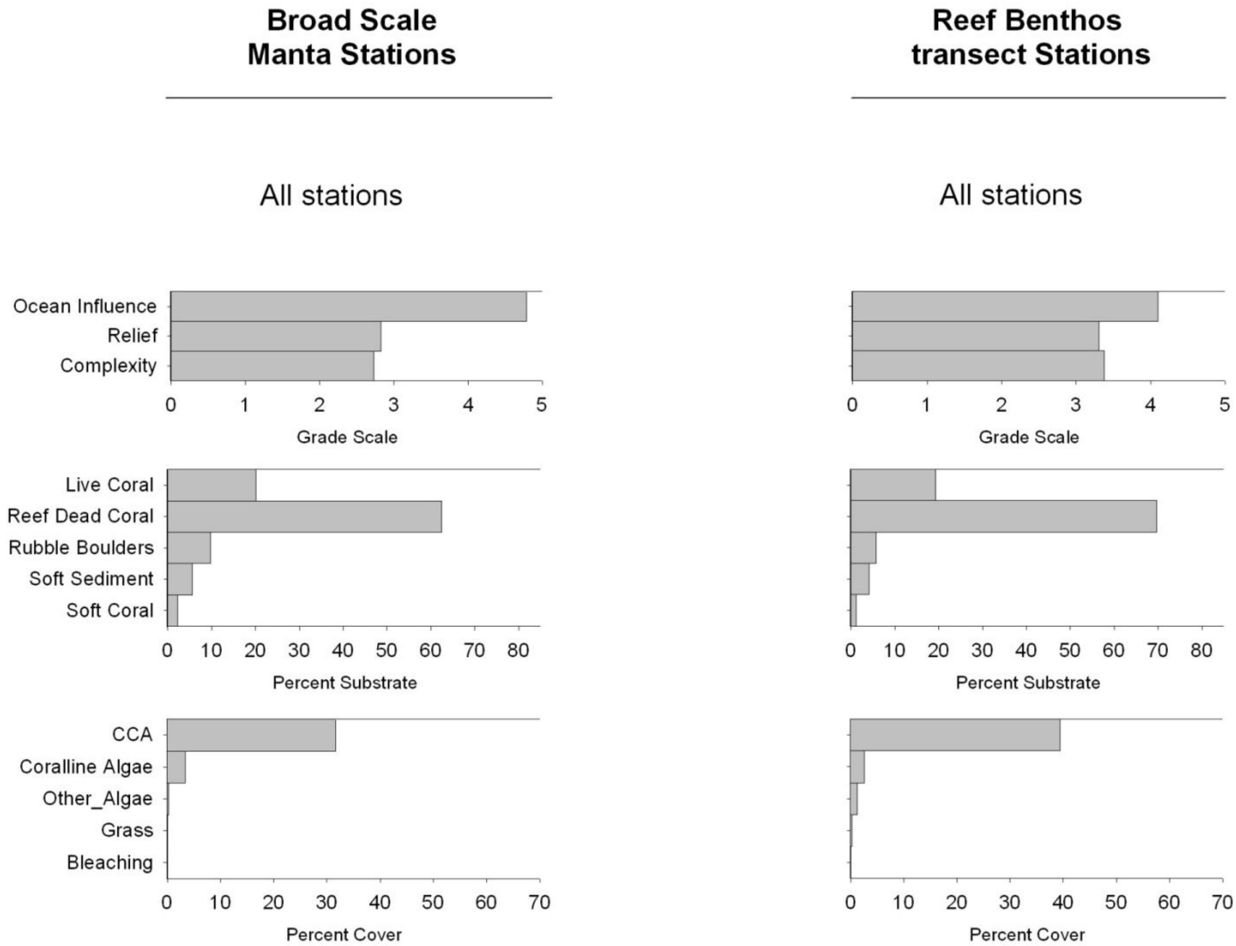
4.1.9 All Futuna species size review – all survey methods

Species	Mean length (cm)	SE	n
Tridacna maxima	15.3	0.5	415
Trochus niloticus	10.5	0.1	293
Holothuria nobilis	29.3	0.4	185
Actinopyga mauritiana	20.0	0.3	160
Conus spp.	5.6	0.2	99
Holothuria atra	31.5	1.2	87
Bohadschia argus	28.8	0.7	74
Tectus pyramis	6.6	0.2	68
Thais spp.	4.2	0.2	51
Thais aculeata	5.1	0.2	39
Eriphia sebana	6.0	0.7	38
Vasum ceramicum	8.5	0.2	35
Thelenota ananas	42.6	1.7	28
Drupa morum	3.5	0.5	17
Stichopus horrens	31.3	1.1	16
Turbo crassus	6.6	0.3	15
Thelenota anax	52.7	3.8	15
Turbo setosus	6.0	0.4	14
Parribacus caledonicus	11.8	1.5	14
Lambis truncata	24.8	0.5	11
Conus flavidus	4.7	0.3	11
Latirolagena smaragdula	5.0	0.4	10
Vasum spp.	7.8	0.7	9
Astralium spp.	4.0	0.4	9
Cypraea caputserpensis	4.7	0.7	9
Cypraea tigris	8.0	0.3	8
Conus imperialis	6.5	0.5	8
Tectus conus	3.9	0.6	8
Conus vexillum	6.2	0.9	6
Thais armigera	3.4	0.2	5
Conus litteratus	7.0	0.4	5
Holothuria fuscopunctata	27.0	5.6	5
Panulirus penicillatus	30.0	0.0	5
Trochus maculata	6.9	1.2	4
Turbo chrysostomus	6.1	0.8	4
Turbo argyrostomus	8.0	0.6	3
Turbo spp.	7.0	1.0	3
Bohadschia vitiensis	27.0	9.0	3
Pleuroploca trapezium	10.0	0.0	2
Cerithium nodulosum	7.5	0.5	2
Mitra stictica	5.3	0.3	2
Conus ebraeus	2.5	0.0	81
Etisus splendidus	6.0	0.0	12
Morula spp.	5.0	0.0	4
Lysiosquillina spp.	7.0	0.0	3
Pleuroploca spp.	5.0	0.0	1
Conus marmoreus	3.5	0.0	1
Asaphis violascens	6.6	0.0	1
Pleuroploca filamentosa	4.0	0.0	1

4.1.9 All Futuna species size review – all survey methods (continued)

Species	Mean length (cm)	SE	n
Tridacna squamosa	30.0	0.0	1
Panulirus femoristriga albiflagellum	25.0	0.0	1
Anadara spp.	8.0	0.0	1
Strombus luhuanus	5.5	0.0	1
Distorsio anus	5.0	0.0	1
Echinothrix diadema	0.0		135
Echinometra mathaei	0.0		116
Linckia laevigata	0.0		36
Penaeus spp.	0.0		35
Cypraea annulus	0.0		25
Cypraea moneta	0.0		17
Culcita novaeguineae	0.0		10
Heterocentrotus mammillatus	0.0		8
Echinothrix calamaris	0.0		5
Stichodactyla spp.	0.0		4
Octopus spp.	0.0		2
Actinodendron spp.	0.0		2
Culcita spp.	0.0		1
Dolabella spp.	0.0		1
Holothuria coluber	0.0		1
Panulirus versicolor	0.0		1
Oliva spp.	0.0		1
Toxopneustes pileolus	0.0		1
Acanthaster planci	0.0		1

4.1.10 Habitat descriptors for independent assessments – All Futuna



4.5 Leava invertebrate survey data

4.5.1 Invertebrate species recorded in different assessments in Leava

Group	Species	Broad scale	Reef benthos	Soft benthos	Others
Bêche-de-mer	*Actinopyga mauritiana*	+	+		+
Bêche-de-mer	*Bohadschia argus*				+
Bêche-de-mer	*Holothuria atra*	+			+
Bêche-de-mer	*Holothuria fuscopunctata*		+		+
Bêche-de-mer	*Holothuria nobilis*		+		+
Bêche-de-mer	*Thelenota ananas*				+
Bêche-de-mer	*Thelenota anax*				+
Bivalve	*Tridacna maxima*	+	+		+
Bivalve	*Tridacna squamosa*				+
Crustacean	*Eriphia sebana*				+
Crustacean	*Etisus splendidus*				+
Crustacean	*Lysiosquillina* spp.				+
Crustacean	*Panulirus femoristriga albiflagellum*				+
Crustacean	*Panulirus penicillatus*				+
Crustacean	*Parribacus caledonicus*				+
Gastropod	*Astralium* spp.		+		+
Gastropod	*Cerithium nodulosum*				+
Gastropod	*Conus ebraeus*				+
Gastropod	*Conus imperialis*				+
Gastropod	*Conus* spp.		+		+
Gastropod	*Conus vexillum*		+		
Gastropod	*Cypraea annulus*				+
Gastropod	*Cypraea caputserpensis*		+		
Gastropod	*Cypraea moneta*				+
Gastropod	*Cypraea tigris*				+
Gastropod	*Distorsio anus*				+
Gastropod	*Dolabella* spp.				+
Gastropod	*Drupa morum*				+
Gastropod	*Lambis truncata*	+			
Gastropod	*Pleuroploca filamentosa*				+
Gastropod	*Pleuroploca trapezium*		+		
Gastropod	*Tectus conus*		+		
Gastropod	*Tectus pyramis*	+	+		+
Gastropod	*Thais aculeata*		+		+
Gastropod	*Thais armigera*				+
Gastropod	*Thais* spp.				+
Gastropod	*Trochus niloticus*	+	+		+
Gastropod	*Turbo crassus*		+		+
Gastropod	*Turbo setosus*		+		
Gastropod	*Vasum ceramicum*		+		+
Octopus	*Octopus* spp.		+		
Star	*Culcita novaeguineae*	+			
Star	*Linckia laevigata*				+
Urchin	*Echinometra mathaei*	+			+
Urchin	*Echinothrix calamaris*				+
Urchin	*Echinothrix diadema*	+	+		

+ = presence of the species.

4.5.2 Leava broad-scale assessment data review

Station: Six 2 m x 300 m transects.

Species	Transect			Transect _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinopyga mauritiana	8.0	2.0	41	23.4	2.8	14	8.2	2.7	7	9.5	2.8	6
Culcita novaeguineae	0.4	0.4	41	16.6		1	0.4	0.4	7	2.7		1
Echinometra mathaei	0.4	0.4	41	16.3		1	0.4	0.4	7	2.7		1
Echinothrix diadema	5.4	4.4	41	110.1	68.5	2	5.4	5.4	7	37.5		1
Holothuria atra	0.4	0.4	41	16.6		1	0.4	0.4	7	2.7		1
Lambis truncata	0.8	0.6	41	16.5	0.1	2	0.8	0.5	7	2.7	0.0	2
Tectus pyramis	0.4	0.4	41	16.7		1	0.4	0.4	7	2.7		1
Tridacna maxima	15.1	4.3	41	38.6	8.0	16	15.3	3.9	7	15.3	3.9	7
Trochus niloticus	4.8	2.3	41	33.0	10.6	6	4.7	4.7	7	32.9		1

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error present.

4.5.3 Leava reef-benthos transect (RBt) assessment data review

Station: Six 1 m x 40 m transects.

Species	Transect			Transect _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinopyga mauritiana	196.4	105.2	42	825.0	392.7	10	196.4	156.4	7	343.8	262.1	4
Astralium spp.	17.9	10.1	42	250.0	0.0	3	17.9	8.4	7	41.7	0.0	3
Conus spp.	17.9	13.2	42	375.0	125.0	2	17.9	12.4	7	62.5	20.8	2
Conus vexillum	17.9	13.2	42	375.0	125.0	2	17.9	17.9	7	125.0		1
Cypraea caputserpensis	29.8	15.2	42	312.5	62.5	4	29.8	11.9	7	52.1	10.4	4
Echinothrix diadema	11.9	11.9	42	500.0		1	11.9	11.9	7	83.3		1
Holothuria fuscopunctata	11.9	11.9	42	500.0		1	11.9	11.9	7	83.3		1
Holothuria nobilis	6.0	6.0	42	250.0		1	6.0	6.0	7	41.7		1
Octopus spp.	6.0	6.0	42	250.0		1	6.0	6.0	7	41.7		1
Pleuroploca trapezium	6.0	6.0	42	250.0		1	6.0	6.0	7	41.7		1
Tectus conus	47.6	27.3	42	500.0	176.8	4	47.6	26.4	7	111.1	36.7	3
Tectus pyramis	41.7	16.9	42	291.7	41.7	6	41.7	18.2	7	72.9	19.9	4
Thais aculeata	23.8	11.5	42	250.0	0.0	4	23.8	8.4	7	41.7	0.0	4
Tridacna maxima	107.1	39.2	42	500.0	110.2	9	107.1	87.1	7	250.0	187.9	3
Trochus niloticus	107.1	37.3	42	450.0	97.2	10	107.1	51.3	7	187.5	64.8	4
Turbo crassus	35.7	16.1	42	300.0	50.0	5	35.7	35.7	7	250.0		1
Turbo setosus	53.6	30.2	42	562.5	187.5	4	53.6	41.4	7	187.5	104.2	2
Vasum ceramicum	65.5	24.2	42	343.8	65.8	8	65.5	20.0	7	76.4	19.9	6

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error present.

4.5.4 Leava reef-front search (RFs) assessment data review
Station: Six 5-min search periods.

Species	Search period			Search period _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinopyga mauritiana	18.3	5.9	18	36.6	8.0	9.0	18.3	8.0	3	18.3	8.0	3
Cypraea tigris	1.3	1.3	18	23.5		1.0	1.3	1.3	3	3.9		1
Holothuria nobilis	1.3	1.3	18	23.5		1.0	1.3	1.3	3	3.9		1
Panulirus femoristriga albiflagellum	1.3	1.3	18	23.5		1.0	1.3	1.3	3	3.9		1
Tectus pyramis	3.9	2.9	18	35.3	11.8	2.0	3.9	3.9	3	11.8		1
Tridacna maxima	3.9	2.1	18	23.5	0.0	3.0	3.9	2.3	3	5.9	2.0	2
Trochus niloticus	37.9	17.9	18	113.7	39.1	6.0	37.9	37.9	3	113.7		1

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error present.

4.5.5 Leava reef-front search by walking (RFs_w) assessment data review
Station: Six 5-min search periods.

Species	Search period			Search period _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinopyga mauritiana	2.4	1.4	30	23.8	4.8	3.0	2.4	1.8	5	6.0	3.6	2
Cerithium nodulosum	1.0	1.0	30	28.6		1.0	1.0	1.0	5	4.8		1
Conus ebraeus	27.1	10.0	30	74.0	20.9	11.0	27.1	16.0	5	33.9	18.7	4
Conus spp.	21.4	6.5	30	53.6	11.0	12.0	21.4	9.3	5	35.7	5.5	3
Cypraea annulus	3.8	2.6	30	38.1	17.2	3.0	3.8	2.2	5	6.3	2.9	3
Cypraea moneta	3.3	2.3	30	50.0	7.1	2.0	3.3	2.1	5	8.3	1.2	2
Dolabella spp.	0.5	0.5	30	14.3		1.0	0.5	0.5	5	2.4		1
Drupa morum	6.2	2.7	30	37.1	5.7	5.0	6.2	2.8	5	10.3	2.1	3
Echinometra mathaei	19.5	9.0	30	97.6	29.1	6.0	19.5	17.2	5	48.8	39.3	2
Echinothrix calamaris	0.5	0.5	30	14.3		1.0	0.5	0.5	5	2.4		1
Eriphia sebana	9.0	3.3	30	30.2	7.3	9.0	9.0	4.5	5	15.1	4.8	3
Holothuria atra	3.3	1.3	30	16.7	2.4	6.0	3.3	2.2	5	5.6	3.2	3
Linckia laevigata	2.9	1.4	30	21.4	4.1	4.0	2.9	2.3	5	7.1	4.8	2
Lysiosquillina spp.	1.4	1.1	30	21.4	7.1	2.0	1.4	1.0	5	3.6	1.2	2

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error present.

4.5.5 Leava reef-front search by walking (RFs_w) assessment data review (continued)

Station: Six 5-min search periods.

Species	Search period			Search period _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Pleuroploca filamentosa	0.5	0.5	30	14.3		1.0	0.5	0.5	5	2.4		1
Rhinoclavis aspera	0.5	0.5	30	14.3		1.0	0.5	0.5	5	2.4		1
Thais aculeata	4.8	2.1	30	28.6	4.5	5.0	4.8	2.6	5	7.9	3.2	3
Thais armigera	2.4	1.7	30	35.7	7.1	2.0	2.4	2.4	5	11.9		1
Thais spp.	18.1	6.9	30	67.9	15.9	8.0	18.1	12.0	5	45.2	14.3	2
Trochus niloticus	1.0	1.0	30	28.6		1.0	1.0	1.0	5	4.8		1
Turbo crassus	1.0	0.7	30	14.3	0.0	2.0	1.0	0.6	5	2.4	0.0	2
Vasum ceramicum	0.0	0.0	30	0.0		1.0	0.0	0.0	5			0

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error present.

4.5.6 Leava mother-of-pearl transect (MOPt) assessment data review

Station: Six 1 m x 40 m transects.

Species	Transect			Transect _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinopyga mauritiana	33.3	13.3	30	166.7	26.4	6	33.3	21.4	5	83.3	20.8	2
Astralium spp.	25.0	12.6	30	187.5	36.1	4	25.0	12.1	5	41.7	12.0	3
Conus imperialis	4.2	4.2	30	125.0		1	4.2	4.2	5	20.8		1
Panulirus penicillatus	4.2	4.2	30	125.0		1	4.2	4.2	5	20.8		1
Tectus pyramis	112.5	35.1	30	281.3	61.8	12	112.5	58.0	5	140.6	65.5	4
Thais aculeata	4.2	4.2	30	125.0		1	4.2	4.2	5	20.8		1
Tridacna maxima	4.2	4.2	30	125.0		1	4.2	4.2	5	20.8		1
Trochus niloticus	291.7	58.2	30	380.4	65.5	23	291.7	87.9	5	291.7	87.9	5

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error present.

4.5.7 Leava sea cucumber night search (Ns) assessment data review

Station: Six 5-min search periods.

Species	Search period			Search period _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinopyga mauritiana	88.9	22.1	12	118.5	21.4	9	88.9	17.8	2	88.9	17.8	2
Echinothrix calamaris	4.4	4.4	12	53.3		1	4.4	4.4	2	8.9		1
Etisus splendidus	4.4	4.4	12	53.3		1	4.4	4.4	2	8.9		1
Holothuria nobilis	4.4	4.4	12	53.3		1	4.4	4.4	2	8.9		1
Panulirus penicillatus	8.9	8.9	12	106.7		1	8.9	8.9	2	17.8		1
Parribacus caledonicus	4.4	4.4	12	53.3		1	4.4	4.4	2	8.9		1
Turbo crassus	8.9	8.9	12	106.7		1	8.9	8.9	2	17.8		1

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error present.

4.5.8 Leava sea cucumber day search (Ds) assessment data review

Station: Six 5-min search periods.

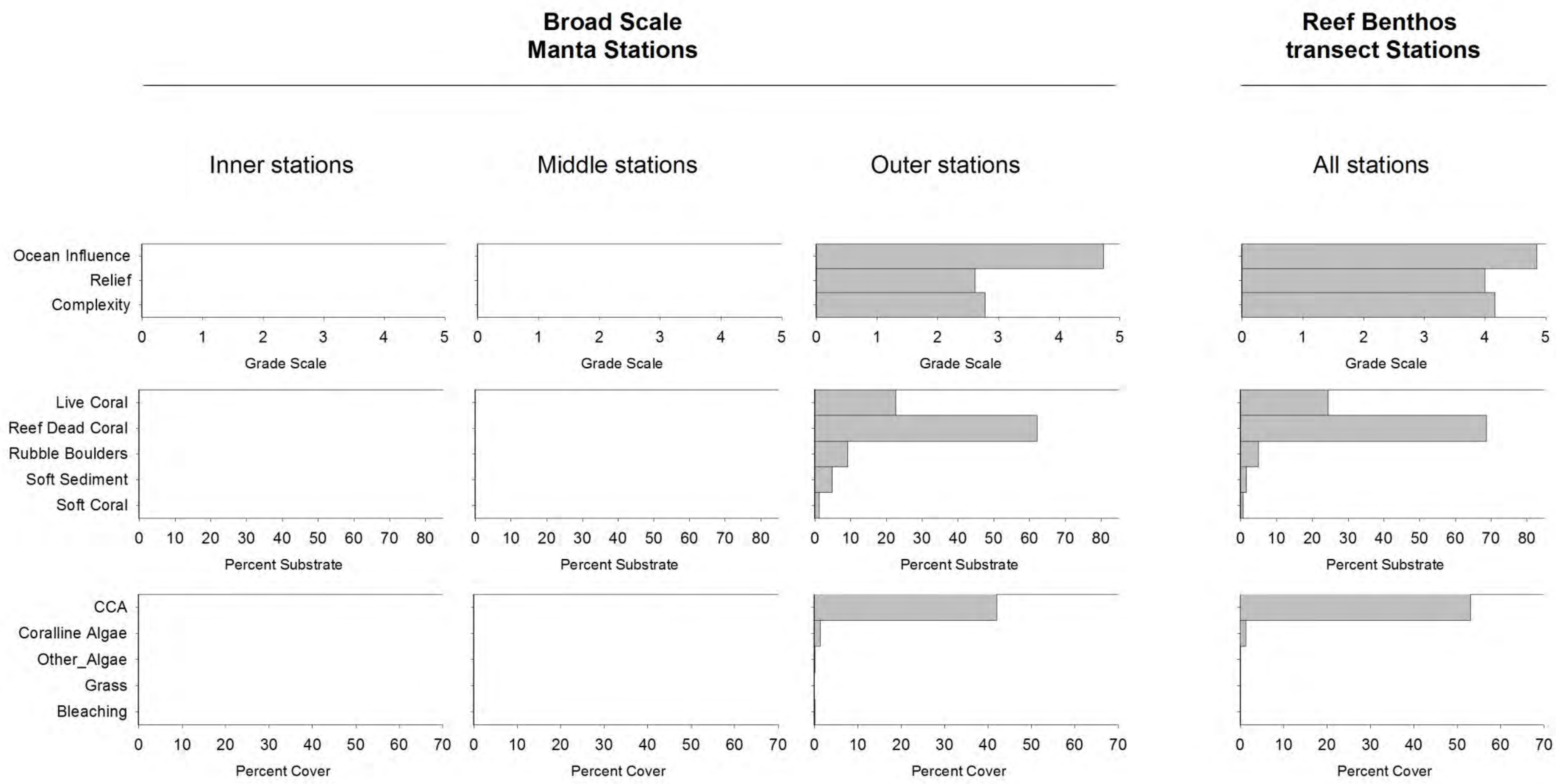
Species	Search period			Search period _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Bohadschia argus	1.2	0.8	24	14.3	0.0	2	1.2	0.7	4	2.4	0.0	2
Holothuria atra	2.4	1.4	24	19.0	4.8	3	2.4	1.4	4	4.8	0.0	2
Holothuria fuscopunctata	0.6	0.6	24	14.3		1	0.6	0.6	4	2.4		1
Holothuria nobilis	0.6	0.6	24	14.3		1	0.6	0.6	4	2.4		1
Thelenota ananas	1.2	0.8	24	14.3	0.0	2	1.2	0.7	4	2.4	0.0	2
Thelenota anax	3.0	1.9	24	23.8	9.5	3	3.0	3.0	4	11.9		1
Tridacna maxima	4.2	3.6	24	50.0	35.7	2	4.2	4.2	4	16.7		1
Tridacna squamosa	0.6	0.6	24	14.3		1	0.6	0.6	4	2.4		1

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error present.

4.5.9 Leava species size review — all survey methods

Species	Mean length (cm)	SE	n
Trochus niloticus	10.5	0.2	132
Actinopyga mauritiana	19.7	0.3	100
Tridacna maxima	15.8	0.9	66
Conus spp.	4.3	0.3	48
Thais spp.	4.5	0.3	38
Tectus pyramis	6.6	0.2	38
Eriphia sebana	6.1	0.9	28
Thais aculeata	5.7	0.8	15
Drupa morum	3.0	0.0	13
Holothuria atra	30.6	1.7	12
Vasum ceramicum	8.5	0.3	11
Turbo crassus	6.4	0.5	10
Turbo setosus	5.6	0.4	9
Astralium spp.	4.0	0.4	9
Tectus conus	3.9	0.6	8
Thelenota anax	51.0	2.9	5
Cypraea caputserpensis	4.7	0.7	5
Thais armigera	3.4	0.2	5
Holothuria nobilis	24.0	3.1	4
Holothuria fuscopunctata	28.3	8.3	3
Conus vexillum	6.3	1.2	3
Thelenota ananas	42.5	2.5	2
Cerithium nodulosum	7.5	0.5	2
Lambis truncata	24.0	0.0	2
Bohadschia argus	28.0	0.0	2
Conus ebraeus	2.5		46
Lysiosquillina spp.	7.0		3
Panulirus penicillatus	30.0		3
Distorsio anus	5.0		1
Pleuroploca filamentosa	4.0		1
Pleuroploca trapezium	10.0		1
Conus imperialis	8.0		1
Panulirus femoristriga albiflagellum	25.0		1
Cypraea tigris	8.0		1
Tridacna squamosa	30.0		1
Echinometra mathaei			42
Echinothrix diadema			16
Cypraea annulus			8
Cypraea moneta			7
Linckia laevigata			6
Echinothrix calamaris			2
Culcita novaeguineae			1
Dolabella spp.			1
Octopus spp.			1
Etisus splendidus			1
Parribacus caledonicus			1

4.5.10 Habitat descriptors for independent assessment – Leava



4.6 Vele invertebrate survey data

4.6.1 Invertebrate species recorded in different assessments in Vele

Group	Species	Broad scale	Reef benthos	Soft benthos	Others
Bêche-de-mer	*Actinopyga mauritiana*	+	+		+
Bêche-de-mer	*Bohadschia argus*	+	+		+
Bêche-de-mer	*Bohadschia vitiensis*	+			+
Bêche-de-mer	*Holothuria atra*	+	+		+
Bêche-de-mer	*Holothuria coluber*				+
Bêche-de-mer	*Holothuria fuscopunctata*				+
Bêche-de-mer	*Holothuria nobilis*	+	+		+
Bêche-de-mer	*Stichopus horrens*				+
Bêche-de-mer	*Thelenota ananas*	+			+
Bêche-de-mer	*Thelenota anax*				+
Bivalve	*Anadara* spp.		+		
Bivalve	*Asaphis violascens*				+
Bivalve	*Tridacna maxima*	+	+		+
Cnidarians	*Actinodendron* spp.		+		
Cnidarians	*Stichodactyla* spp.	+	+		+
Crustacean	*Eriphia sebana*				+
Crustacean	*Etisus splendidus*				+
Crustacean	*Panulirus penicillatus*				+
Crustacean	*Panulirus versicolor*				+
Crustacean	*Parribacus caledonicus*				+
Crustacean	*Penaeus* spp.				+
Gastropod	*Conus ebraeus*				+
Gastropod	*Conus flavidus*		+		+
Gastropod	*Conus imperialis*		+		
Gastropod	*Conus litteratus*		+		
Gastropod	*Conus marmoreus*		+		
Gastropod	*Conus* spp.	+	+		+
Gastropod	*Conus vexillum*				+
Gastropod	*Cypraea annulus*				+
Gastropod	*Cypraea caputserpensis*		+		+
Gastropod	*Cypraea moneta*		+		+
Gastropod	*Cypraea tigris*		+		+
Gastropod	*Drupa morum*		+		+
Gastropod	*Lambis truncata*	+	+		
Gastropod	*Latirolagena smaragdula*		+		+
Gastropod	*Mitra stictica*				+
Gastropod	*Morula* spp.		+		
Gastropod	*Oliva* spp.		+		
Gastropod	*Pleuroploca* spp.		+		
Gastropod	*Pleuroploca trapezium*		+		
Gastropod	*Strombus luhuanus*		+		
Gastropod	*Tectus pyramis*	+	+		+
Gastropod	*Thais aculeata*		+		+
Gastropod	*Thais* spp.	+	+		+
Gastropod	*Trochus maculata*				+
Gastropod	*Trochus niloticus*	+	+		+

+ = presence of the species.

4.6.1 Invertebrate species recorded in different assessments in Vele (continued)

Group	Species	Broad scale	Reef benthos	Soft benthos	Others
Gastropod	*Turbo argyrostomus*		+		+
Gastropod	*Turbo chrysostomus*		+		
Gastropod	*Turbo crassus*		+		+
Gastropod	*Turbo setosus*		+		+
Gastropod	*Turbo* spp.		+		
Gastropod	*Vasum ceramicum*		+		+
Gastropod	*Vasum* spp.		+		+
Octopus	*Octopus* spp.	+			
Star	*Acanthaster planci*				+
Star	*Culcita novaeguineae*	+			+
Star	*Culcita* spp.				+
Star	*Linckia laevigata*	+	+		
Urchin	*Echinometra mathaei*	+	+		+
Urchin	*Echinothrix calamaris*		+		
Urchin	*Echinothrix diadema*	+	+		+
Urchin	*Heterocentrotus mammillatus*				+
Urchin	*Toxopneustes pileolus*		+		

+ = presence of the species.

4.6.2 Vele broad-scale assessment data review

Station: Six 2 m x 300 m transects.

Species	Transect			Transect _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinopyga mauritiana	1.1	0.5	78	17.0	0.4	5	1.1	0.4	13	2.8	0.0	5
Bohadschia argus	3.4	1.4	78	32.8	7.9	8	3.5	3.1	13	22.7	17.2	2
Bohadschia vitiensis	0.4	0.3	78	16.7	0.0	2	0.4	0.3	13	2.7	0.0	2
Conus spp.	0.7	0.4	78	19.0	2.4	3	0.6	0.5	13	4.1	1.4	2
Culcita novaeguineae	0.4	0.3	78	16.7	0.0	2	0.4	0.4	13	5.6		1
Echinometra mathaei	5.4	5.1	78	209.3	190.7	2	5.4	5.4	13	69.8		1
Echinothrix diadema	12.8	10.3	78	166.4	127.4	6	12.8	11.5	13	41.6	36.2	4
Holothuria atra	0.4	0.3	78	16.7	0.0	2	0.4	0.4	13	5.3		1
Holothuria nobilis	11.6	3.1	78	53.4	8.5	17	11.8	5.3	13	30.7	8.7	5
Lambis truncata	1.3	0.5	78	16.5	0.7	6	1.3	0.5	13	3.3	0.6	5
Linckia laevigata	0.5	0.4	78	20.2	3.6	2	0.4	0.3	13	2.7	0.1	2
Octopus spp.	0.2	0.2	78	16.7		1	0.2	0.2	13	2.7		1
Stichodactyla spp.	0.4	0.3	78	15.9	0.8	2	0.4	0.3	13	2.8	0.0	2
Tectus pyramis	0.6	0.4	78	16.7	0.0	3	0.6	0.3	13	2.7	0.0	3
Thais spp.	0.4	0.3	78	15.9	0.8	2	0.4	0.3	13	2.7	0.0	2
Thelenota ananas	0.9	0.5	78	22.2	5.6	3	0.8	0.6	13	5.4	0.1	2
Tridacna maxima	52.7	7.3	78	80.6	8.9	51	52.2	11.6	13	56.6	11.7	12
Trochus niloticus	4.4	1.5	78	31.4	6.2	11	4.6	2.6	13	15.0	5.8	4
Tridacna squamosa	0.2	0.2	66	16.3		1	0.2	0.2	11	2.7		1
Trochus niloticus	1.2	0.5	66	16.3	0.2	5	1.2	0.4	11	2.7	0.0	5

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error present.

4.6.3 Vele reef-benthos transect (RBt) assessment data review

Station: Six 1 m x 40 m transects.

Species	Transect			Transect _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinodendron spp.	4.6	3.3	108	250.0	0.0	2	4.6	3.2	18	41.7	0.0	2
Actinopyga mauritiana	39.4	11.9	108	303.6	53.6	14	39.4	12.8	18	70.8	17.6	10
Anadara spp.	2.3	2.3	108	250.0		1	2.3	2.3	18	41.7		1
Bohadschia argus	62.5	18.6	108	421.9	81.4	16	62.5	23.6	18	125.0	37.4	9
Conus flavidus	18.5	7.1	108	285.7	35.7	7	18.5	7.7	18	66.7	10.2	5
Conus imperialis	16.2	6.0	108	250.0	0.0	7	16.2	8.3	18	72.9	19.9	4
Conus litteratus	11.6	6.1	108	312.5	62.5	4	11.6	6.6	18	69.4	13.9	3
Conus marmoreus	2.3	2.3	108	250.0		1	2.3	2.3	18	41.7		1
Conus spp.	97.2	19.4	108	403.8	41.8	26	97.2	32.3	18	159.1	43.8	11
Cypraea caputserpensis	6.9	4.0	108	250.0	0.0	3	6.9	3.8	18	41.7	0.0	3
Cypraea moneta	4.6	3.3	108	250.0	0.0	2	4.6	3.2	18	41.7	0.0	2
Cypraea tigris	11.6	6.1	108	312.5	62.5	4	11.6	7.4	18	69.4	27.8	3
Drupa morum	4.6	3.3	108	250.0	0.0	2	4.6	3.2	18	41.7	0.0	2
Echinometra mathaei	69.4	17.0	108	416.7	49.5	18	69.4	24.8	18	138.9	37.4	9
Echinothrix calamaris	6.9	4.0	108	250.0	0.0	3	6.9	3.8	18	41.7	0.0	3
Echinothrix diadema	74.1	19.5	108	444.4	68.7	18	74.1	31.9	18	222.2	61.5	6
Holothuria atra	74.1	30.4	108	727.3	222.2	11	74.1	49.2	18	266.7	155.7	5
Holothuria nobilis	166.7	56.6	108	900.0	250.3	20	166.7	102.8	18	375.0	215.9	8
Lambis truncata	6.9	4.0	108	250.0	0.0	3	6.9	3.8	18	41.7	0.0	3
Latirolagena smaragdula	20.8	9.9	108	450.0	93.5	5	20.8	10.2	18	93.8	19.9	4
Linckia laevigata	64.8	18.1	108	411.8	70.9	17	64.8	24.1	18	145.8	38.6	8
Morula spp.	9.3	4.6	108	250.0	0.0	4	9.3	4.2	18	41.7	0.0	4
Oliva spp.	2.3	2.3	108	250.0		1	2.3	2.3	18	41.7		1
Pleuroploca spp.	2.3	2.3	108	250.0		1	2.3	2.3	18	41.7		1
Pleuroploca trapezium	2.3	2.3	108	250.0		1	2.3	2.3	18	41.7		1
Stichodactyla spp.	2.3	2.3	108	250.0		1	2.3	2.3	18	41.7		1
Strombus luhuanus	2.3	2.3	108	250.0		1	2.3	2.3	18	41.7		1
Tectus pyramis	32.4	11.0	108	350.0	55.3	10	32.4	12.4	18	83.3	20.3	7

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error present.

4.6.3 Vele reef-benthos transect (RBt) assessment data review (continued)

Station: Six 1 m x 40 m transects.

Species	Transect			Transect _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Thais aculeata	18.5	10.2	108	400.0	150.0	5	18.5	10.2	18	83.3	29.5	4
Thais spp.	23.1	10.2	108	416.7	83.3	6	23.1	10.2	18	83.3	18.6	5
Toxopneustes pileolus	2.3	2.3	108	250.0		1	2.3	2.3	18	41.7		1
Tridacna maxima	62.5	13.6	108	321.4	30.6	21	62.5	12.3	18	75.0	12.3	15
Trochus niloticus	78.7	16.7	108	354.2	39.6	24	78.7	22.3	18	128.8	27.2	11
Turbo argyrostomus	4.6	3.3	108	250.0	0.0	2	4.6	3.2	18	41.7	0.0	2
Turbo chrysostomus	9.3	4.6	108	250.0	0.0	4	9.3	5.4	18	55.6	13.9	3
Turbo crassus	4.6	3.3	108	250.0	0.0	2	4.6	3.2	18	41.7	0.0	2
Turbo setosus	2.3	2.3	108	250.0		1	2.3	2.3	18	41.7		1
Turbo spp.	6.9	4.0	108	250.0	0.0	3	6.9	3.8	18	41.7	0.0	3
Vasum ceramicum	30.1	8.5	108	270.8	20.8	12	30.1	10.0	18	60.2	14.1	9
Vasum spp.	18.5	9.1	108	400.0	100.0	5	18.5	14.0	18	111.1	69.4	3

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error present.

4.6.4 Vele reef-front search (RFs) assessment data review

Station: Six 5-min search periods.

Species	Search period			Search period _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinopyga mauritiana	3.4	1.5	42	28.2	4.7	5	3.4	1.6	7	5.9	2.0	4
Conus flavidus	1.7	0.9	42	23.5	0.0	3	1.7	1.2	7	5.9	2.0	2
Conus vexillum	1.7	0.9	42	23.5	0.0	3	1.7	0.8	7	3.9	0.0	3
Cypraea caputserpensis	0.6	0.6	42	23.5		1	0.6	0.6	7	3.9		1
Drupa morum	1.1	1.1	42	47.1		1	1.1	1.1	7	7.8		1
Echinometra mathaei	6.7	4.7	42	94.1	47.1	3	6.7	5.5	7	23.5	15.7	2
Echinothrix diadema	12.3	5.7	42	73.9	24.3	7	12.3	8.7	7	43.1	15.7	2
Holothuria nobilis	0.6	0.6	42	23.5		1	0.6	0.6	7	3.9		1
Latirolagena smaragdula	0.6	0.6	42	23.5		1	0.6	0.6	7	3.9		1
Panulirus penicillatus	0.6	0.6	42	23.5		1	0.6	0.6	7	3.9		1
Tectus pyramis	1.1	0.8	42	23.5	0.0	2	1.1	1.1	7	7.8		1
Thais aculeata	11.2	2.7	42	33.6	3.2	14	11.2	3.0	7	13.1	2.8	6
Tridacna maxima	6.2	2.3	42	32.4	6.2	8	6.2	1.7	7	7.2	1.6	6
Trochus niloticus	1.1	0.8	42	23.5	0.0	2	1.1	0.7	7	3.9	0.0	2
Turbo crassus	0.6	0.6	42	23.5		1	0.6	0.6	7	3.9		1
Turbo setosus	1.7	1.7	42	70.6		1	1.7	1.7	7	11.8		1
Vasum ceramicum	0.6	0.6	42	23.5		1	0.6	0.6	7	3.9		1

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error present.

4.6.5 Vele reef-front search by walking (RFs_w) assessment data review

Station: Six 5-min search periods.

Species	Search period			Search period _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinopyga mauritiana	3.6	2.6	12	21.4	7.1	2	3.6	3.6	2	7.1		1
Asaphis violascens	1.2	1.2	12	14.3		1	1.2	1.2	2	2.4		1
Conus ebraeus	41.7	17.3	12	83.3	24.9	6	41.7	17.9	2	41.7	17.9	2
Conus spp.	7.1	4.1	12	28.6	8.2	3	7.1	7.1	2	14.3		1
Cypraea annulus	20.2	11.6	12	40.5	20.7	6	20.2	10.7	2	20.2	10.7	2
Cypraea moneta	9.5	8.3	12	57.1	42.9	2	9.5	9.5	2	19.0		1
Eriphia sebana	11.9	6.0	12	28.6	11.1	5	11.9	7.1	2	11.9	7.1	2
Holothuria atra	16.7	5.8	12	28.6	7.0	7	16.7	11.9	2	16.7	11.9	2
Holothuria coluber	1.2	1.2	12	14.3		1	1.2	1.2	2	2.4		1
Mitra stictica	3.6	3.6	12	42.9		1	3.6	3.6	2	7.1		1
Thais spp.	1.2	1.2	12	14.3		1	1.2	1.2	2	2.4		1

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error present.

4.6.6 Vele mother-of-pearl transect (MOPt) assessment data review

Station: Six 1 m x 40 m transects.

Species	Transect			Transect _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Acanthaster planci	2.6	2.6	48	125.0		1	2.6	2.6	8	20.8		1
Actinopyga mauritiana	41.7	16.8	48	285.7	59.2	7	41.7	25.8	8	111.1	48.6	3
Bohadschia argus	2.6	2.6	48	125.0		1	2.6	2.6	8	20.8		1
Culcita novaeguineae	7.8	4.4	48	125.0	0.0	3	7.8	3.8	8	20.8	0.0	3
Culcita spp.	2.6	2.6	48	125.0		1	2.6	2.6	8	20.8		1
Holothuria atra	5.2	3.6	48	125.0	0.0	2	5.2	3.4	8	20.8	0.0	2
Holothuria nobilis	33.9	14.8	48	270.8	59.7	6	33.9	31.0	8	135.4	114.6	2
Tectus pyramis	28.6	9.3	48	152.8	18.4	9	28.6	13.0	8	45.8	16.7	5
Thelenota ananas	7.8	5.8	48	187.5	62.5	2	7.8	7.8	8	62.5		1
Tridacna maxima	143.2	21.7	48	237.1	22.7	29	143.2	22.1	8	143.2	22.1	8
Trochus maculata	5.2	3.6	48	125.0	0.0	2	5.2	3.4	8	20.8	0.0	2
Trochus niloticus	239.6	55.8	48	442.3	85.0	26	239.6	105.3	8	239.6	105.3	8
Turbo argyrostomus	2.6	2.6	48	125.0		1	2.6	2.6	8	20.8		1
Turbo setosus	2.6	2.6	48	125.0		1	2.6	2.6	8	20.8		1
Vasum ceramicum	13.0	6.7	48	156.3	31.3	4	13.0	7.8	8	34.7	13.9	3

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error present.

4.6.7 Vele sea cucumber night search (Ns) assessment data review

Station: Six 5-min search periods.

Species	Search period			Search period _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Actinopyga mauritiana	38.5	9.5	18	69.3	8.1	10	38.5	5.9	3	38.5	5.9	3
Bohadschia argus	3.0	3.0	18	53.3		1	3.0	3.0	3	8.9		1
Bohadschia vitiensis	3.0	3.0	18	53.3		1	3.0	3.0	3	8.9		1
Cypraea tigris	5.9	5.9	18	106.7		1	5.9	5.9	3	17.8		1
Echinometra mathaei	20.7	8.8	18	74.7	13.1	5	20.7	5.9	3	20.7	5.9	3
Echinothrix diadema	14.8	7.2	18	66.7	13.3	4	14.8	5.9	3	14.8	5.9	3
Etisus splendidus	5.9	4.1	18	53.3	0.0	2	5.9	3.0	3	8.9	0.0	2
Heterocentrotus mammillatus	23.7	12.4	18	85.3	32.0	5	23.7	14.8	3	23.7	14.8	3
Holothuria nobilis	3.0	3.0	18	53.3		1	3.0	3.0	3	8.9		1
Panulirus penicillatus	3.0	3.0	18	53.3		1	3.0	3.0	3	8.9		1
Panulirus versicolor	3.0	3.0	18	53.3		1	3.0	3.0	3	8.9		1
Parribacus caledonicus	38.5	10.4	18	77.0	9.4	9	38.5	12.9	3	38.5	12.9	3
Penaeus spp.	103.7	56.8	18	373.3	155.5	5	103.7	71.2	3	155.6	84.4	2
Stichopus horrens	47.4	11.3	18	77.6	11.1	11	47.4	10.7	3	47.4	10.7	3
Trochus maculata	5.9	5.9	18	106.7		1	5.9	5.9	3	17.8		1
Trochus niloticus	29.6	10.8	18	76.2	15.9	7	29.6	21.4	3	44.4	26.7	2
Turbo crassus	5.9	4.1	18	53.3	0.0	2	5.9	5.9	3	17.8		1

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error present.

4.6.8 Vele sea cucumber day search (Ds) assessment data review

Station: Six 5-min search periods.

Species	Search period			Search period _P			Station			Station _P		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Bohadschia argus	15.5	3.9	24	26.5	4.9	14	15.5	6.2	4	15.5	6.2	4
Cassiopea spp.	0.6	0.6	24	14.3		1	0.6	0.6	4	2.4		1
Culcita novaeguineae	2.4	1.4	24	19.0	4.8	3	2.4	1.7	4	4.8	2.4	2
Holothuria atra	0.6	0.6	24	14.3		1	0.6	0.6	4	2.4		1
Holothuria fuscopunctata	0.6	0.6	24	14.3		1	0.6	0.6	4	2.4		1
Holothuria nobilis	23.2	5.6	24	39.8	6.6	14	23.2	10.3	4	31.0	9.6	3
Thelenota ananas	11.3	4.9	24	38.8	11.5	7	11.3	5.0	4	11.3	5.0	4
Thelenota anax	6.0	2.8	24	28.6	7.8	5	6.0	2.8	4	7.9	2.9	3
Tridacna maxima	5.4	2.2	24	21.4	4.9	6	5.4	2.5	4	7.1	2.4	3
Trochus niloticus	0.6	0.6	24	14.3		1	0.6	0.6	4	2.4		1

Mean = mean density (numbers/ha); _P = result for transects or stations where the species was located during the survey; n = number of individuals; SE = standard error present.

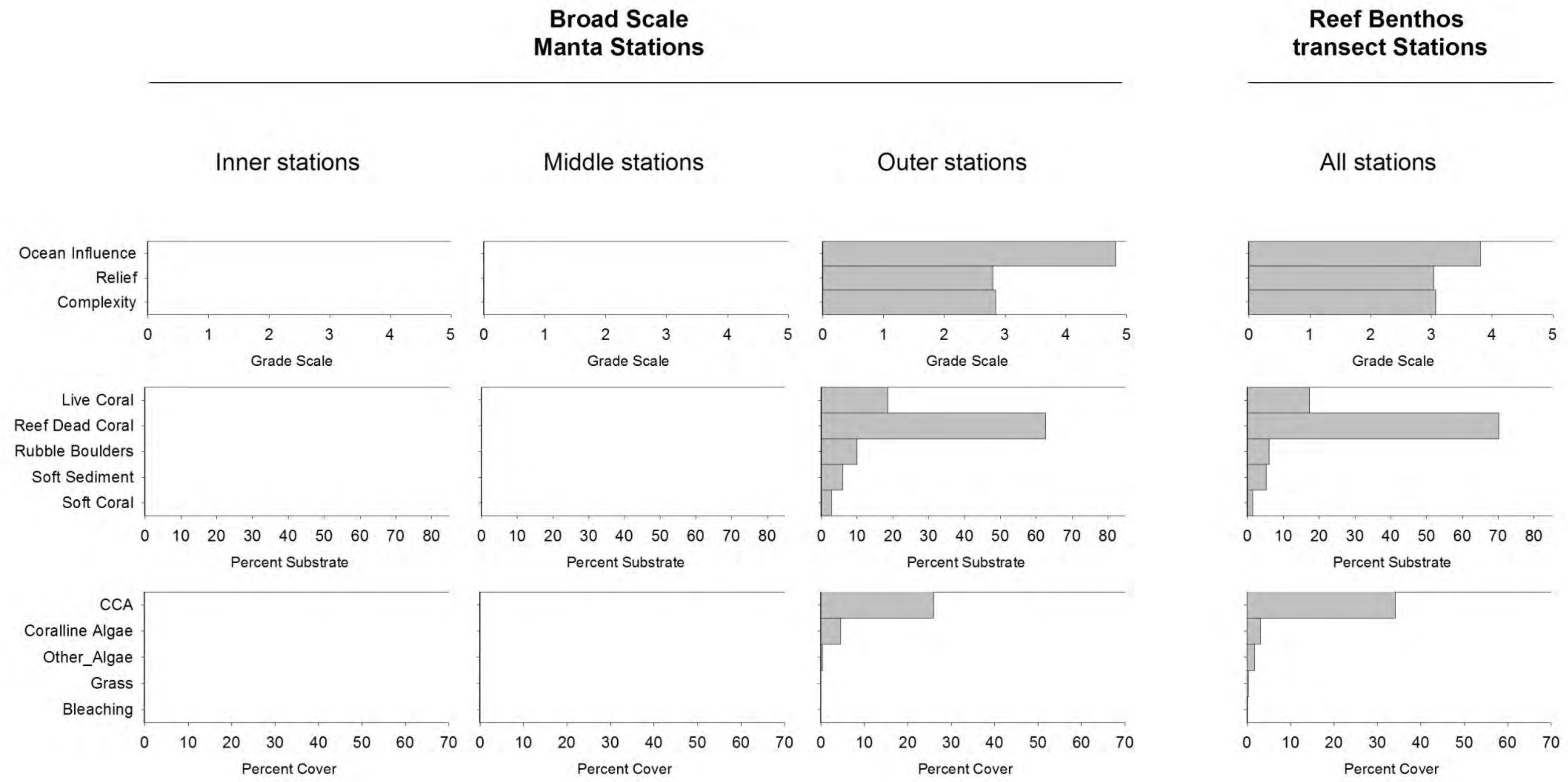
4.6.9 Vele species size review – all survey methods

Species	Mean length (cm)	SE	n
Tridacna maxima	15.1	0.5	349
Holothuria nobilis	29.5	0.4	181
Trochus niloticus	10.5	0.1	161
Holothuria atra	31.7	1.5	75
Bohadschia argus	28.8	0.7	72
Actinopyga mauritiana	20.5	0.6	60
Conus spp.	6.2	0.3	51
Tectus pyramis	6.7	0.3	30
Thelenota ananas	42.6	1.8	26
Thais aculeata	4.9	0.2	24
Vasum ceramicum	8.5	0.2	22
Stichopus horrens	31.3	1.1	16
Parribacus caledonicus	11.8	1.5	13
Thais spp.	4.0	0.3	13
Conus flavidus	4.7	0.3	11
Thelenota anax	54.2	6.8	10
Eriphia sebana	5.5	0.5	10
Latirolagena smaragdula	5.0	0.4	10
Vasum spp.	7.8	0.7	9
Lambis truncata	25.0	0.6	9
Conus imperialis	6.3	0.5	7
Cypraea tigris	8.0	0.4	7
Turbo setosus	6.8	0.5	5
Conus litteratus	7.0	0.4	5
Turbo crassus	7.0	0.3	5
Trochus maculata	6.9	1.2	4
Turbo chrysostomus	6.1	0.8	4
Bohadschia vitiensis	27.0	9.0	3
Conus vexillum	6.0	1.5	3
Turbo spp.	7.0	1.0	3
Turbo argyrostomus	8.0	0.6	3
Holothuria fuscopunctata	25.0	10.0	2
Mitra stictica	5.3	0.3	2
Etisus splendidus	6.0		11
Drupa morum	5.0		4
Morula spp.	5.0		4
Panulirus penicillatus	30.0		2
Strombus luhuanus	5.5		1
Conus marmoreus	3.5		1
Anadara spp.	8.0		1
Pleuroploca spp.	5.0		1
Pleuroploca trapezium	10.0		1
Asaphis violascens	6.6		1
Echinothrix diadema			119
Echinometra mathaei			74
Conus ebraeus			35
Penaeus spp.			35
Linckia laevigata			30

4.6.9 Vele species size review - all techniques (continued)

Species	Mean length (cm)	SE	n
Cypraea annulus			17
Cypraea moneta			10
Culcita novaeguineae			9
Heterocentrotus mammillatus			8
Cypraea caputserpensis			4
Stichodactyla spp.			4
Echinothrix calamaris			3
Actinodendron spp.			2
Holothuria coluber			1
Oliva spp.			1
Acanthaster planci			1
Octopus spp.			1
Culcita spp.			1
Toxopneustes pileolus			1
Panulirus versicolor			1

4.6.10 Habitat descriptors for independent assessments – Vele



4.7 Trochus and bêche-de-mer management

4.7.1 Trochus management sheet

Information for consideration when making decisions regarding the harvesting of trochus

Trochus is a relatively slow growing, locally recruiting commercial gastropod. There is value in protecting the smaller and largest individuals from fishing. In some trochus fisheries small and large size limits are in place ('gauntlet' style fishery[4]) to protect young shells which have not had sufficient time to spawn or produce valuable weight of nacre. The oldest shells, which have the greatest potential of producing the next generation (largest egg producers), and are often of low value due to infection by boring sponge (*Cliona* sp., 'rotten top'), are also protected. Studies have shown that trochus between 70 and 110 mm diameter show little increase in fecundity (related to number of eggs in gonad), but there is a markedly greater increase in egg production for large trochus. Trochus over 125 mm provide by far the largest supply, often double the amount produced by trochus just 10–20 mm smaller.

In successful trochus fisheries in the Pacific, stocks are allowed to reach densities of 500–600 individuals per hectare before pulse harvest commences. These pulse harvests on healthy stock seek to remove a portion of the legal stock (See notes above.), at a rate not exceeding 60 per cent of the egg production capability. Although this is hard to calculate and relies on adaptive management techniques, harvests are usually spread throughout the stock, and approximately 30 per cent of the total legally fishable stock is taken (less than 3 in 10 from a stock at good densities). This 30 per cent is a rough, 'ballpark' figure.

[4] A minimum-size limit of 80 mm and maximum-size limit of 125 mm applies to trochus fishing in the Torres Strait Trochus Fishery.

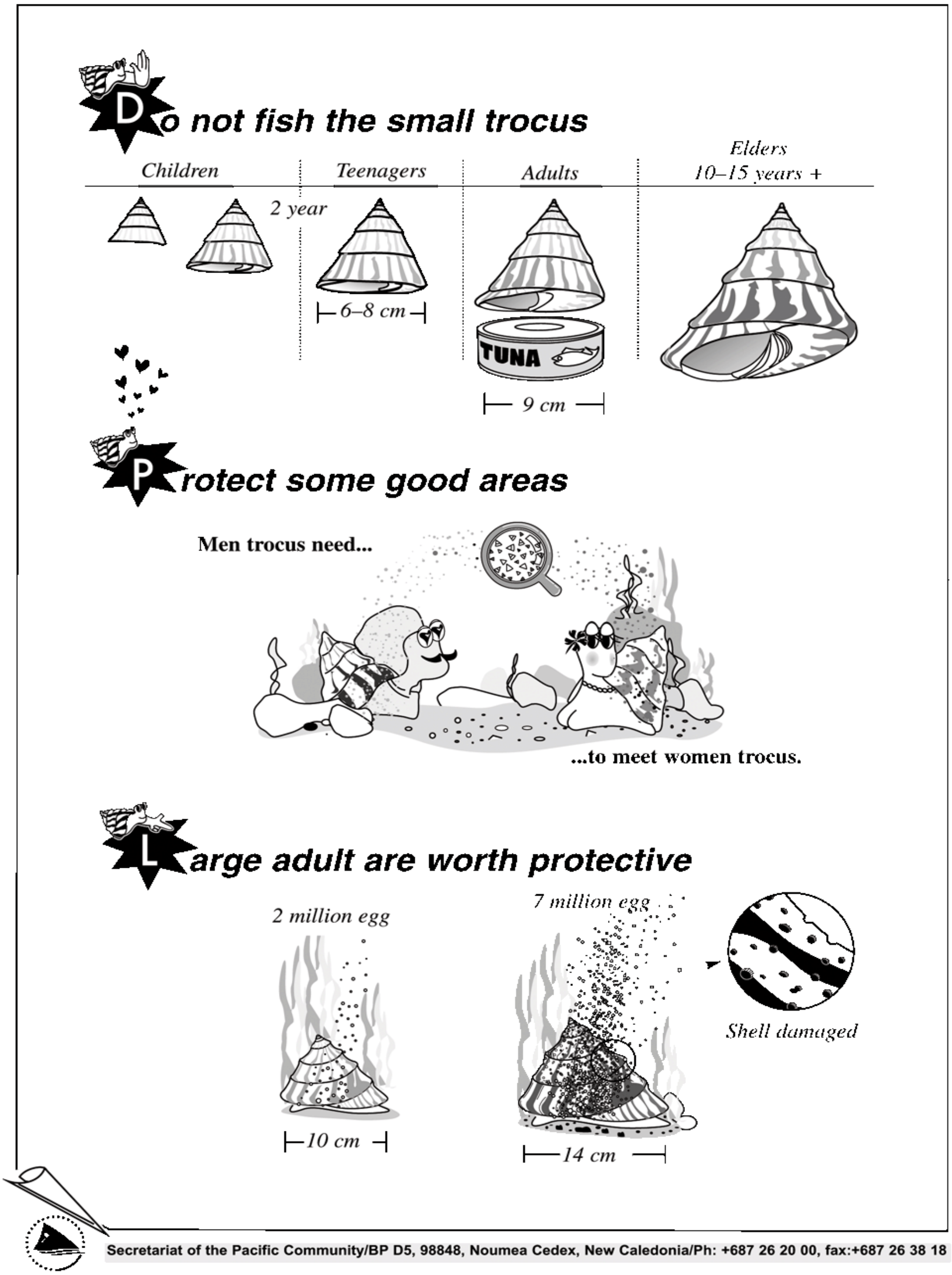


Figure 4.7.1-1: Small flyer made up for potential release with report.
Drawings prepared by Youngmi Choi in consultation with K. Friedman.

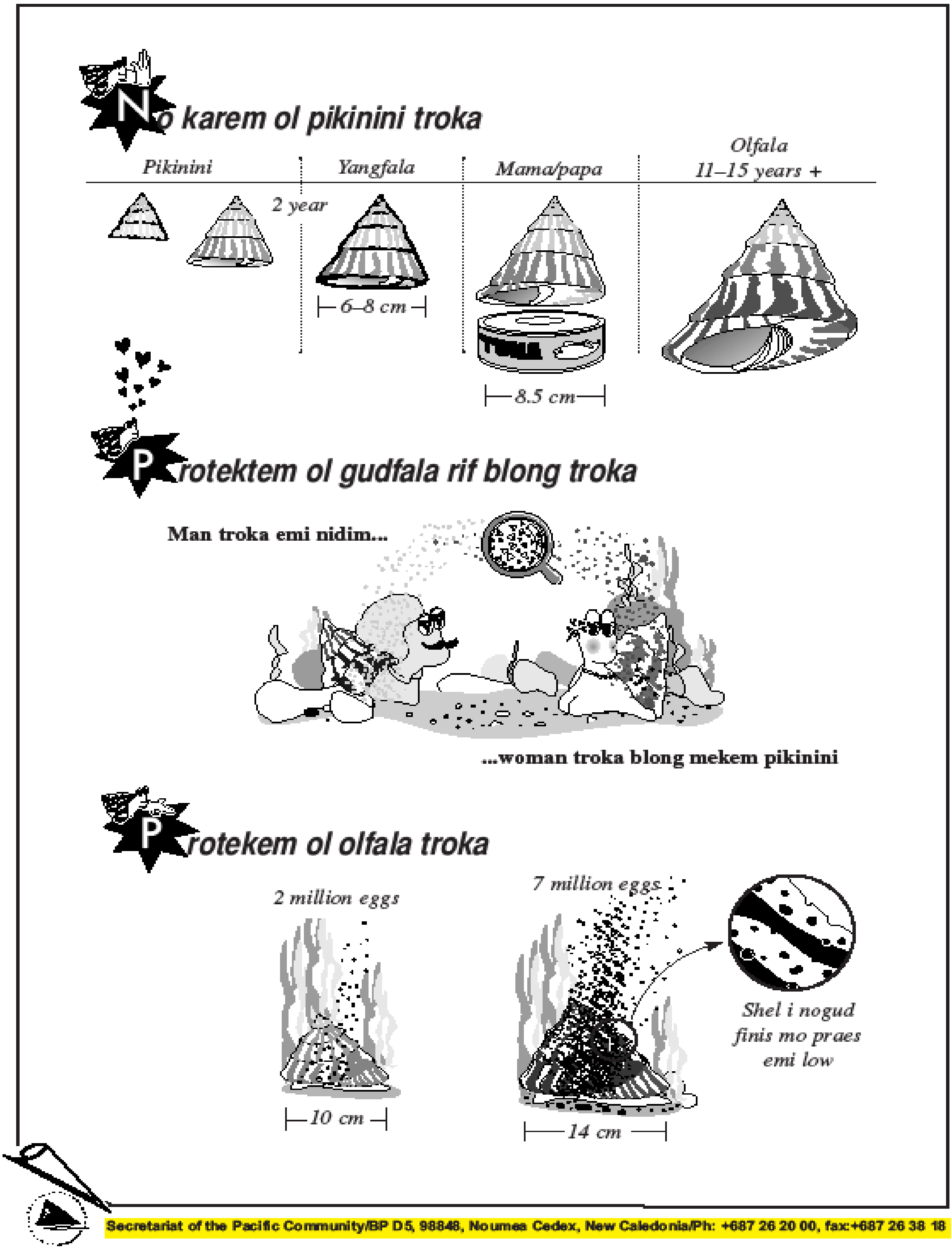


Figure 4.7.1-2: Small flyer made up for potential release with report.
Drawings prepared by Youngmi Choi in consultation with K. Friedman. Bishlama translation by K. Pakoa.

4.7.2 Bêche-de-mer management sheet

A range of measures can be used in combination to establish a management regime for the bêche-de-mer fishery. Specific management measures will depend on local circumstances, status of target species, and the capacity of the fishery division for monitoring and enforcement.

Input Controls

- **Limiting the number of fishers:** This is not generally recommended, both on the grounds of equity and due to enforcement difficulties.

- **Limiting the types of fishing gear used:** Restricting fishing techniques to low-technology methods that do not require capital investment in order to enter the industry or compete are recommended. The introduction of scuba gear, hookahs, or other types of underwater breathing equipment is not recommended. In addition to the very high risk of disability or death to divers (already experienced in some Pacific Island countries), management plans would need to be radically altered and strictly enforced to ensure the sustainability of the fishery. In the absence of such equipment, depth acts as a surrogate reserve for some high-value species.

- **Specific legislation:** The Government could specifically legislate against or otherwise prevent or discourage the use of various gear [underwater breathing apparatus, etc.]. Legislation will likely be required to support arrangements and allow effective enforcement of arrangements stipulated in the management plan that are needed to support sustainability in the fishery.

- **No-take areas:** The use of no-take areas can be useful but requires substantial resources for enforcement. No-take areas might however be worth considering for localised and specific stocks (e.g. *H. scabra versicolor*) and possibly by considering rotational fishing for stocks of *A. mauritiana*.

Further, specific zones for scientific study may be designated. These may play a role for fisheries department or community monitoring of un-fished stocks, be used to run fishery experiments or to experiment with enhancement, should hatchery juveniles become available. Recent success in the spawning and rearing of sea cucumbers in Kiribati (*H. fuscogilva*), Solomon Islands (*H. scabra*) and New Caledonia (*H. scabra*) should be monitored closely to see if there are opportunities for supplementing wild stocks with juveniles reared in the hatchery.

- **Spreading the fishing effort:** Ensuring that fishing effort is distributed will assist in countering local serial depletion of sea cucumbers, which is often masked when examining amalgamated catch reports. An apparently sustainable export trade through one or two ports can mask serial depletion at local sites as buyers move to more and more distant islands as resources near ports start to produce lower yields.

- **Periodic closures:** Periodic closures can be the most cost-effective management measure, but with 2 or 3 major buying periods a year from Asia, a 'stop-start' fishery can compromise fishing continuity, and marketing and exporting arrangements. Relying on longer-term fisheries closures to allow stocks to rebuild requires acceptance of periods of lower reproductive output. The time lag needed to build a critical spawning mass of sea cucumbers appears through preliminary research to be prolonged and therefore, although good for the fishery in the long term, this approach severely compromises medium-term profitability.

- **Limiting exporters:** Issuing of only a small number of licences leveraged against greater reporting and export controls can make the export process easier to control and monitor.

Output controls

- **Stock assessment:** It is recommended that the resource be rapidly re-assessed every three years, using similar methodologies and at a selection of the same sites, so as to provide resource-specific information to decision-makers.

- **Catch quotas:** Restriction on the amount that can be exported from the country or from individual island groups is likely to provide significant fishery protection. A 'trigger mechanism', which will automatically re-impose the moratorium across the whole country if certain well-publicised limits are exceeded in the country as a whole, or in an island group, could be established.

- **Monitoring exports and enforcement:** Monitoring and enforcement, concentrating on the port of export. All shipments of bêche-de-mer would need to be cleared by Fisheries Officers trained to recognise the major species groups. Data must be reported by species or species group (for lower value species). For higher value species, piece counts should accompany total weights in the documentation.

- **Size limits:** Exporters supply the market by species and grade (lower value groups are sometimes sold together, e.g. *H. atra* and *H. edulis*). A large part of the grade value, after presentation, is the piece per kilo rate (a higher rate is paid for larger pieces). Grades for different high value species groups have generally accepted numbers associated with them that are recognised in the market (e.g. 'A' grade white teatfish is listed as 3–4 pieces per kilo). A method that might be considered to push up the grade quality, income, and thereby reduce the catch of juvenile product would be to follow the lead of exporters themselves. This could be done by regulating minimum export grades within a management plan. If there was a realisation in the fishery early on that low grade stock was not marketable in Vanuatu there would be a chance to maximise the income from the fishery and support sustainability by discouraging the harvesting of juveniles.

There would initially be some waste in this approach as product is turned away by the buyers as shipments that didn't meet the regulations in the management plan could not be exported. Mechanisms would need to be in place in the management plan that jeopardises an agent's licence if an unacceptable amount of below-grade product is marketed. Also high grade (and weight) catches can be processed in such a way as to lose weight. Community education should emphasis not only when and how much to fish but also post-harvest processing techniques that will maximise income.

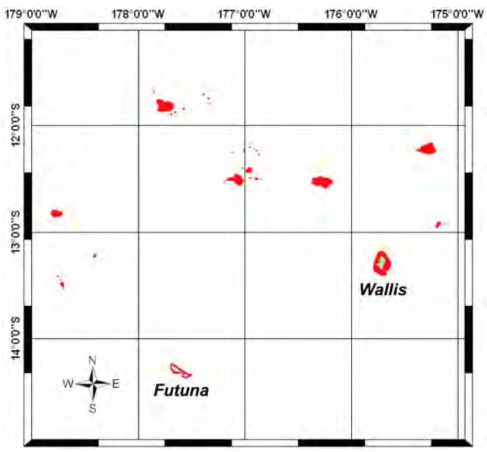
- **Codes of Practice:** Management can benefit significantly from education, training and dissemination of resource tools targeting all levels of the chain of custody as appropriate (e.g. local fishers, processors, buyers, middlemen, resource managers and owners, and enforcement officials), and focussing on:
  - sea cucumber identification;
  - best collection practices;
  - reporting provisions;
  - processing techniques; and
  - management approaches.

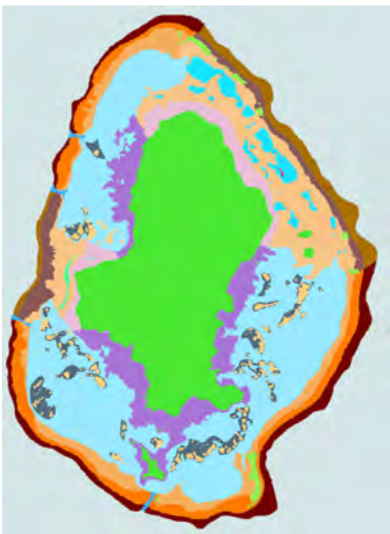
APPENDIX 5: MILLENNIUM CORAL REEF MAPPING PROJECT, WALLIS AND FUTUNA

Institut de Recherche pour le Développement, UR 128 (France)
Institute for Marine Remote Sensing, University of South Florida (USA)
National Aeronautics and Space Administration (USA)

Millennium Coral Reef Mapping Project
Wallis and Futuna

(Octobre 2008)





The Institute for Marine Remote Sensing (IMaRS) of University of South Florida (USF) was funded in 2002 by the Oceanography Program of the National Aeronautics and Space Administration (NASA) to provide an exhaustive inventory of coral reefs worldwide using high-resolution multispectral satellite imagery (Landsat 7 images acquired between 1999 and 2002 at 30 meters resolution). Since mid-2003, the project is a partnership between Institut de Recherche Pour le Développement (IRD, France) and USF. The goal is to characterize, map and estimate the extent of shallow coral reef ecosystems in the main coral reef provinces (Caribbean-Atlantic, Pacific, Indo-Pacific, Red Sea). The program aims to highlight similarities and differences between reef structures at a scale never considered so far by traditional work based on field studies. We believe the data set generated by this research program will be critical for comparative geochemical, biological and geological studies. It provides a reliable, spatially well constrained data set for biogeochemical budgets, biodiversity assessment, reef structure comparisons, and management. It provides critical information for reef managers in terms of reef location, distribution and extent since this basic information is still of high priority for scientists and managers.

As part of this project, Wallis and Futuna coral reefs are systematically mapped. The figure on the top left shows the mapping status as in October 2008 for the Wallis and Futuna EEZ, with mapped reefs in red. Reefs are mapped at geomorphological level, the result of a compromise between richness of information and accuracy when no ground-truthing is available. A preview is provided on the bottom left, for Wallis Island.

The PROCFish/Coastal project who is reporting on this document on Wallis and Futuna fishery status has been using Millennium products in the last three years in all targeted countries in order to optimize sampling strategy, access reliable reef maps, and further help in fishery data interpretation. The level of mapping used by PROCFish/C is a thematically simplified version of the Millennium standard. PROCFish/C is using Millennium maps only for the fishery grounds surveyed for the project.

For further inquiries regarding the status of the coral reef mapping of Wallis and Futuna and data availability (satellite images and Geographical Information Systems mapped products), please contact:

Dr Serge Andréfouët
IRD, Research Unit COREUS 128, BP A5, Nouméa Cedex,
98848 New Caledonia;
E-mail: andrefou@noumea.ird.nc

For further information on the project: http://imars.marine.usf.edu/corals.

Reference: Andréfouët S, and 6 authors (2005), Global assessment of modern coral reef extent and diversity for regional science and management applications: a view from space. Proc 10th ICRS, Okinawa 2004, Japan: pp. 1732-1745.