An assessment of the fisheries of Kaledupa

Kaledupa Fisheries Pilot project 2005

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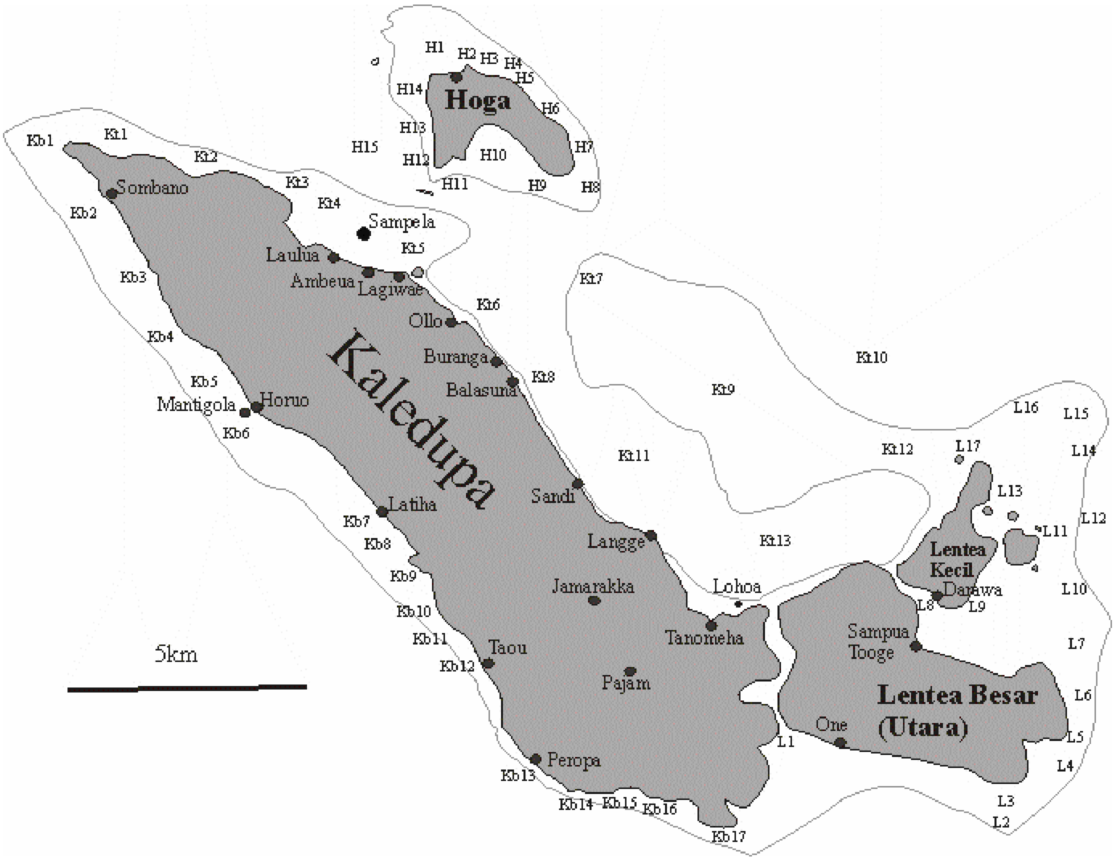
Executive Summary

Fisheries scientists believe that the nearshore traditional fisheries around Kaledupa are declining. Social data has identified a perceived reduction of species diversity and mean fish size in catches over previous decades by fishers. Fisheries catch per unit effort data, percentage of mature fish caught, catch species composition and boom and bust cycles of export fisheries indicates that current fishing is not biologically sustainable. This inability of Kaledupa fish stocks to replenish themselves is mainly attributed to an ever increasing number of fishers using an increasing number of highly efficient 'traditional' fishing gears in conjunction with the ability of certain traditional fishing gears to catch fish below the size of maturation.

It is concluded that current unmanaged traditional fisheries threaten food security, coastal livelihoods, culture and biodiversity on the island of Kaledupa. Presently there is limited capacity or funds to manage the fisheries and little has been done to address the core issues of unsustainable fishing gears or increasing numbers of fishers causing over fishing. Factors contributing to stock decline and suggested management approaches are discussed in detail based on focus group discussions with fishers, which form the precursor to village level legislation. Essential components for a long term fisheries program are outlined.



Map of Kaledupa Island showing the main locations of traditional fishing grounds and villages

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Section 1: Introduction

The status of Indonesian traditional near-shore fisheries

A large proportion of the world's fish stocks (70%) are fully exploited, over-exploited, depleted or in need of recovery, and in many cases such major ecological damage may not always be reversible (FAO). Indonesia has one of the longest coastlines in the world, with over 17,000 islands and 51,020 km^2 of coral reef (17% of world's total). This vast area is coming under increasing threat from overfishing by the expanding Indonesian population (1.49% per annum) of over a quarter of a billion in 2004, who derive 60% of their protein from fisheries - 90% of which are traditional artisanal fisheries. Overfishing throughout Indonesia and in most tropical near-shore fisheries the world over is resultant from five main factors: 1) meeting food demands of an increased population; 2) commercialisation of traditional fisheries due to increased material aspirations as communication improves; 3) lack of sustainable management to optimise the long-term utilisation of finite resources which were traditionally viewed as infinite; 4) inability and apathy of local government or communities to address the problems before overfishing becomes critical and 5) lack of alternatives livelihoods for coastal communities with limited resources. In Indonesia, this increasing exploitation of nearshore fisheries by 'traditional' fishers remains unmanaged under the current open-access government fisheries policy.

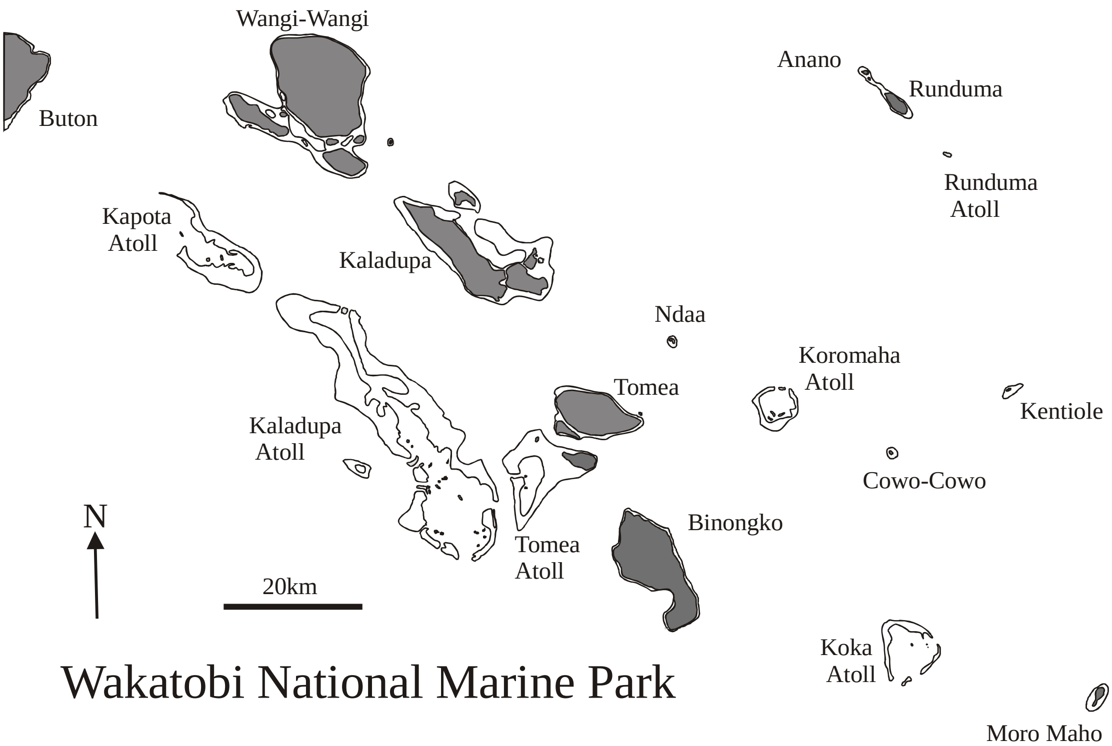

Figure 1.1. Wakatobi Marine National Park

The Wakatobi National Park and Traditional fisheries of Kaledupa

The remote islands of Wanci, Kaledupa, Tomea and Binongko form the Tukang Besi archipelago, which lies at the centre of the Wallace region in SE Sulawesi. In 1996 these islands and surrounding atolls, including 50,000ha of coral reef, were designated as the Wakatobi National Park to protect a marine area of 13,900km^2 (figure 1.1). The Wallace region is a biodiversity 'Hot Spot' for both terrestrial and marine organisms on a global level, possessing a quarter of the world's fish species and the highest diversity of coral in the world. Protection of marine biodiversity within the Wakatobi by preventing the loss of species and decline in the level of diversity is thus of high priority both nationally and internationally. Though the protection of biodiversity is a somewhat abstract concept to fishers, who have more pressing issues of food security and income to address, there are more tangible reasons for communities to protect biodiversity. The Wakatobi is one of the world's last relatively untouched marine habitats, which combined with its high diversity of marine species, makes it of high value to dive tourism and the associated income for local communities. Furthermore, maintaining marine biodiversity has a direct link with maintaining sustainable fisheries by maintaining high catch levels and species diversity for fishers.

Although the population of Kaledupa only represents 16.9% of the Wakatobi population, approximately half of the fishers (49.6%) in the Wakatobi National Park live on Kaledupa or in Bajo settlements around Kaledupa. The heavy reliance on traditional fishing as a source of food and income stems from limited agricultural opportunities (due the small land mass, poor soil and sparse rain fall) and a lack of alternative livelihoods.

On Kaledupa there were an estimated 3360 traditional fishers in 2004, spread over fishing grounds that contain 78km of fringing reef and 135km^2 of reef flat. Most of the protein for the population (approximately 20,000 in 2005) is supplied from near-shore fish and invertebrates, with only a small fraction of the catch being exported or coming from pelagic fisheries. The fisheries are highly complex, both spatially and temporally, with multiple landing sites and numerous fishing grounds. Fishing technique use varies according to tides and seasons, but over 15 different techniques are used on a regular basis to target over 350 species of fish and invertebrates. These techniques can be grouped into: bamboo pot traps (bubu traps); fish fences (sero); gill nets (set and drive-in); seine nets, reef gleaning; speargun; hand line fishing and hand trawling.

Although these fisheries remain essential to communities on Kaledupa for food and income, the notion that all fishing is performed at traditional levels, using traditional techniques primarily for subsistence is no longer accurate. Since the 1950's there has been a rapid increase in fishing power, from subsistence-orientated, low efficiency traditional techniques to highly efficient commercial techniques using modern materials (figure 1.2). The increase in the economic importance of the Kaledupan fisheries is reflected by the development of commercial fisheries, namely the export of live fish and lobster (1993), and fresh octopus (1995) and tuna (1997), in the last twelve years, as trade routes and facilities such as ice have improved. During this period, commercial fisheries have been characterised by boom and bust cycles. To a certain extent, this has masked the impact of resource decline for communities because as one species is fished out, new species have become available for exploitation, from which they have been able to generate an income. However at present, the number of new species available for commercial exploitation is limited.

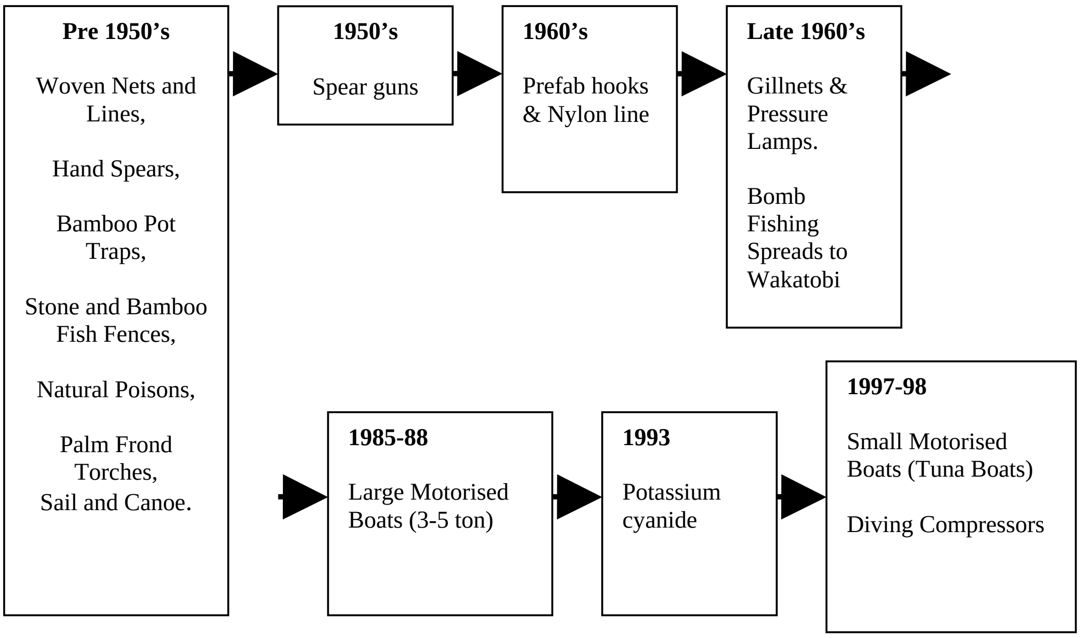

Figure 1.2. Change in fishing techniques (power) around Kaledupa in the last 60 years.

Due to the classification of these fisheries as 'traditional', they have been exempt by law (Law 32/2004: Article 18) from any form of management that would ensure that fisheries develop in a sustainable manner. The fact that traditional fisheries remain open access means they are often exploited to the benefit of individuals rather than the long-term needs of local communities as a whole. Recent developments in the number of fishers (both from Kaledupa and beyond), the number and types of fishing gear and commercialisation of traditional fisheries, together with an increased demand to supply food and meet material aspirations of a growing population, has placed fish stocks under additional pressure. If left unmanaged the presently overfished stocks around Kaledupa will eventually collapse which will have a serious impact on the food security and livelihoods of communities on Kaledupa.

Declining catches around Kaledupa

There is significant evidence from interviews with Kaledupa fishers between 2002 and 2004 of a loss of species, reduction in catch weight and reduction in the average size of fish in the last 5 years (figure 1.3). Elders have particularly noticed long-term changes and are the first to point out that they believe that increased use of gill nets has caused decline in fish abundance. Now many net fishers blame the decline in catches on the rapid increase of fish fences, which increased in number from 27 in 2002 to over 100 at present. Many fishers comment that they have had to change fishing techniques in recent years from line fishing to net fishing or net fishing to fish fences, to maintain catch levels. The need for a transition from low to highly efficient gears in itself indicates a drop in standing stock. This technological creep in traditional fisheries represents a major management concern as highly efficient, less selective gears tend to catch more trash fish and sexually immature fish, which fails to maximise fisheries production and has serious implications for the reproductive capacity of stocks.

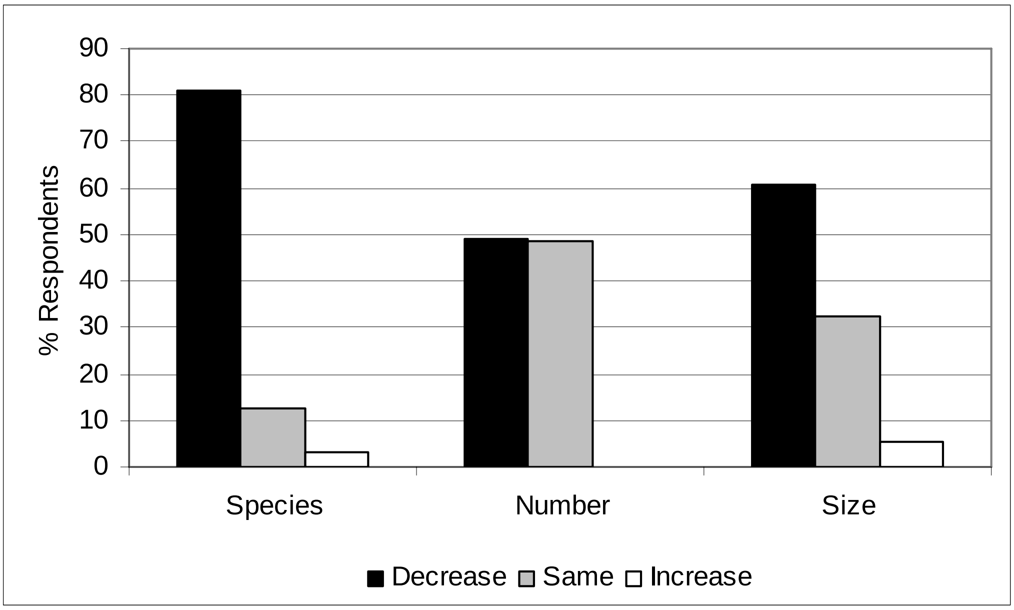

Figure 1.3: The perception of 315 fishers interviewed in 2003 and 2004 on the changes in fish species, numbers and sizes caught over the last 5 years, using the same fishing technique and fishing period.

Length-frequency data from catches of gillnets, fish fences and Bubu traps since 2002 (which form the majority of landings on Kaledupa) show that about 80% of fish are below the mean size of maturation (fig. 1.4) which is a strong indication that recruitment fishing is occurring.

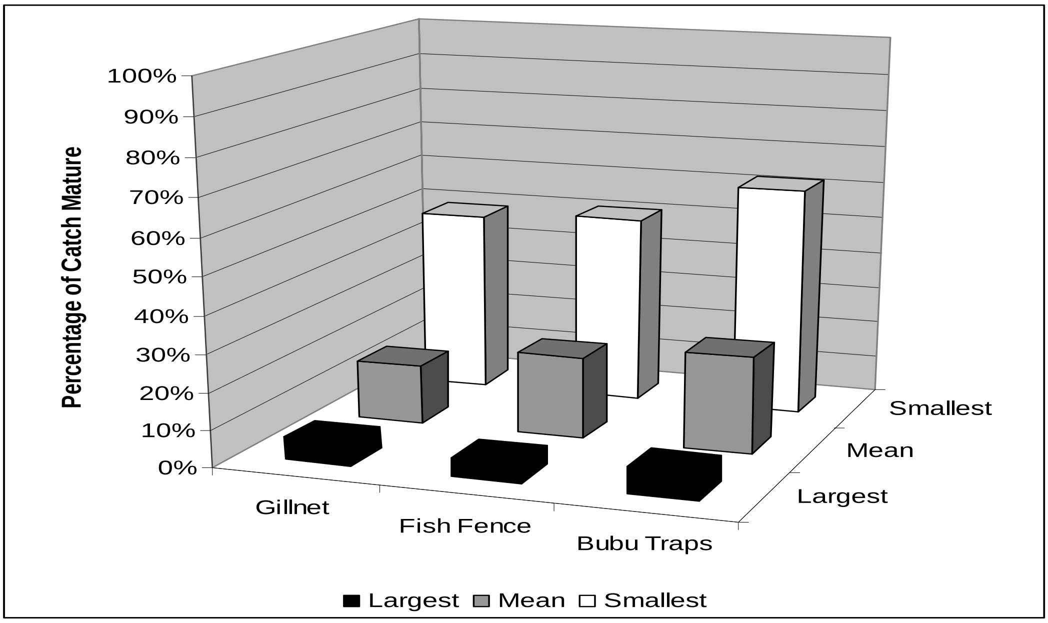

Figure 1.4: The percentage of mature reef fish (excluding nearshore pelagic) caught per technique in 2003, sizes of maturation are from FISHBASE 2000.

An examination of the Catch per Unit Effort (CPUE) for the three main fishing techniques in 2003 (figure 1.5) showed that values were low for Kaledupa compared to a relatively under-exploited fishery in Papua New Guinea, and were very similar to heavily exploited fisheries on the Spermonde Archipelago, SW Sulawesi and Malalison Island, Philippines. This indicates that fishers have fished stocks down to a level (and/or the habitat has been degraded to a point) where CPUE will only decline further as fishing effort increases.

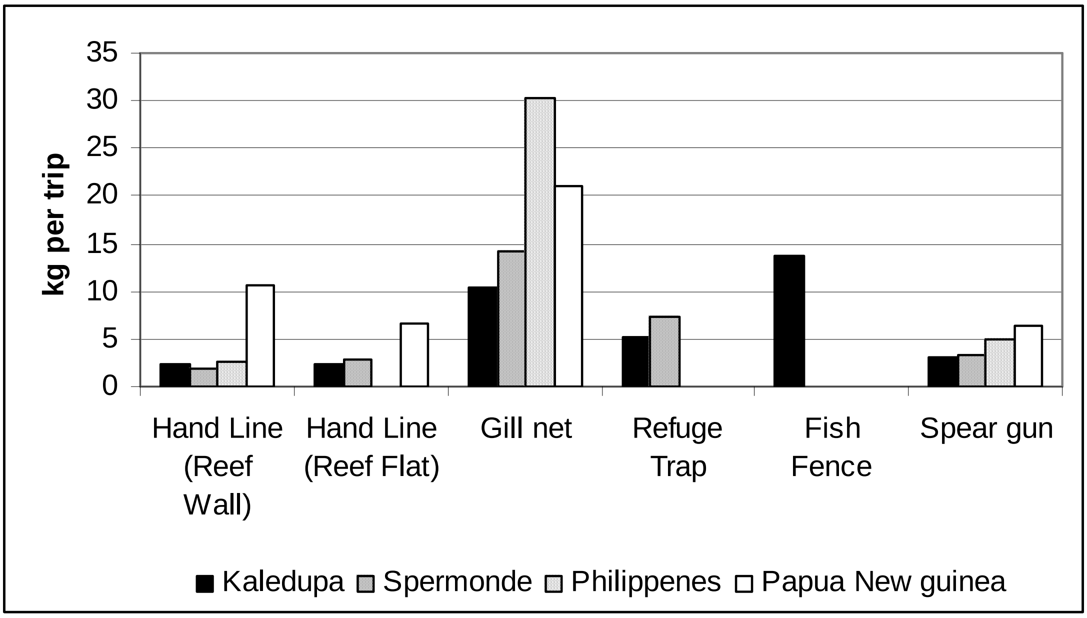

Figure 1.5: Catch Per Unit Effort (kg per trip) for Kaledupa (2003), West Spermonde Archipelago, Malalison Island (Philippines) and Papua New Guinea.

The most commonly suggested solution to declining catches is the creation of Marine Protected Areas (MPA's) which can either be viewed as a precautionary approach to fisheries management or as a at a tool of last resort. MPAs can have many important functions in protection and recovery of fisheries, providing a buffer against recruitment failure, producing a spill over of species into fished areas (recruitment and density-dependent migration), provide temporal protection to transient coastal pelagic species. Furthermore they are a relatively easy concept for communities and government to understand and can be implemented where financial and technical capacity is lacking. However marine protected areas fail to address the root problems underlying the cause overfishing, which requires an understanding of the biological and socio-economic complexities of artisanal fisheries. MPAs on their own do not encourage fishers to understand or be proactive enough in resource management or install a management system to tackle overfishing. This can only be achieved by actively involving fishers in co-management to develop sustainable exploitation. Without fisheries management, marine protected areas will only concentrate fishing effort in open-access zones, increasing overexploitation and the use of destructive fishing techniques. Bomb and cyanide use are often blamed for the decline in catches, however is a common misperception of the actual underlying problems which have led to the use of destructive techniques in the first place; low catches, poor enforcement and lack of economic alternatives. The impact of habitat degradation has only compounded effects of decline fisheries resources and thus increased the tendency to turn to easy methods of making money. The key to creating sustainable fisheries is a combination of MPAs, economic alternatives for fishers and fisheries management, and without all these components the continued decline of fish stocks is highly likely.

Long-term Objectives of the Kaledupa Fisheries Program

As with all fisheries, a balance between resource exploitation and resource protection is essential for sustainable fisheries. Within the Wakatobi the balance must be made between BTNKW directive to protect marine biodiversity and the needs of traditional fishing communities to exploit marine resources. Furthermore, we need to raise awareness among fisher communities that in order to protect food security and coastal livelihoods, management restrictions will have to apply to ensure that stocks are maintained at sufficient levels to provide catches in the long-term.

The long-term goal of the Kaledupa Fisheries Program is to protect biodiversity, food security and coastal livelihoods of communities on Kaledupa, by developing sustainable use of fisheries resources. The aim is to increase the capacity of communities, through transfer of information and technical skills to manage their fisheries in a sustainable manner.

The following issues have been identified in previous studies as causes of declining catches in the near-shore fisheries around Kaledupa:

1. ***Increased local fishing effort*** *due to population growth, increased material aspirations and few alternative incomes. This is a combination of increased number of fishers and their increased ability to catch fish using more fish fences and bubus or longer nets, and the use of unsustainable fishing practices i.e. sub-optimal mesh sizes.*

2. ***Destruction of habitat*** *supporting fisheries by the use of destructive fishing techniques, coral mining and mangrove wood collection.*

3. ***Increased number of external fishers*** *using destructive and commercial fishing techniques around Kaledupa.*

4. ***Lack of clear indicators to communities*** *and local government of the status of the fisheries.*

5. ***Lack of community ownership*** *of fisheries resources or responsibility for fisheries management.*

These issues are to be addressed by 4 outputs of the long-term program:

1. *Locally-agreed fishing regulations and enforcement based on co-management between communities and district authorities (Issue 1 & 5)*

2. *Alternative incomes targeted at destructive fishers and in exchange for fishing gear (Issue 1 &2)*

3. *Small motorised boat licence scheme, combined with increased park ranger patrolling and SSB radio network (Issue 2, 3 & 5)*

4. *Community monitored, co-managed and regulated fisheries (Issue 4 & 5)*

The long-term program proposes to create an island level forum (Kaledupa Fisheries Forum) as a mechanism for fisheries co-management. Through the creation of a collaborative forum, the project will build capacity of stakeholders and district institutions to participate in fisheries co-management and empower local communities to manage fisheries resources under decentralised government legislation. Information will be supplied to the Forum by the Kaledupa Fisheries Program that will run island level socio-economic and fisheries monitoring. The project will put in place protocols for bottom up policy development, based on biological and social issues identified by monitoring, whereby fishers' agreements together with solutions to other fisheries issues can be endorsed through the creation of local legislation. These mechanisms and protocols will heighten legitimacy of legislation, increase compliance and the long-term success of management. In addition, the project aims to develop a best practice fisheries management model that can be replicated on other islands in the Wakatobi National Park and in similar coastal communities elsewhere in Indonesia.

Kaledupa Fisheries Program Pilot Project

Due to the size, complexity and challenges of the long-term program, a pilot project was required to address two main aims: 1) develop clear methodologies for multidisciplinary fisheries monitoring employing local staff and community members in data collection; and 2) develop a strategy for determining village-level fishing agreements which have high legitimacy among fishers on which island or district-level regulations can be based. The pilot project was also required to establish strong links with and generate support from the community and district level institutions for the project.

The pilot project run by Operation Wallacea Trust on Kaledupa between mid-June and mid-November, working in the four villages of Darawa, Lentea, Sama Bahari and Sombano, which have been selected to take part in the COREMAP Phase II Program. These villages important have attributes for fisheries research and management, which include: adjoining fishing grounds between the village pairs of Darawa/Lentea, and Sama Bahari/Sombano; the presence of key spawning aggregation sites within their fishing grounds and the high dependence of communities on the marine environment for their livelihoods. It is hoped that in early 2006, the Kaledupa Fisheries Program can be extended to the remaining villages in Kaledupa.

The pilot project focused specifically on traditional techniques that were considered to have the largest impact on fisheries resources and offered the largest challenge to fisheries management (nets, bubus traps, fish fences and octopus fishers and traders of marine products).

The general approach of the project has been to involve community members in the collection of data to build capacity and increase awareness and work with local NGO’s to facilitate project socialisation, training, and transfer and feedback of information. The project worked in partnership with two local institutions: Forum Kaledupa Toudani (FORKANI) and NGO Yayasan Bajo Matila (YBM).

FORKANI is a forum that was created in 2002 to address concerns about the capacity of communities to understand environmental problems and to provide a means of communication between governments and international NGO's. FORKANI has two members in every village on Kaledupa to facilitate the process of community organisation and thus has a higher status than an NGO due to the unanimous support they receive on Kaledupa. *Yayasan Bajo Matila* is an NGO based in Sama Bahari concerned in addressing ethnic Bajo social issues and thus their involvement as consultants has increased the capacity to communicate complex issues effectively to the largest fishing village, with the least capacity to address fishing issues.

Section 2: Methodology

The main components of the pilot project are described below and their integration is illustrated in figure 3.1. Prior to commencing each component of the project, the concepts underlying each activity and their relevance were socialised during village meetings to ensure maximum community understanding and support. The emphasis was made that data collected by both members of the community and local staff would be fed back to fishers during focus groups and meetings to help the community find solutions for sustainable fisheries management. All data collection, interviews and village meetings were conducted in local languages.

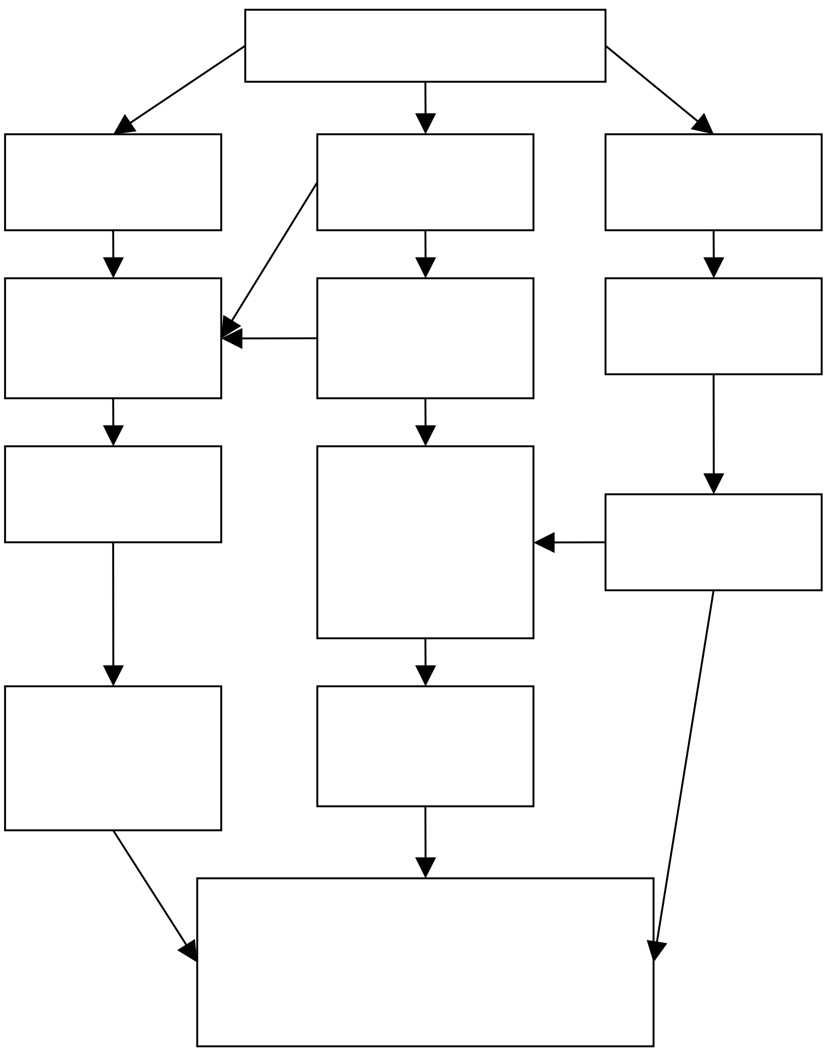

Figure 3.1. Pilot project components and their integration.

Village censuses

The Kaledupa and Bajo extension officers conducted censuses of all fisher households in Darawa, Lentea and Sombano and Sama Bahari. The head of the household was interviewed in their local language and basic statistics were collected on each member within an economic unit. An economic unit (EU) is here defined as a group of people who share the same income and expenditures, often living together as a household. The main economic activities for each EU and estimated minimum, maximum and average weekly income during the Easterly season were recorded. If the EU was involved in trading marine commodities, details including species traded and to whom and income were also recorded. The number and details of fishing equipment (spearguns/spears, lanterns, bubu traps, fish fences and gill nets) and boats were recorded. An example of the census data sheet is shown in appendix I.

Fisheries monitoring and analysis

In each of the four villages, two fishermen were trained to carry out fisheries catch surveys on techniques used in their village, with specific focus on nets, bubu, fish fences, speargun, hand trawl and hand line catches. The fisheries surveyors carried out monitoring over a 24hr period on one day per week (randomly selected) over a 6 week period. A list of vernacular fish names specific to each village and cross-referenced to Kaledupan and Latin names was made (appendix IV) to allow identification and recording of fish names in local languages and re-interpretation of the data during analysis.

The surveyors were trained to weigh the entire catch (to the nearest 0.1kg), count the number of fish of each species and measure the length (to the nearest 0.5cm) of up to 20 randomly selected fish of each species. All fish names were recorded in local languages (Bahasa Bajo and Bahasa Kaledupa), however to ensure accurate identification, fishers also referenced the fish names to an identification guide (Marine Fishes of South-East Asia, Gerry Allen). Additional data on fishing activities included; technique details; location; habitat; time spent fishing and travelling; estimated value of the catch; percentage of catch by weight that fishers estimate will be eaten, sold or given away as gifts; weather and season; and estimated number of days they fished in the last week. Surveys did not attempt to record every single fishing operation due to the presence of multiple landings sites and the large number of fishers who could return at one time, but instead focused on accurately recording as many catches from each gear type as possible. Surveys therefore represent a sub-sample of fishing activities that day, on which calculations are based. A fisheries monitoring data sheet is shown in appendix II.

In tropical fisheries, an assessment of the status of the fishery is often based on comparing annual estimates of total catch, total fishing effort and yield for individual fishing grounds. However in artisanal fisheries, the estimation of total fishing effort is renowned to be difficult to accurately estimate due to problems with monitoring the high number of fishing trips made over 24 hour period that return to multiple landing sites. In 2003 interview surveys were conducted on Kaledupa in an attempt to estimate total fishing effort, however estimates made by fishers were found to be 3-4 times higher than actual observed effort. Although it may appear that total fishing effort can be easily calculated by multiplying the total number of fishers of each technique in the village (census) by the number of days they fish per week and number of hours per trip (fish mon). However this would lead to an overestimation of effort, catch and yield as fisheries monitoring is more likely to regularly sample fishers that fish on a frequent basis than those that only fish occasionally. Estimations of yield (which also suffer from the same difficulties) are not possible to calculate at present as the area of fishing grounds around Kaledupa remain unknown, however GIS mapping will be form one of the components of the long-term project.

More accurate methods that are commonly used to estimate the status of the fisheries in the tropics are based on indicators such as average time spent fishing, CPUE, VPUE, catch composition, and percentage of sexually mature fish in the catch, etc. These indicators are used in this study to assess the status of the Kaledupa fisheries and are calculated per fishing operation for each gear type in each village (appendix V) and then combined to give an overall representation of the Kaledupa fisheries which is presented in Chapter 6.

Catch per unit effort (CPUE), value per unit effort (VPUE), percentage of mature fish and catch composition was calculated per technique for each village. Total monthly catch and total monthly standardised effort of all techniques in each village was calculated. Standardised effort was calculated for each fishing techniques as the relative effort in hours required to obtain similar catch weights using line fishing on the reef. Catch per unit effort (CPUE), percentage of mature fish within catches, mean size of target species, percentage of fish families was calculated per technique for all villages was combined to give an overall estimate for Kaledupa to allow comparison to other similar tropical fisheries. Size of sexual maturity for each species was based on estimates of the smallest size of maturation which were taken from Fishbase 2000. However it is important to note that these are conservative figures and thus may underestimate the percentage of immature fish in catches.

Socio-economic Monitoring

The socio-economic monitoring framework was designed with the assistance of social scientists from Operation Wallacea with long-term experience in Kaledupa, and with additional input from the NGO Bajo Matila and FORKANI members. The themes were developed to examine locally important issues, which included the identification and monitoring of: 1) user groups and opinion formers; 2) existence of rights, agreements or conflicts over fishing grounds; 3) perceptions of resource conditions/decline and human impacts; 4) awareness and understanding of proposed motorised boat registration trial; 5) policing strategies; and 6) alternative incomes & financial management capacity. Socio-economic monitoring targeted 5 groups of fishers: net, bubu, fish fence and octopus fishers and traders of marine traders. A sub-sample of at least 70% of all fishers per group that were identified by the census were interviewed in each village. An example of the socio-economic monitoring data sheets are shown in appendix III.

Database

A Microsoft ACCESS database was constructed with assistance from a database expert to store all census, fisheries monitoring and socio-economic monitoring data for analysis. A local fisheries officer was trained to input and analyse the data.

Focus groups

This was an interactive process between fishers and scientists to tackle the sensitive and extremely difficult issues of unsustainable fishing and trading practices. Five fisheries groups were targeted: nets, bubu traps, fish fences, octopus and other commercial fisheries. Biological issues identified in fisheries monitoring and from previous fisheries studies were combined with issues raised by fishers during socio-economic monitoring and discussed informally during focus groups. The process was designed to achieve three functions: raise awareness of fisheries issues; discuss problems facing fishers; and work together to find solutions through the establishment of agreements on which potential regulations could be based. The link between increased economic and biological sustainability was stressed, and the use of sub-optimal fishing practices together with methods of reducing high fishing effort were discussed. The feedback and outputs of these focus groups is summarised in Chapter 7 and attendance records of meetings are given in Appendix VI.

Boat registration trials

Initial village meetings were arranged to discuss issues posed by local and external fishers using destructive or commercial fishing practices and socialise the concept of a motorised boat registration scheme as a mechanism to address these problems. It was stated that boat registration in combination with a SSB radio network, will assist both Park Rangers and local communities to identify and report incursions and co-ordinate the apprehension of illegal fishers.

The socio-economic monitoring included an assessment of the awareness and understanding of fishers of the registration scheme, the results of which were presented to communities during a second village meeting. Communities were then asked if supported the scheme and would agree to trial it in their village. Feedback from village meetings is summarised in Chapter 8 and attendance records are given in Appendix VII. After obtaining consent to trial boat registration, two fishers per village were hired to paint registration numbers under the supervision of village leaders, supplying each motorised boat with a unique code and recording owner and boat details. The code composed of three components: firstly an island identifying code (K for Kaledupa), then a 3 digit number code specific to each boat within the village and lastly a village code based on sub-district government administrative codes (Darawa - M, Lentea - J, Sombano - O and Sama Bahari - P).

Section 3: Social characterisation of Fisher villages

To obtain a fuller understanding on the social dynamics of fisher communities in the study villages of Darawa, Lentea, Sama Bahari and Sombano, anecdotal information was collected from various sources about the historical background of village and development of the fisheries, current status of marine resources and the potential for economic improvement

Darawa Village

Overview

Population:	564 (M 273; F 291)
No of households:	187
Sub-villages:	Horuso and Watukoila.

Geographic location

Darawa village is located on the island of Lentea Kiwolu, the smaller of the two islands named Lentea (Lentea Kiwolu and Lentea Utara/Langge). The two islands of Lentea lie to south-east of Kaledupa Island, with Lentea Kiwolu being the north-east of Lentea Utara/Langge. Darawa village is situated on the south end of the channel which runs between Lentea Utara/Langge and Lentea Kiwolu, directly opposite the village of Lentea on the other side of the channel. Darawa faces south onto Lentea village and east onto a large open reef flat that is exposed to the Banda Sea. The island of Tomea is within easy access to the south of Lentea Utara/Langge.

Village establishment

Darawa was first named Lentea Kiwolu, as the original people to settle on the island came from the village of Buranga (Kaledupa) and used the old Kaledupa kingdom names. These settlers moved to Darawa to farm and access local fisheries resources, some staying for long periods of time. After the rebellion of DI-TII (Islam State Association Indonesia Muslim Army) between 1959 and 1963, the government re-located these settlers permanently on Darawa. The status of Darawa village has changed many times, becoming a sub-village of Langge village (Kaledupa) between 1945 and 1967, before finally achieving village status in 1997.

Community facilities

Water Supply: The composition of the ground in Darawa is rocky (coralline limestone), making it difficult for the community of Darawa to obtaining a clean water supply for household needs. Villagers currently fulfil water requirements by collect rain water in water tanks without attention as to whether it is safe to drink. During the dry season (May-October) the quantity of water decreases the community is forced to obtain water from neighbouring villages on the mainland of Kaledupa.

Environmental Sanitation: The problem of environmental sanitation has not been addressed, as few households have a toilet and many families use the woods or beach close to the village resulting in epidemics of sickness and diarrhoea in the dry season. Information has been given out regarding these issues by Kaledupa sub-district government, however the community still pays little attention as they do not consider this it to be important.

Access: A regualar speed boat ferry connects to Kaledupa island, Tomia and Wanci. Alternatively the community must charter motorised boats from other people in the village.

Power: To fulfil the power needs of each household, families use a communal generator, managed by a few members of the community. Electricity needs are not yet sufficient as the management capacity and financial capacity of the community for operational costs is low.

Village fisheries

Fishing methods and history

The majority of the people in the village depend on the marine environment for their livelihoods as the land is of poor quality for agriculture. The island consists mainly of coralline limestone and so is predominately rocky and sandy, with very little organic content in the soil, hence the orientation towards marine-based activities. However as with other communities on Kaledupa, people also have a secondary source of food and income from farming.

A number of fishing techniques are used in Darawa including Bubu traps, seine nets, fish fence, a two stick technique for catching octopus and gleaning at night. Although recently there has a technological improvement in fishing gears, many traditional techniques are still used such as Bubu traps, the two stick method for octopus and gleaning at night. Techniques that have changes are fish fences, which were traditionally built from stone and bamboo and are now made from of nylon nets, and seine nets which were traditionally made from tree bark and now are fishers use nylon. Techniques used in each village are described in detail in section 6.

Marine resource management

Over exploitation of marine resources has had an impact on the condition and quality of the marine resources.

Bomb and cyanide use and Coral reef destruction

Even though there was a government campaign to stop the uses of explosive and cyanide fishing and enforce a heavy punishments this did not stop their use, and it is continued to be used by fishers from the other village or outside of Kaledupa. The use of these methods has damage the marine habitat and some marine species have disappeared. Fishers catches have decreased, and there continues to be a lack of awareness of the damage caused by bomb and cyanide fishing, a lack of understanding of the importance of sustainable fishing management to fishers, and the government (BTNW and Police) continues to be inactive to control or patrol in the area.

Mostly the reef in this village has been damage due to the high intensity of the outsider fisherman using the destructive fishing methods, especially during the spawning seasons (November-March) for groupers from the genus Plectropomus and Epinephelus, and Napoleon wrasse. In addition local people still damage coral to find abalone. Some of the community understand and are aware that the reef is being destroyed and need protection but have limited facilities to enforce and control the use of their resources, especially spawning areas, from destructive activities.

Marine resources management.

There has been a big difference/extreme decrease in marine and fisheries condition in this area for last few years, which has made the community worry about their future. It is believed that compared to the fishing grounds of other village on Kaledupa, Darawa's fishing grounds have the highest bio-diversity but the management of resources uses is not good for the marine environment. The community did not realise the problems that could arise from the way they have been fishing and are unfamiliar the concept of sustainability.

Law enforcement and controlling system.

There are a large number of fishers using destructive fishing techniques in Darawa fishing grounds as there is no government control system in place. The community has tried to protect their fishing grounds from destructive fishing but they are not able to identify the perpetrator. Even though there are many regulations, the government does not follow up with strong enforcement to the village level.

Fishing grounds

The demarcation of Darawa fishing grounds is not legally defined, which affects the management of marine resources. However, traditionally fishing grounds extend to the northern point of Lentea Kiwolu down the east coast of Lentea Kiwolu to the channel between the two Lenteas. The southern border of the fishing ground follows a deeper channel out to the sea to the east close to the island of Lentea Langge.

The community is expanding seaweed cultivation which is known to cause conflict on resource ownership. Currently, informal agreements and traditional legitimacy is not considered fair enough to settle disputes among villages.

Potential economic improvement

Catch management

The management and distribution of fisheries catches are not fair enough yet. Some of marine catches with a high economic value like octopus, sea-cucumber, abalone, and other commercial fish have not a good preparation. If the people have a good catch management, that can give them a good alternative income.

Seaweed cultivation

Recently the main occupation of the community in Darawa is the cultivation of Seaweed. However, for last few years seaweed product has been hampered by seaweed diseases. Seaweed production has also been affected by the use of cyanide by outside fishers, which has been blamed for the destruction of seaweed crops.

Potential for agricultural improvement

Even though land farming produces poor crops many people in Darawa farm and still do not fulfil their daily food requirements. Farmers attribute poor crops to: slash and burn methods – no rotation; farming methods only clear area and plant where there is soil without using fertilizers; farm sizes are too small farm because most of the land is rocky; and many crops are planted seasonally, such as corn and cassava, due to dry seasons.

Lentea Village

Overview

Population:	775 (M 313; F 462)
No of households:	155
Sub-villages:	Sampua Tooge and Sampua.

Geographic location

Lentea village is situated on north-east of the island of Lentea Utara/Langge facing onto the village of Darawa on Lentea Kiwolu. The island of Lentea Utara/Langge is the most south easterly part of the Kaledupa sub-district with the island district of Tomia to the south.

Village establishment

Lentea is a name of the small island in the eastern part of the Kaledupa called Lentea Utara or Lentea Langge. As the Indonesian government established itself, Lentea Utara/Langge island and Lentea Kiwolu island was associated with the village of Langge (Kaledupa). In 1968 Langge Village expanded and formed the sub-villages of Langge, Sandi, and Lentea. The village of Lentea was then divided to be two sub villages of Sampua Tooge and Darawa as the sub villages had different characteristics with communities originally coming from different villages (most of the resident of Sampua Tooge came from Langge and Tomia but the resident of Darawa came from Buranga).

In 1997 Darawa and Lentea were made into an independent villages, with Lentea villages being divided into the two sub-villages of Sampua Tooge and Sampua.

Community facilities

Water Supply: The quantity and the quality of water in the village are limited due to: as it is predicted that the rocky geographic condition has no underground water; well water is not distributed equally among the community especially during the dry season; and in the rain season the quality of the water is not guaranteed.

Sanitation: The awareness of the people about sanitation is still low and few houses have toilets and use the bush or the beach and in the dry season there are often cases of diarrhoea. The clinic officer is aware how the problems with sanitation but the community are not concerned.

Power: Now there is a generator self-managed by the community which operates only at night (for a maximum of 6 hours) but it does not supply all the houses on Lentea. The majority of the community use kersone lanterns or high pressure kerosene lanterns at night.

Access: A regualar speed boat ferry connects to Kaledupa island, Tomia and Wanci. Alternatively the community must charter motorised boats from other people in the village.

Village Fisheries

Overview

The fishers in Lentea mostly use hand lines and trawls where as other fishing method as net fishing, pot trap, and fish fence are rarely used, and mostly by fishers that have settled in Lentea from other villages or islands.

Marine resources management

Over exploitation of marine resources has impacted and reduced the condition and quality of the marine resources.

Bomb and cyanide use and Coral reef destruction

Though the government had a campaign to stop the uses of explosive and cyanide with heavy fines many fishers the other village or outside of Kaledupa continue to use destructive fishing practices. The people in the village are frustrated and pessimist about government capacity to stop destructive fishing and are concerned about the effect of cyanide on seaweed culture. Some of the community want to find a solution to destructive fishing but there are limited facilities. In addition to the local people still dig out the coral to seek abalone.

Law enforcement and controlling system.

The large number of destructive fishers can not be stopped as there is not a good control system applied by the government or other related security institutions. If this problem is not dealt with soon, it may become a serious problem for the future.

Fishing grounds

The demarcation border between the villages especially in Lentea is not clear yet. A kind agreement among the community, even in the traditional way is not make a sense to reduce a conflict among the community. In other hand the community activity to expand to explore the marine product without aware to the environment damage without a fix regulation or have a clear right to improve their area.

The demarcation of Lentea fishing grounds is not legally defined. Traditional fishing grounds extend from the middle of the channel separating Lentea Kiwolu and Lentea Langge, out to the reef to the east and extends south to the southern tip of Lentea Langge.

Potential economic improvement

Seaweed cultivation

The main occupation of the people in Lentea is seaweed cultivation, even though production has been affected in the last few years by a seaweed disease which appears to be worsening. Fishers also believe that use of cyanide has affected their production.

Marine Product Management

The Fishery condition and catches have become significant lower that in the last few fears. This is attributed to destructive fishing by both fishers from Lentea and beyond.

Potential for agricultural improvement

The main occupation of the people in the village is farming but their product not enough to meet home consumption and crops often fail. This is attributed to: slash and burn methods; general lack of good farming practices; and infertility of the rooky land and no use of fertilizers; seasonally plant like corn or a kind of cassava and banana. The other crop farmers plant are coconut and different kinds of fruits. Farmers are interested to learn to plant other crops.

Sama Bahari village

Overview

Population: 1106 (M 552: F 554)
No of households: 251
Sub-villages: Sampela and Pagana.

Geographic location

Village establishment
Though the Bajo have been in the Wakatobi since Duch colonial time, the Bajo did not settle on Kaledupa till around 1900, when Bajo started to build coral platforms for houses on the reef flat in the north-west of Kaledupa which eventually became the village of Mantigola. Prior to this the Bajo lived on houseboats and never settling permanantly anywhere on the land or sea, seasonally making long distance fishing trips. Some Bajo then settled in one area called Buli La Tompe, part of Laulua village in the north east of Kaledupa. In 1958 the DI-TII army came to Kaledupa and the frightened Bajo community dispersed. Some Bajo went to Sampuanu Toroho (Balasuna), Mola, Sampuanu Lagiwae (Lagiwae village now), Lohoa (Tanomeha) and other area where they were safe form mistreatment by the DI-TII army.

In1960 some of the Bajo community return to build coral platforms for houses on the reef flat called Pagana, oposite the village of Laulua. In 1970 the Bajo settlement on Pagana and the settlement in Mantigola became sub villages of Laulua village, and finally Pagana became the village of Sama bahari in 1997.

Village facilities

Water supply: As the village is in the middle of the reef flat, water supply is a big problem as there is no main water resource. All the community obtains water from wells on Kaledupa island by canoe or motor boat.

Sanitation: Sanitation is of little interest to the community as human waste and rubbish is deposited in the sea, where it subject to tidal flushing.

Access: The the village is separated from the land by 1km and all access is by boat. A daily speedboat ferry conects to Kaledupa, Wanci and Lentea.

Power: For a long time long the government has wanted to supply the village with electricity but has not yet due to the distance from the mainland of Kaledupa. To fulfill the need of the community for power the sub-District Development Program supplied a generator that is self-managed by the community. However, because of running costs and the financial capacity of the commuity, the generator can only be run at night (for a maximum of 6 hours).

Village Fisheries

Overview

The community of Sama Bahari are skilled fishers and depend on the sea for their food and livelihoods. Traditionally the Bajo used tree bark to make fishing net, gleaned the reef flats, fished for tuna using canoes and used spear made for tree roots. In the 1950 spearguns were introduced and in the 1970 nylon gillnets and pressure lamps became commonly used. In the 1990s the Bajo started to use small motorised boats to search for tuna further out to sea. Now the Bajo are commercially dependent on fishing for incomes and are active octopus and live fish traders.

Marine resource management

In Sama Bahari almost all the 251 household have fishers and few understand of how to use the resources sustainably. The quality and the marine resource conditions around Sama Bahari are poor compared to previous years.

Coral use for building materials

There have been many government awareness programs to raise the awareness of environmental issues but the frequency of coral reefs mining has not decrease. As there is no alternative building materials to make living platforms on the reef flat the Bajo must continue to mine coral for platform construction.

Mangrove uses

Many people in Sama Bahari cut down the mangrove for house building materials as well alternative income of the family by sale fire wood. There is little alternative to use of mangrove wood for cooking as oil based cooking fuel is expensive.

Law enforcement

There are still people in Sama Bahari who break the law using destructive fishing or mining coral. However the government has little capacity to enforce or follow up regulation especially within a tight village community.

Fishing grounds

The Bajo in Sama Bahari have never had a clear traditional fishing ground due to their relatively recent settlement on Kaledupa. However, fishers from Sama Bahari fish as far away as Sombano and Lentea and are the most frequent fishers around the Island of Hoga. As there is an open access fishing policy in Indonesia there are technically no borders to traditional fishers from Sama Bahari though the placement of fish fences and seaweed farms has caused disputes over ownership of marine resources and access.

Potential economic improvement

Women involvement in sea-shore development

Women and children take an active role in gleaning on the reef flats, which can supply good incomes due to the trade in invertebrates. However, women do not take part in any decision making within the village beyond an involvement in health services.

Potential improvement of fish catches

Most fishers fish primarily to feed their family and have a limited understanding of the benefits of good fisheries management on improving their catch or how to improve the value of their catch. Fishers stated that the number and size of fish they catch has dropped each year. This is attributed to: the fishing grounds gillnet fishers have access to have decreased every year; fish habitat has been destroyed because of dynamite and cyanide uses; and there are many outsider fishermen come to fishing in their fishing ground. Catch value is not maximised because: there are still many people who barter there catch for goods or fishers sell their catch in low price; marketing information how to improve their catch value of export species is low; and often middle man play low prices and the fishers have no choice but to sell.

Sombano Village

Overview

Population: 595 (M 296; F 299)
No of households: 127
Sub-villages: Taruntu and One.

Geographic location

Village establishment

Sombano is located on the north-western of Kaledupa and is mostly populated by people from Kaledupa but it now many people have settled there from the islands of Wangi-Wangi, Tomia and Binongko. The original Kaledupa population came from the old villages of Koroki and Lifuto, which were relocated to Sombano by the Buton District government in the 1940s. At this time Sombano was a sub-village, with Mantigola, Umala, which together formed Horuo Village. In 1997 the villages in Kaledupa had grown to the extent that Sombano was made into an independent village with the sub- villages of Taruntu and One.

Community Facilities

Water Supply: Only one the public well of brackish water is located about 300 m from the village. In the dry season they must travel to a well 1 km away to get fresh water.

Sanitation: Awareness of sanitation is low and few people have a toilet and must use the bush or beach nearby their house. The clinic officer is aware of how important the sanitation is but the community are not concerned.

Access: The village is situated 6km by a single track road from the nearest village and capital town of Kaledupa. Villagers must use chartered forms of transport such as minibuses.

Power: Sombano is situated far from the capital town of Kaledupa where there is a government-owned electricity supply. Because of the distance the Sub-District Development Program procured a generator as a means of fulfilling power requirements, which is only run at night for a maximum of 5 hours due to running costs.

Sombano fisheries

Overview

In before 1950 the community in Sombano used fish fences, gleaning, bubu traps, seine net, octopus and line fishing made from traditional materials. From about 1950 onward some techniques drastically changed because most of the Kaledupa community, particularly Sombano, had much sailing experience to many other islands in Indonesia, such us Java, East Timor (Timor Leste) and up to Singapore. These experiences brought back new methods and fishing materials to the area. Fish fences which were originally made form coral and bamboo are now made from thick nylon mesh of 1.5”. Seine net fishing is now doe using thick nylon mesh instead of nets made form tree bark. Gleaning at night when it is easier to catch invertebrates is no longer performed using torches made from Bamboo and coconut fronds by use pressure lamps. Octopus fishing is now done using metal barbed rods instead of a mangrove stick. Line fishing is no longer done using a bamboo rod and line made from tree bark and now they use nylon line allowing fishers to catch fish deeper down. Bubu not changed but less different type

Marine resource management

Over exploitation of marine resources has impacted and reduced the condition and quality of the marine resources in Sombano.

Mangrove uses

Mangrove wood is still used in Sombano and sold for the family cooking need. As in other villages there is no control and the location is remote.

Coral reef destruction

If the conditions of the reefs around Sombano are compared to a few years ago, most the reef has been damage. It is evident by the current low fish catches which fishers consider to have decreased. This is attributed to destructive fishing originally by Sombano fishers who have now stopped and now by the high intensity of the outsider fishers using destructive fishing methods. In addition there are people from other villages who collect coral from areas considered to be traditional Sombano fishing grounds.

Law enforcement

There are still many people break the law. How ever the government does not enforce or follow up regulation.

Fishing grounds

The demarcation of Sombano fishing grounds is not legally defined, which affects the management of marine resources. Traditional fishing grounds extend round the North tip of Kaledupa and down the east coast to half between Laulua village and the northern tip on and extends down the west side of Kaledupa to half way between Sombano and Horua village.

Potential economic improvement

Woman role in marine management

The woman play an important in generating alternative income through collect invertebrates, especially abalone during big low tide, and through farming and seaweed culture.

Decreasing of seaweed production.

Most people in Sombano have seaweed farms which form their main income. Recently the seaweed production has declined and some people have had to leave the village for work to support their families. The decline is attributed to: seaweed disease; The fertilizer of the farm decrease; cyanide fishing; and fluctuations in the price of seaweed.

Decreasing of Agriculture product

Farming the land also is important for mostly for the production of food for home consumption and some for sale. Some people plant coconut and cashew-nut. Farming is not considered to generate a good income and crops sometimes fail. This is attributed to: slash and burn technique use; They didn't have a good tending yet. They just try to pick off the disturbance plant around the main plant.; lack of ownership of the land as there are many migrants; seasonality of crops such as banana, corn, and cassava.

Section 4: Economic status and alternative incomes

Incomes

A total of 431 Economic Units (EU) were surveyed during the census in July 2005: 75 in Darawa; 61 in Lentea; 221 in Sama Bahari; and 74 in Sombano. The average number of people in each EU showed little variation between villages, ranging from 4.27 in Sama Bahari to 4.91 in Darawa, with a mean of 4.51. A broad range of incomes were recorded during the census, table 4.1 shows the number of people in each village that generated an income from each occupation. It is important to note that this does not include people that perform these activities for subsistence only, and so for example, the total number of gleaners in each village would be much higher. For all other techniques, the catch surveys recorded that all fishers sold a proportion of their catches, thus it was assumed that the number of net, bubu, fish fence, hand trawling, hand line, speargun and octopus fishers in table 4.1 is representative of the total number of fishers.

Table 4.1. Number of people involved in each economic activity (income source) in each village from the census.

	Darawa	Lentea	Sama Bahari	Sombano
Bubu fishers	31	2	3	8
Sero fishers	2	1	0	2
Net fishers	18	17	103	7
Octopus fishers	23	11	74	6
Handline fishers	9	15	69	5
Handtrawl fishers	4	0	54	0
Speargun fishers	0	0	39	0
Gleaners	21	18	13	54
Live fish traders	0	0	1	0
Octopus traders	1	0	5	2
Invertebrate commodity trader	5	2	7	8
Seaweed growers	69	44	23	62
Seaweed traders	1	1	0	1
Chicken farmers	0	0	0	1
Cashew farmers	0	0	0	2
Clove farmers	1	0	0	1
Dried coconut producers	1	2	0	23
Cassava growers	50	3	0	3
Hoga staff owners	0	0	3	0
NGO staff owners	0	0	1	0
Small shop owners	0	0	6	0
Boat builders	0	1	2	0
Brick layers	0	0	0	1
Carpenters	0	0	0	2
Casual workers	?	1	?	?
Number receiving remittance	4	2	9	0
Cake sellers	1	0	0	0
Roof sellers	0	0	1	0
Food product traders	1	0	0	0

In summary, economic data is thought to be accurate for fishing related activities and seaweed growing but less so for land based activities, as these were not the focus of the census. Numbers of land based incomes are dominated by cassava in Darawa and dried coconut Sombano. However it was believed that most people from Sombano and Lentea grow cassava and figures are distorted from difficulties during the census to distinguish commercial and subsistence land incomes, as most people sold only a very small percentage of their crops.

Marine-based activities dominated the forms of income generation in all villages. In Darawa, Lentea and Sombano, the majority of the people in generated an income from agar farming, whereas this activity only formed an income source for 23 people in Sama Bahari. Reef gleaning – specifically the collection of abalone was also an important form of income generation in Sombano. In Sama Bahari, net fish fishing employed the highest number of people, followed by octopus, handline, hand trawl and speargun fishing.

Table 4.2 groups economic activities into three main types of livelihood (fishing-based, agar-based and farming-based) and the percentage of economic units that generate and depend on income from each type of activity.

Table 4.2. Percentage of marine, seaweed growing and non-marine income sources used by economic units in each village. Figures in parenthesis indicate the percentage of economic units that are dependant on income source.

	Darawa	Lentea	Sama Bahari	Sombano
Fishing and trade marine products	59.5 (1.4)	51.0 (5.9)	98.6 (79.2)	71.6 (6.8)
Grow or trade seaweed	94.6 (5.4)	88.2 (31.4)	10.9 (1.4)	85.1 (5.4)
Farm or trade non-marine products	75.7 (2.7)	19.6 (5.9)	10.9 (0.0)	44.6 (5.4)

In Sama Bahari, EUs showed the highest dependence on fishing and trading of marine products (79.2%), with 98.6% of all EUs involved in this activity. Although more than half of the EUs in villages other than Sama Bahari were involved in fishing or trading of marine products (ranging from 51% in Lentea to 71.6% in Darawa), the dependency of each EU on these activities was relatively low in comparison to Sama Bahari (ranging from 1.4% in Darawa to only 6.8% in Sombano). Seaweed farming was particularly important to EUs in Darawa with 94.6% of EUs involved in this activity, although EUs in Lentea were more dependent on seaweed farming (31.4%) as a sole source of income. EUs in Sama Bahari showed both low involvement (10.9%) and a low dependency (1.4%) on agar farming. Overall none of the villages were dependent on farming and trading in non-marine products, however, farming is an important income source for Darawa (75.7%) and Sombano (44.6%), although less so for Lentea (19.6%) and Sama Bahari (10.9%).

Gross weekly incomes from fishing were the highest for Sama Bahari, followed by Sombano, with Darawa and Lentea having roughly similar incomes (table 4.3). In communities with a high involvement in agar farming, such as Darawa where almost the whole community is involved in this activity, the income generated from seaweed farming was almost 3 times greater than from fishing. Alternately, with respect to farming or trading of non-marine products, gross weekly incomes were low overall and formed a minor part of income generation, even if communities were heavily involved in this activity. EU in Sombano generated the highest gross weekly income from farming of Rp 46,019, whereas other villages generated only between Rp 16,000 (Lentea) and Rp 20,000 (Sama Bahari).

Table 4.3 Mean weekly gross income of fishing, seaweed growing and farming per economic unit. Products given as gifts or consumed at home are not taken into account

	Darawa	Lentea	Sama Bahari	Sombano
Fishing	Rp 109,720	Rp 108,440	Rp 164,903	Rp 125,745
Seaweed	Rp 322,246	Rp 259,148	Rp 137,391	Rp 125,347
Farming	Rp 17,990	Rp 16,000	Rp 20,000	Rp 46,019

To obtain an overall view of the income generated on a village level by each type of activity, the number of people involved in each activity (table 4.1) was multiplied by the average gross weekly income. Figure 4.1 illustrates the high importance of fishing-based activities to households in Sama Bahari which generate the highest total gross weekly income of almost Rp 35 million per week. In Darawa and Lentea, agar farming and trading represents the main source of income generation for these villages with approximate total gross incomes of Rp 22 million per week and Rp 12 million per week respectively. In Sombano, fishing and agar-based activities have an almost equal importance to the village economy, with farming also making an important contribution.

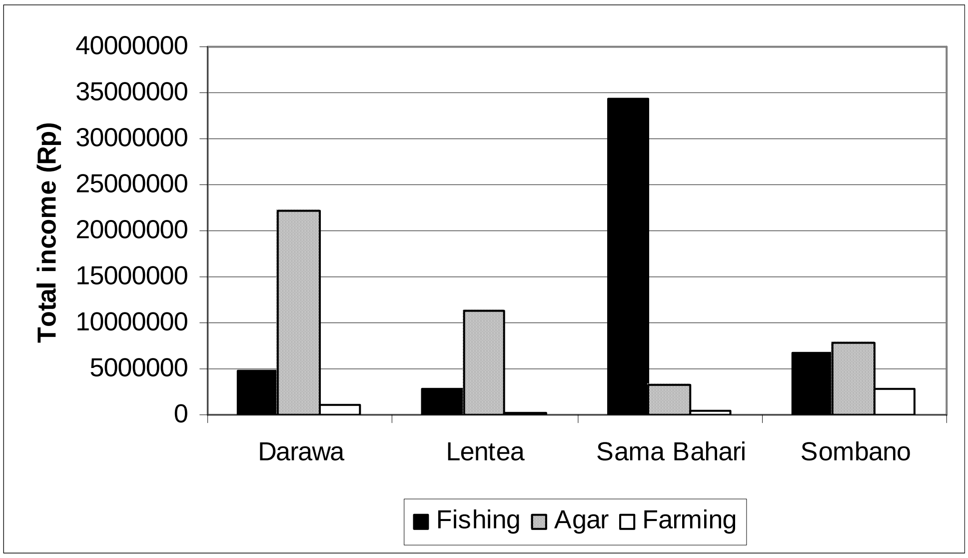

Figure 4.1. Total gross weekly income of all EU in each village from fishing, seaweed growing (agar) and farming.

When economic activities are considered separately and averaged across the four villages the mean weekly gross income is highest for seaweed traders followed by traders in dried marine commodities (table 4.4). However it should be noted particularly in the case of traders, that these figures represent gross weekly incomes as opposed to net incomes which would give a more accurate figure for comparative purposes. Remittance sent home by members of the economic unit working abroad is also important ranking as the third highest gross weekly income source. In terms of fishing activities, fish fence owners generate the highest gross weekly income, followed by gleaning, octopus fishing, net fishing (combined gears), hand trawl, hand line, speargun and finally bubu traps.

Table 4.4. Mean weekly gross income for each economic activity for all four villages combined.

Economic Activity	Average Rp
Seaweed trading	16,818,743
Invertebrate trading	1,310,000
Remittance	490,740
Boat building	350,000
Fish fence	245,000
Seaweed growing	211,033
Working on Hoga	195,833
Gleaning	157,953
Clove farming	150,000
Brick laying	150,000
Octopus trading	146,932
Live fish trading	120,000
Small shop	120,000
Octopus	100,346
Net	83,677
NGO wage	80,000
Hand trawl	73,657
Casual work	70,000
Handline	55,065
Speargun	54,615
Bubu	48,394
Chicken farming	30,000
Cake selling	30,000
Carpentry	27,500
Cashew farming	25,625
Dried Coconut	24,612
Cassava Farming	17,341

Figure 4.2 represents the total weekly gross village income from each fishing technique, together with the estimated subsistence value of the catch - which incorporates components of the catch that are both consumed at home and given away as food gifts. In Sama Bahari, where fishing is the mainstay of the village economy, net fishing, followed by octopus, handline, hand trawl and gleaning, represent the most lucrative fishing techniques. The relative economic value of subsistence fishing generated from both catch and census data is relatively low for Sama Bahari though comparatively important in other villages.

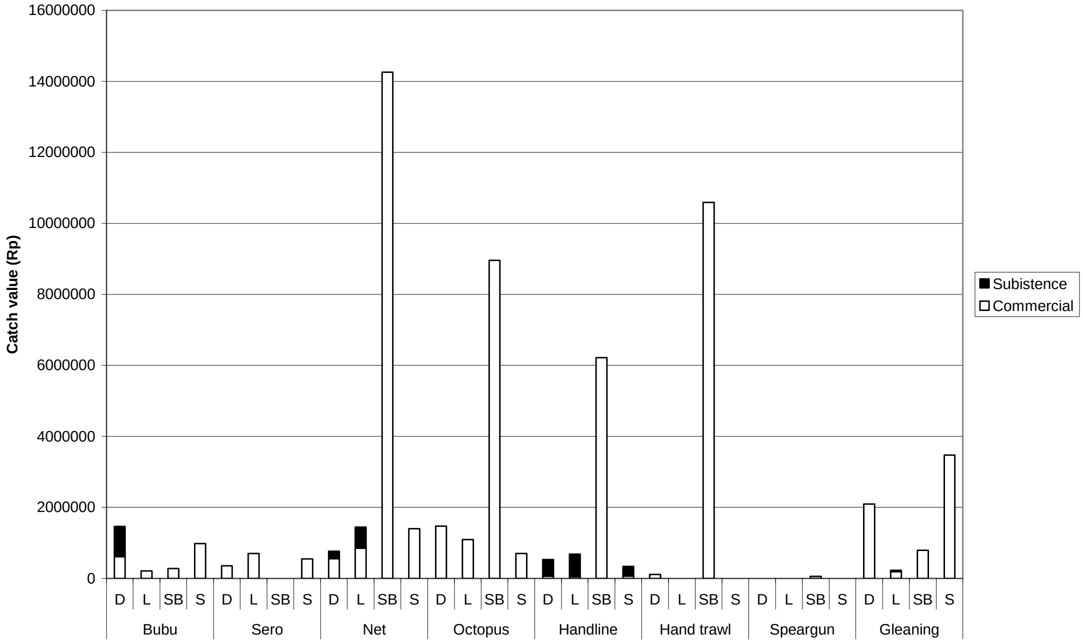

Figure 4.2. Total weekly gross village income from each fishing gear type and the estimated economic value of catches used for subsistence (eaten or given as gifts).

Economic aspirations and alternative incomes

During socio-economic monitoring, fishers were asked a number of questions relating to their current economic status, financial management capacity and interest in alternative incomes. The numbers of respondents (heads of EUs, which were normally the primary fisher in the EU) interviewed in each village were: 27 Darawa, 21 in Lentea, 61 in Sama Bahari and 20 in Sombano. Respondents included octopus, net, bubu trap, fish fence fishers and traders. When fishers were interviewed on their level of contentment with current incomes, almost all fishers from Sama Bahari expressed that they were very discontent or discontent (figure 4.3). This is surprising, as respondents in Sama Bahari were mainly octopus or net fishers that were shown to be commercially driven and capable of generating the highest gross weekly incomes compared to fishers in other villages and other techniques. The majority of fishers in Lentea (88%) were discontent with their current level of income, Sombano showed a mixed level of contentment and only fishers in Darawa expressed majority contentment with their income (61%).

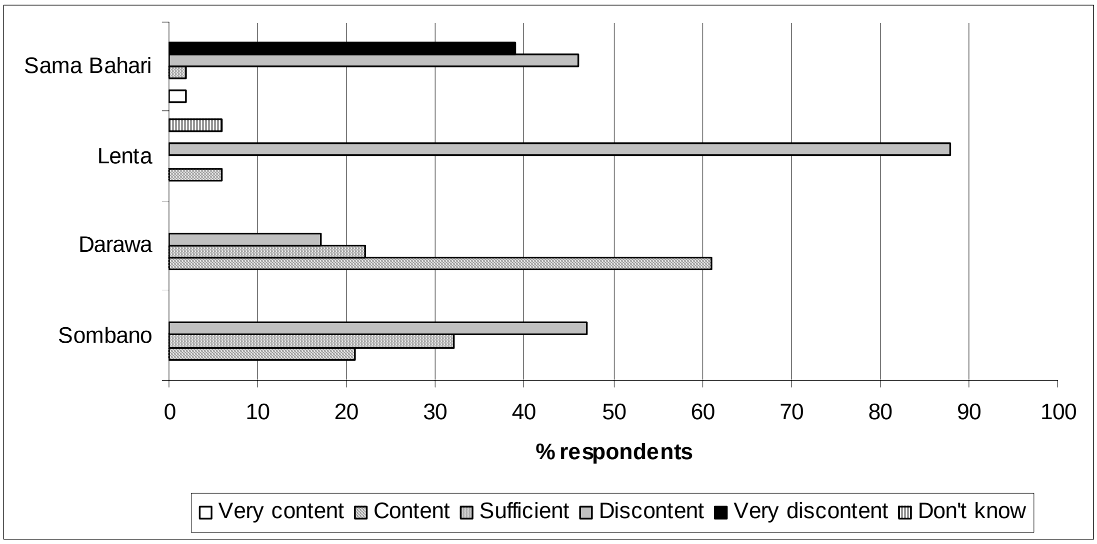

Figure 4.3. Level of contentment of fishers with current income.

When fishers were interviewed on the status of their household finances, fishers from Sama Bahari expressed a large problem, while many fishers from other villages expressed slight problems with income stability, especially Lentea (75%) (figure 4.4). Fishers in Darawa and Sombano appear to have the most stable incomes (figure 4.4). None of the respondents claimed to have a large surplus and only 18% of fishers in Sombano had some surplus. Overall, very few people had any form of savings (figure 4.5) the highest being 9% of the EU in Sama Bahari. Alternately, although debt does exist in all of the villages, the majority of people interviewed said they had no form of debts (figure 4.6).

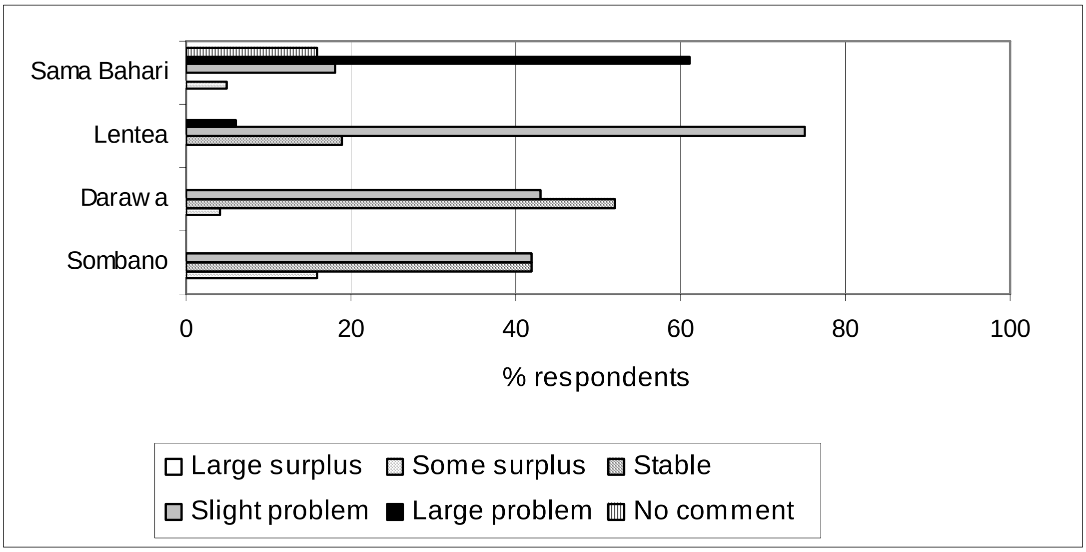

Figure 4.4. Household finances

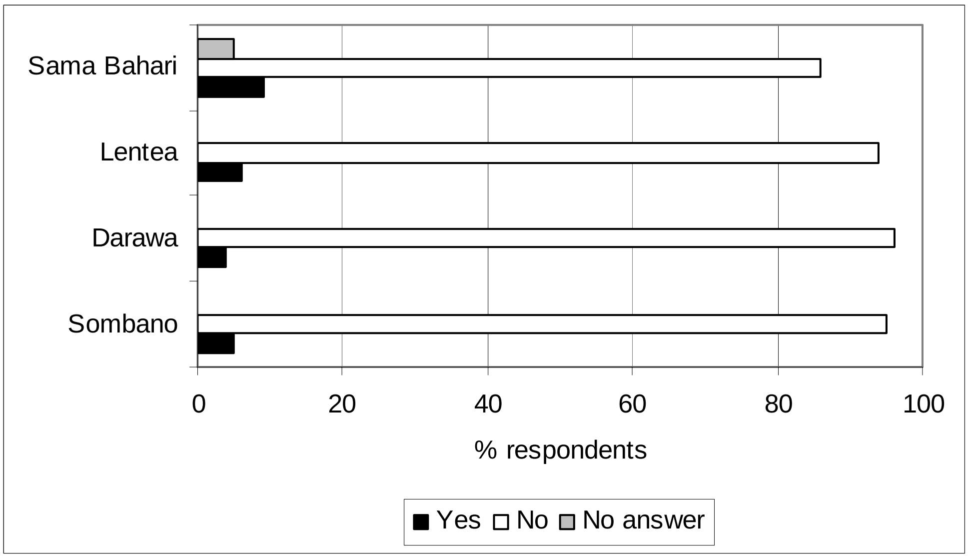

Figure 4.5: Level of household savings

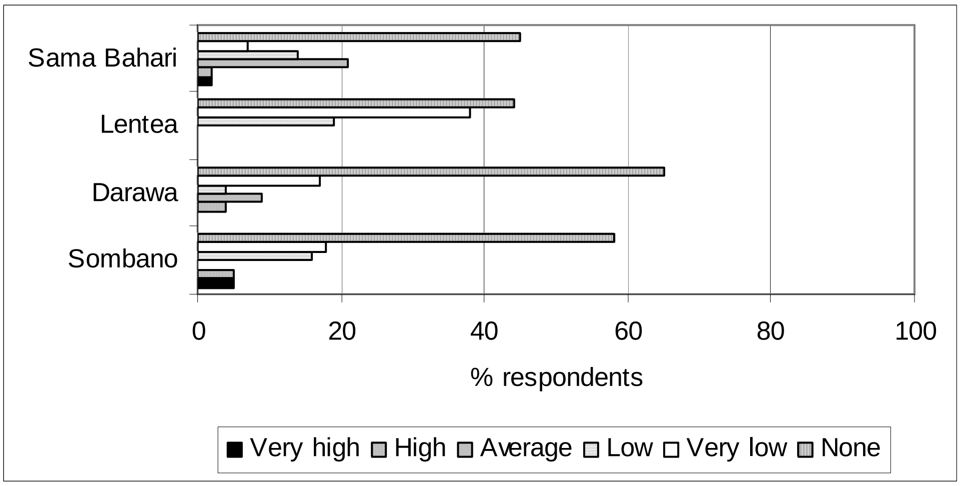

Figure 4.6: Level of household debt

A clear desire to improve fishers' livelihoods in all villages was expressed during the social monitoring, where a wide range of requests were made by fishers for training and financial management (table 4.5). Most training requests were linked to business and aquaculture, though there were some requests for training to improve fisheries management. Requests to improve marketing reflect the lack of access to commercial markets and a need to improve sale prices for products. Financial management requests focus on training to manage finances and a need for capital to invest in new businesses.

The desire of communities to improve their current livelihoods is clear from their aspirations and requests for support to help achieve this. When interviewed about their interest in alternative income sources, interest was extremely high (over 70%) in all villages (figure 4.7).

Table 4.5: Aspirations and requests of community with respect to their livelihoods, financial management and alternative incomes.

Aspirations	Sombano	Darawa	Lentea	Sama Bahari
Requests to improve livelihoods				
Improvement of community livelihoods and household income	*	*	*	*
Provision of (or information about) alternative incomes	*	*	*	*
Programs from government or other organisations to provide alternatives that will improve household income	*			
Cooperation between Trust project and government to maintain and improve community livelihoods	*	*		
Requests for training				
Provide information and training about different kinds of aquaculture and fishery management	*		*	
Provide training and facilities for aquaculture	*			*
Improving fishery aquaculture skill			*	
Training and education linked to alternative incomes	*			
Give understanding about marine resource management to improve catches			*	
Carry out focus group discussions, training and introduction to new fisheries information	*	*		
Provide training and information about potential new businesses		*		
Teaching and training about management of marine resources that have high economic value that can be supported by capital business		*		*
Marketing				
Improvement of marketing techniques for marine products		*		
Provide information about marketing marine products	*			
Improved prices for marine products			*	
Efforts to increase economic value of catch, increasing prices etc.	*			
Providing market for fishery production such as commercial fish and the other marine resources	*	*		
Bring in investors/traders to buy cooperate with community and buy fishery products and agar	*	*	*	
Financial management				
Supply financial management training (particularly accounting)		*		
Financial capital to start new businesses				*
Give financial assistance			*	*
Providing economic institution such us credit bank to access money and have savings account		*		
Training and financial aid to alleviate financial pressures	*	*	*	*
Money instalments for fishers	*			
Financial capital to start business			*	*
Improvement of financial management	*			

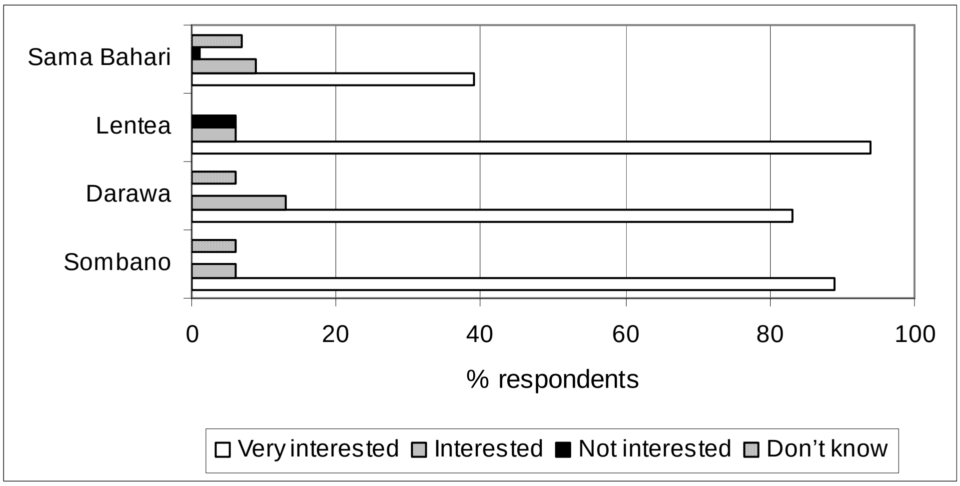

Figure 4.7. Level of interest in alternative income sources

Many alternative or improvements on current sources of income were suggested by fishers during interview, which fall under the categories of improved fisheries management and fishing practices (including pelagic fishing), aquaculture and farming and businesses related to marine products (table 4.6). Although fishers from Darawa, Lentea and Sombano made a range of different suggestions, fishers from Sama Bahari could only suggest seaweed growing and trading of marine products, which are activities already undertaken in Sama Bahari.

Table 4.6. Types of alternative livelihood or ways to improve current livelihoods suggested by fishers during interviews.

	Sombano	Darawa	Lentea	Sama Bahari
Improved fishing techniques	*			
Fishery management		*		
Efforts to increase fishing productivity	*			
Management of groupers and other commercial fish		*		
Pelagic net fishing	*	*	*	
Pelagic fishing			*	
Fish aggregating devices and supporting facility	*			
Abalone aquaculture	*	*	*	
Sea cucumber aquaculture	*		*	
Fish aquaculture		*		
Improved seaweed growing	*	*	*	*
Coral farming		*	*	
Gardening	*			
Chicken farming			*	
Goat farming			*	
Business based on marine products	*			
Trading of marine products	*	*		*

Section 5: Resource decline – perceptions and solutions

General issues

During socio-economic monitoring, a range of technique users (table 5.1) were interviewed firstly about general problems threatening the marine environment and then specifically with respect to each fishing technique they used. Fishers were asked to list the problems, the cause of the problem, how this affected their livelihood/income and what possible solutions could be found to address each problem.

Table 5.1. Number of respondents that were interviewed on general issues and technique specific issues.

	Darawa	Lentea	Sama Bahari	Sombano
Bubu fishers	6	2	-	7
Net fishers	7	8	26	5
Octopus fishers	11	10	35	6
Octopus traders	1	0	4	1
Fish fence fishers	2	1	0	1
Total	27	21	61	20

The majority of fishers in each village (over 70%) identified the use of bombs and cyanide as the main problems facing the marine environment and affecting fishers' livelihoods (figure 5.1. Habitat degradation and declining catches were also perceived to be important problems. Sama Bahari was the only village where some respondents (14%) claimed that there was no problem.

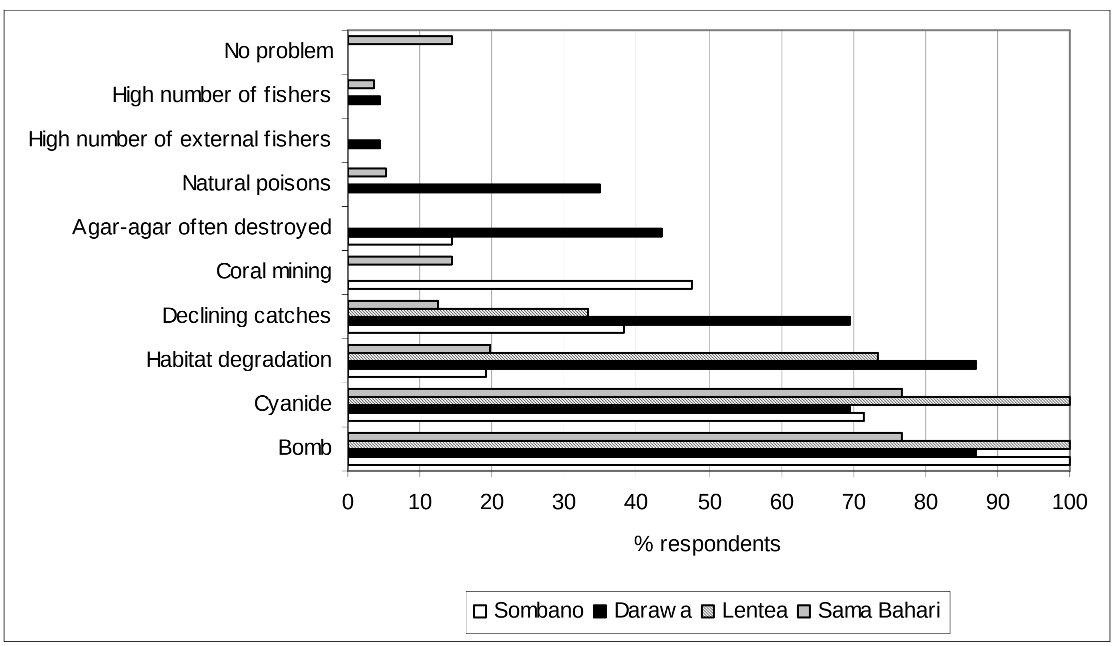

Figure 5.1. Fishers' perceptions of general problems facing the marine environment and affecting fishers' livelihoods.

When questioned further on the causes of bomb and cyanide use, the majority of fishers from Darawa, Lentea and Sombano (74-87%) indicated that bomb and cyanide users came from outside Kaledupa, although a high percentage of fishers in Darawa and Lentea also attributed bomb and cyanide use to local fishers from Kaledupa (table 5.2). Some fishers in Sombano (10%) went further and identified Bajo fishers from villages around Kaledupa as bomb fishers. In the Bajo village of Sama Bahari, 49% of fishers blamed the use of bombs on the difficulty of catching fish and believed the use of bombs to be a fast and easy alternative to obtain high catches. There were also many fishers in Sama Bahari (55%) who would not comment on bomb and cyanide fishing.

Table 5.2. Community perceptions about the causes of bomb and cyanide fishing. B = 'bomb' and C = 'cyanide'.

	Sombano		Darawa		Lentea		Sama Bahari	
	B	C	B	C	B	C	B	C
Fishers from outside Kaledupa	80	70	74	74	87	87	40	14
Local fishers	20	20	61	61	60	40	9	14
Fishers in general	-	-	-	-	13	13	-	-
Bajo fishers	10	-	-	-	-	-	-	-
Low awareness of dangers of bomb	-	-	-	-	-	-	5	-
Too many fishers so people look for short cut	-	-	-	-	-	-	49	7
Low level of policing	-	-	-	-	-	-	-	10
Compressors	-	-	-	-	-	-	-	5
Don't know	-	-	4	17	-	-	-	-
No comment	-	4	-	-	-	-	-	55

When questioned about solutions to stop bomb and cyanide fishing the answers were almost uniform across communities, identifying the need for more intensive and harder policing, including collaborative patrolling between communities and Police/Park Rangers together with efforts to increase public awareness of the impacts of bomb and cyanide on marine resources (table 5.3). Collaborative surveillance was a frequent response and numerous requests were made for support facilities such as patrol boats and radios for communities, to facilitate surveillance and rapid report of incursions to government and National Park authorities. Fishers from Sama Bahari also suggested a 'Name and Shame' method for known bomb and cyanide fishers within the village to force individuals to stop and the supply of alternative incomes for bomb and cyanide fishers as 'a way out'. Comments on how to improve fisheries management included: increasing the understanding of the function of coral reefs and their links to fisheries, and heightened awareness of concepts and benefits of sustainable fisheries management (Sama Bahari and Sombano); general improved management (Sombano); and protection of aggregation sites (Darawa).

Table 5.3. General comments on marine resource decline and management

General comments	Sama Bahari	Sombano	Lentea	Darawa
Surveillance				
Increase awareness of the need for collaborative surveillance and patrolling by community and Police/Park Rangers	*	*	*	*
Community patrolling with radio link and speed boat to report information to Park Rangers and Police	*		*	*
Destructive fishing techniques				
Increase public awareness as many members of the community don't understand problems caused by bombs, cyanide, and coral mining on the sustainability of sea resources	*	*	*	*
Co-operation between community and government to stop bomb and cyanide fishers	*	*	*	
Hard sanctions and maximum fines from district government to punish bomb and cyanide fishers	*	*	*	*
List the names of bomb and cyanide fishers in each village	*			
Provide alternative incomes to communities (mainly bomb and cyanide fishers)	*			
Fisheries Management				
Socialisation of the functions of the coral reef ecosystem and sustainable marine resource management	*	*		
Provide information and support facilities for communities to solve local fisheries problems		*		
Sub-district and village government must play a strong role in protecting marine resources in traditional fishing grounds		*		
Create marine protected area outside of traditional fishing grounds for local fishers		*		
Regulations to protect fishing grounds needed for some areas such as spawning aggregation sites				*
Commitment between government and community to protect spawning aggregation sites				*

Problems facing fisher user groups

Bubus: Most bubu fishers identified the low abundance of fish as the biggest concern, attributing this to “many fishers”, and “bomb and cyanide use” or “unknown” causes (figure 5.2 and table 5.4). In terms of solutions, fishers suggested that there should be limits for fishers from outside Kaledupa, socialisation with Park Rangers and more effective policing (table 5.4). Destruction of coral was also a concern in Darawa and

Lentea, attributed to abalone fishers and bomb and cyanide use, with efforts towards collaborative surveillance between government and communities as a solution.

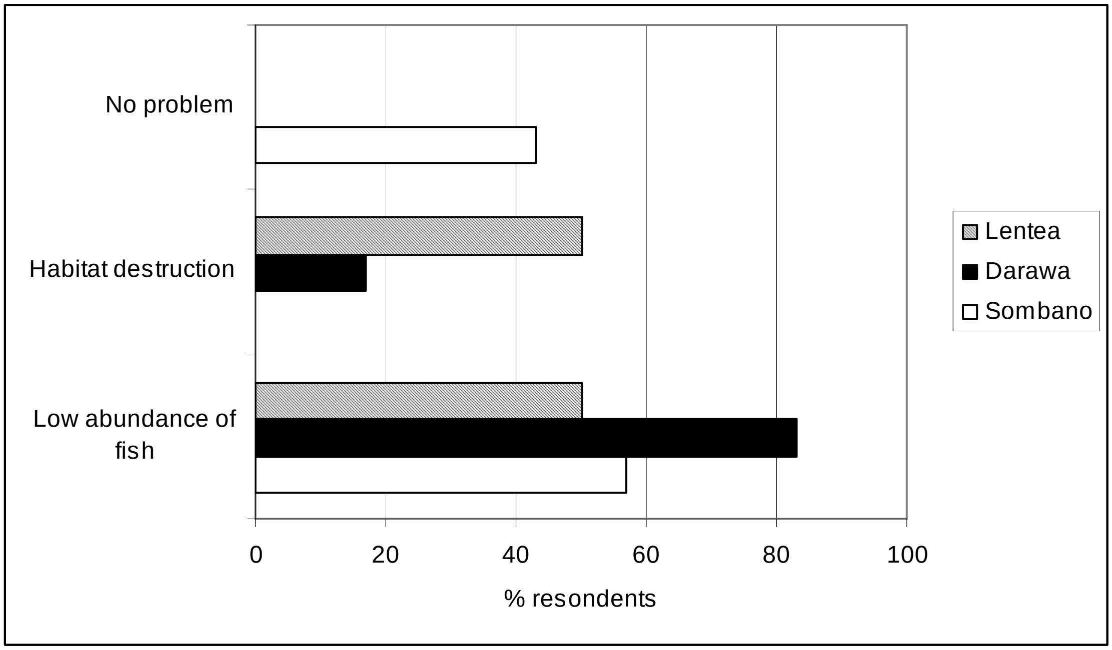

Figure 5.2. Problems with the bubu trap fishery identified by fishers in interviews.

Nets: Net fishers in Darawa and Lentea also identified the main problem as being low abundance of fish, with some net fishers form Sama Bahari and Sombano also sharing this opinion (figure 5.3). Low abundance of fish was attributed to bomb and cyanide fishing, and to some high fishing pressure, both from too many fishers (Darawa and Lenea) or to external fishers (Lentea and Sama Bahari) (table 5.5). Socialising the effects of bomb and cyanide on marine resources, and increased surveillance and policing were suggested as solutions. Many net fishers from Sombano (60%) did not believe there were any problems threatening their livelihoods.

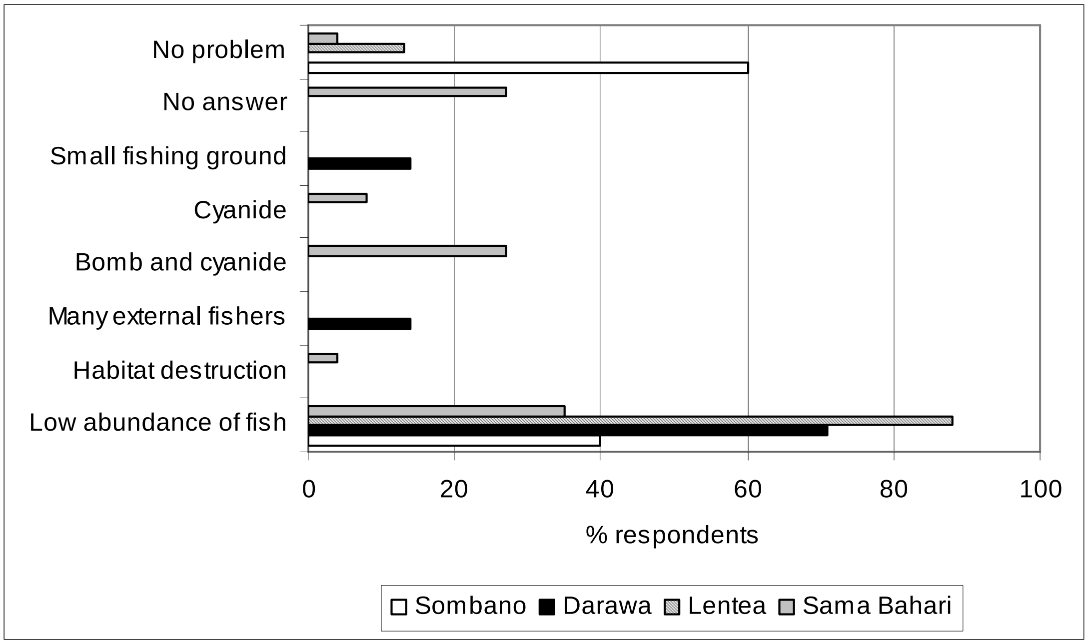

Figure 5.3. Problems with the net fisheries identified by fishers in interviews.

Fish fences: 100% of fish fence owners identified the low abundance of fish as the main problem facing them, with fish fence fishers from Darawa also expressing problems posed by too many net fishers and people stealing catches from their fish fence (figure 5.4). The cause of these problems was attributed to high fishing pressure, net fishers, too many Bajo fishers from Mola (Wanci Island) and Mantigola (Kaledupa) and use of bomb and cyanide, however no solutions could be suggested apart from alternative income sources (table 5.6).

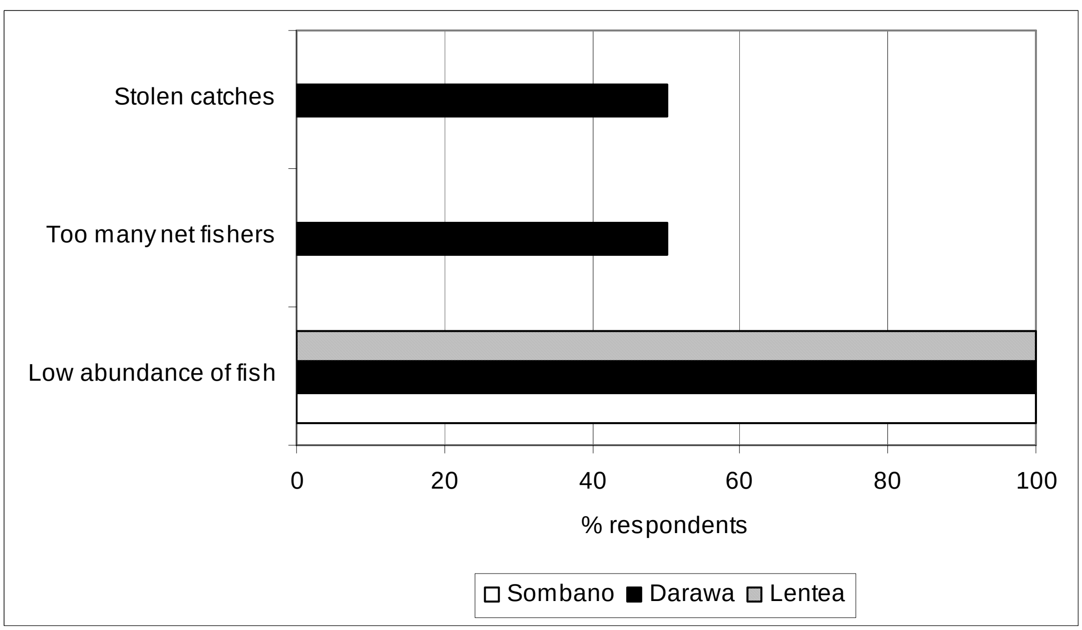

Figure 5.4 Problems with the fish fence fishery identified by fishers in interviews.

Octopus: Octopus fishers in Darawa, Lentea and Sombano identified the low abundance of octopus as a problem facing their livelihood. In Lentea octopus fishers identified the habitat destruction as the biggest problem, and in Sama Bahari octopus fishers identified bomb and cyanide use as the problem or did not comment (figure 5.5). Habitat destruction in one form or another was believed to be the largest cause of low abundance of octopus (bomb and cyanide, octopus habitat destruction or abalone fishers destroying coral) (table 5.7). Octopus fishers in Sombano believed that too many octopus fishers had led to the decline in octopus abundance. A wide range of solutions were suggested by octopus fishers, including socialisation of problem issues, management and increased policing (table 5.7).

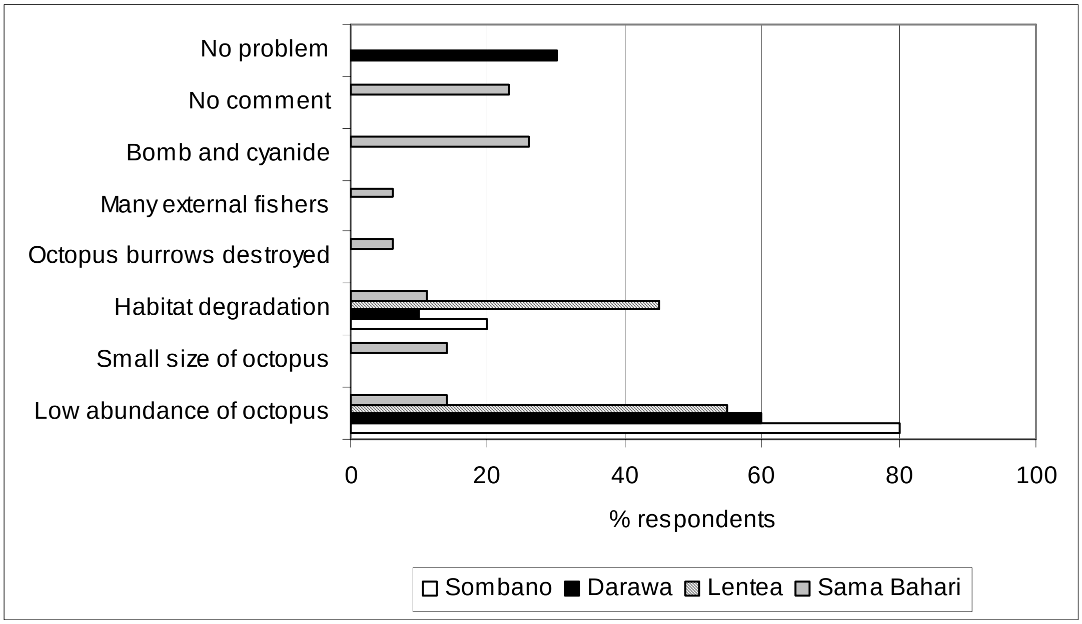

Figure 5.5. Problems with the octopus fishery identified by fishers in interviews.

Octopus traders: The octopus middleman in Darawa identified the low awareness of the economic value of octopus and lack of information about current market prices as a problem (table 5.8). He suggested that the low level of understanding could be addressed by socialisation of good management practices. In Sombano the octopus trader identified a lack of preservation facilities (ice or freezing facilities) as a problem due to lack of financial capital for investment. Traders in Sama Bahari identified a range of issues including: low octopus abundance as the main problem due too many traders and thus a need for management; habitat destruction by external bomb and cyanide fishers, requiring government and community discussions; and low income for fishers due to the high number of fishers and thus a need for financial aid.

Table 5.4. Attributed causes and suggested solutions to problems faced by **bubu fishers**, given as percentage of respondent's answers. * indicate multiple answers and thus will total higher than 100% of respondents.

Problem	L	D	S	Cause of problem	L	D	S	Effect on income	L	D	S	Solution	L	D	S
Low abundance of fish	50	83	57	Many fishers	50*	17	-	Decrease	50	17	-	Efforts to achieve security	-	17	-
												Don't know	50*	-	-
				Coral destroyed	50*	17	-	Decrease	50	17	-	Don't know	50*	17	-
				Don't know	-	33	-	Decrease	-	33	-	Socialisation with Rangers	-	33	-
				Bomb and cyanide	-	17	57	Decrease	-	17	57	Efforts to achieve security	-	-	14
												Policing and efforts to achieve security	-	-	29
												Policing and efforts to achieve security between government and communities	-	-	14
												Ban bomb and cyanide fishing	-	17	-
Habitat degradation	50	17	-	Abalone fishers	50*	-	-	Decrease	50	-	-	Guarding by community and government	50*	-	-
				Bomb and cyanide	50*	17	-	Decrease	50	17	-	Guarding by community and government	50*	-	-
												Don't know	-	17	-
None	-	-	43	None	-	-	43	None	-	-	43	Don't know	-	-	43

Table 5.5. Problems faced by **net fishers**, their attributed causes and suggested solutions

Problem	L	D	SB	S	Cause of problem	L	D	SB	S	Effect on income	L	D	SB	S	Solution	L	D	SB	S
Low abundance of fish	88	71	31	40	Bomb and cyanide fishers	38	57	15	40	Decrease	25	57	27	40	Socialisation and efforts to achieve security	-	57	-	-
															Punish bomb and cyanide fishers	-	-	4	-
															Increased guarding	25	-	-	20
										None	-	-	-	20	Stopped by community and government	-	-	-	20
					External fishers	25	-	8	-	Decrease	25	-	14	-	Surveillance	25	-	-	-
															Socialisation	-	-	4	-
					Many fishers	25	14	-	-	Decrease	25	14	-	-	Efforts to achieve security and surveillance	25	-	-	-
															Alternative income source	-	14	-	-
					Use of small net mesh sizes	-	-	8	-		-	-	-	-	Don't know	-	-	8	-
					Coral destroyed	13	-	4	-	Decrease	13	-	-	-	Don't know	-	-	15	-
															Guarding	13			
No problem	13	-	4	60	None	13	-	4	60	No effect	13	-	4	60	Don't know	13	-	4	60
Many external fishers	-	14	-	-	Low level of policing	-	14	-	-	Decrease	-	14	-	-	Strict security measures	-	14	-	-
Bomb and cyanide	-	-	27	-	External fishers	-	-	8	-	Decrease	-	-	27	-	Socialisation	-	-	4	-
					Fishers	-	-	4	-		-	-	-	-	Community and government patrolling	-	-	8	-
					Don't know	-	-	15	-		-	-	-	-	Increase awareness of impact of bomb and cyanide	-	-	8	-
															No comment	-	-	8	-
Fishing ground	-	14	-	-	Agar – Agar	-	14	-	-	Decrease	-	14	-	-	Don't know	-	14	-	-
Cyanide	-	-	8	-	Fishers	-	-	4	-	Decrease	-	-	4	-	Alternative livelihood	-	-	4	-
					Don't know	-	-	4	-	No answer	-	-	4	-	Don't know	-	-	4	-
Habitat degradation	-	-	4	-	Bomb	-	-	4	-	Decrease	-	-	4	-	Don't know	-	-	4	-
No comment	-	-	27	-	No comment	-	-	23	-	No comment	-	-		-	No comment	-	-	27	-

Table 5.6. Problems faced by **fish fence fishers**, their attributed causes and suggested solutions. * indicate multiple answers and thus will total higher than 100% of respondents.

Problem	L	D	S	Cause of problem	L	D	S	Effect on income	L	D	S	Solution	L	D	S
Low abundance of fish	100	100*	100	Net and other fishers	100	-	-	Decrease	100	-	-	None	100	-	-
				Fishers from Mola & Mantigola	-	50*	-	Decrease	-	50*	-	Alternative income source	-	50*	-
				Bomb and cyanide	-	-	100	Decrease	-	-	100	None	-	-	100
Catches stolen by other fishers	-	50*	-	Don't know	-	50*	-	Decrease	-	50*	-	-	-	50*	-
Many net fishers	-	50*	-	Bomb and cyanide	-	50*	-	Decrease	-	50*	-	Don't know	-	50*	-
				High fishing pressure	-	50*	-	Decrease	-	50*	-	Don't know	-	50*	-

Table 5.7. Problems faced by **octopus fishers**, their attributed causes and suggested solutions

Problem	D	L	SB	S	Cause of problem	D	L	SB	S	Effect on income	D	L	SB	S	Solutions	D	L	SB	S
Low abundance of octopus	60	45	14	80	Many fishers	20	20	3	80	Decrease	20	10	-	80	Alternative livelihood	20	-	-	-
															Regulate external fishers	-	-	20	-
															Limit entry of external fishers	-	-	-	20
															Good management	-		20	20
															Management regulations	-	-	20	-
															Don’t know	-	-	40	40
															Efforts to achieve security	-	20	-	-
					Bajo fishers	20	-	-	-	Decrease	20	-	-	-	Efforts to achieve security	10	-	-	-
															Don’t know	10	-	-	-
					Fishing	-		3	-	-	-		4	-	Socialisation	-	-	3	-
					Bomb and cyanide	-	10	6	-	Decrease	-	20	4	-	Socialisation	-	-	6	-
															Efforts to achieve security by government and community	-	10	-	-
					Many external fisher	-	-	3	-	Decrease	-	-	4	-	Regulate external fishers	-	-	3	-
					Octopus habitat destroyed	-	-	3	-	Decrease	-	-	4	-	Don’t know	-	-	3	-
					Coral destroyed	-	10	-	-	Decrease	-	10	-	-	Efforts to achieve security	-	10	-	-
					Don’t know	-	5	-	-	Decrease	-	5	-	-	Don’t know	-	5	-	-

Table 5.7 continued. Problems faced by **octopus fishers**, their attributed causes and suggested solutions

Problem	D	L	SB	S	Cause of problem	D	L	SB	S	Effect on income	D	L	SB	S	Solutions	D	L	SB	S
Habitat degradation	10	55	11	20	Bomb and cyanide	30	10	9	-	Decrease	30	6	-	-	Surveillance by government and community	20	10	-	-
															Don’t know	10	-	-	-
															No comment	-	-	3	-
					Bajo fishers	-	-	-	10	Decrease	-	-	-	10	Management regulations	-	-	-	10
					Abalone fishers	-	30	-	10	Decrease	-	30	-	10	Management regulations	-	-	-	10
															Ban	-	30	-	-
					Fishers	-	10	3	-	Decrease	-	6	11	-	Don’t know	-		9	-
															Guarding by government and community	20	10	-	-
					Don’t know	-	5	-	-	Decrease	-	5	-	-	Don’t know	-	5	-	-
Bomb and Cyanide	-	-	26	-	Coral destroyed	-	-	3	-	No comment	-	-	3	-	Don’t know	-	-	3	-
					Many fisher	-	-	17	-	Decrease	-	-	11	-	Socialisation	-	-	17	-
					Don’t know	-	-	6	-	Decrease	-	-	11	-	Alternative incomes	-	-	6	-
Size of octopus decrease	-	-	14	-	Octopus habitat destroyed	-	-	14	-	No comment	-	-	14	-	Socialisation	-	-	14	-
Many external fishers	-	-	6	-	Many fishers	-	-	6	-	Decrease	-	-	6	-	Don’t know	-	-	6	-
Octopus habitat destroyed	-	-	6	-	Fault of fishing techniques	-	-	6	-	Decrease	-	-	6	-	Socialisation	-	-	6	-
No comment	-	-	23	-	No comment	-	-	23	-	No comment	-	-	23	-	No comment	-	-	23	-
No problem	30	-	-	-	None	30	-	-	-	No effect	30	-	-	-	No comment	40	-	-	-

Table 5.8. Problems faced by **octopus traders**, their attributed causes and suggested solutions. * indicate multiple answers and thus will total higher than 100% of respondents.

Problem	D	S	SB	Cause of problem	D	S	SB	Effect on income	D	S	SB	Solution	D	S	SB
Low awareness about economic value of catches	100*	-	-	Low level of understanding among fishers	100*	-	-	Decrease	100*	-	-	Socialisation of good management techniques	100*	-	-
Fishers move to other traders	100*	-	-	Problem with pricing system	100*	-	-	Decrease	100*	-	-	Agreement on standard sizes and prices	100*	-	-
Preservation of octopus	-	100	-	Don't have financial capital	-	100	-	Decrease	-	100	-	Have freezing facilities	-	100	-
Low abundance of Octopus	-	-	50*	Many fishers and traders	-	-	25	Decrease	-	-	25	Better management	-	-	25
				Over exploitation	-	-	25*	Decrease	-	-	25*	Alternative incomes	-	-	25*
Coral destroyed	-	-	25	Bom	-	-	25	Decrease	-	-	25	No comment	-	-	25
Bomb and cyanide	-	-	25	Many external fishers	-	-	25	Decrease	-	-	25	Discussion between government and community	-	-	25
Financial capital	-	-	25*	Fishers	-	-	25*	Decrease	-	-	25*	Financial aid for fishers	-	-	25*

Section 6: Fisheries analysis

Fisheries monitoring and analysis

Fisheries catch surveys were performed on one randomly selected day each week over a 6 week period between 16th July and 25th August 2005 in the Easterly season. During the 24 survey days, 135 fisheries operations were recorded with catches comprising a total of 233 species of fish. Bubu traps were the most frequently recorded technique followed by drive-in encircling gillnets, set gillnets parallel to the reef and hand line (table 6.3 & 6.4). As only a few reef gleaning and octopus catches were recorded during fisheries monitoring they are not included in the analysis. Furthermore, fishers targeting deep sea pelagics (*Thunnus obesus, Katsuwonis pelamis* and *Auxis thazard*) are not included in hand trawls. Fisheries catch data presented in this chapter is meant to give an overview of the individual fisheries on Kaledupa as it is calculated from combining catch survey results from each of the four villages. Analysis of data at village level can found in Appendix V.

Characterisation of fishing techniques and fishing capacity in each village

A census of the villages of Darawa, Lentea, Sama Bahari and Sombano collected specific data on the number and type of fishing gear owned by each fisher household (table 6.1) while general information regarding technique use was gathered informally. The number of fishers who generate a regular income per gear type for each village was calculated from census data (table 6.2).

Table 6.1. Details of fishing gear in each village collected from census data. Total number of gears, mesh size (inches) and mean length (metres) are shown. The numbers of households are taken from local government statistics (2005).

Village	House -holds	Bubu traps	Fish fence	Lantern	Spear-gun	Spear	Seine net	Gill net
Darawa	187	89	2 1.5” 150m	19	0	41	0	12 1.5-5" 90m
Lentea	155	23	1 1.5” 100m	13	0	25	2 2.5-5" 130m	12 1.5-2.5" 170m
Sama Bahari	251	38	0	86	264	33	9 2.5-30" 360m	85 1-2.5" 160m
Sombano	127	95	2 1.5” 120m	28	0	42	1 2.5" 150m	5 2.5" 235m

Table 6.2. Number of fishers in each village who generate a regular income from specific fishing techniques (based on census data collected in the Easterly season 2005).

	Darawa	Lentea	Sama Bahari	Sombano	Total per Technique
Bubu fishers	31	2	3	8	44
Fish fence fishers	2	1	0	2	5
Net fishers	18	17	103	7	145
Octopus fishers	23	11	74	6	114
Hand line fishers	9	15	69	5	98
Hand trawl fishers	4	0	54	0	58
Speargun fishers	0	0	39	0	39
Gleaners	21	18	13	54	106

Hand line fishing using bait is performed in all villages on the reef crest and flat, mostly during the day or on rising tides at night, although in Sombano it is used infrequently and thus was not recorded during fisheries monitoring. In Sama Bahari, the number of fishers that generated an income from hand line fishing was four times higher than in other villages (table 6.2), although fishers in Darawa fished on an almost daily basis, travelling the furthest and fishing for the longest period (appendix V). In Darawa, the catch is divided almost equally between home consumption, given as gifts and sale, whereas in Sama Bahari and Lentea fishing is more commercially driven with 70% and 66% of the catch respectively being sold in the village or at the local market (appendix V). Overall, active Kaledupa hand line fishers on average fished for 5 days per week, catching 5.1kg per day with an average sale value of Rp16,733 per day, although 11% of Kaledupa hand line catches were not considered to be good eating (table 6.3).

Hand trawling using lures in the mid-water off the reef is only performed by fishers from Sama Bahari and Darawa, with fishers from Sama Bahari spending twice as long to travel to fishing grounds (appendix V). The number of hand trawl fishers in Sama Bahari is very high (54) in comparison to Darawa (4) (table 6.2) but included fishers from Sama Bahari who fished for deep sea pelagics. Fishers from both villages consume most of their reef fish catch. Overall, active Kaledupa hand trawl fishers surveyed during monitoring on average fished for 4 days per week catching 3.5kg per day (Rp10,000 per day) with 99% of the catch considered good eating (table 6.3).

Spear-gun fishing is performed during high tides only by fishers from Sama Bahari in relatively close fishing grounds. On average every household has a speargun (table 6.1) as this technique was frequently used in the past, however, now presently only 39 fishers generate an income from this technique (table 6.2) with catches being mainly for consumption (72%). Often speargun fishing is used in conjunction with other fishing trips, for example, hand line or net fishing trips. Active Sama Bahari speargun fishers surveyed during the monitoring period, on average fished for 4 days per week catching 3.4kg per day (Rp13,333 per day), with 99% of the catch considered as good eating (table 6.3).

Gleaning is performed at low tides in all villages, either during the day on foot or using canoes, or at night using lanterns and sometimes spears. Gleaning includes the collection of a range of invertebrates that can be processed and sold for export, such as sea cucumbers, abalone, decorative shells, sold to local markets (urchins, spider conches, bivalves) or just for home consumption. Most people collect both for sale and home consumption on one trip. Gleaning in the villages of Darawa, Lentea and Sombano is performed solely by men, but in Sama Bahari it is performed mostly by women and children. Though lanterns are frequently used for line fishing, the number of lanterns and spears in each village gives an indication of the importance of gleaning for all villages (table 6.1). From this data and personal experience, it is extrapolated that the number of gleaners is highest in Sama Bahari, followed by Sombano (high number of abalone fishers), Darawa and then Lentea. Data on the number of people earning an income from gleaning is not an accurate representation of total number of fishers due to the high level of subsistence.

Octopus fishing is performed in all 4 villages however different techniques are used. Fishers in Darawa use the traditional method of ‘Hepuria’ which uses two curved sticks made from mangrove wood to ‘tickle’ the octopus out of its den. In Lentea and Sombano, men and women glean on foot at low tide or free dive (men only) using iron bars to extract octopus from their dens. In Sama Bahari, a range of techniques are used including gleaning, free-diving (3-pronged spears or spearguns) lures (octopus doll) which used by a few people to catch octopus when they are actively foraging on the reef. All octopus catches are commercial which are sold to middlemen in the village for export (fresh) to Japan and Hong Kong.

Bubu trap fishing is generally only performed by ethnic Pulo fishers and thus bubu traps were not expected to be used by fishers in Sama Bahari. However are three Pulo fishers living in Sama Bahari who use Bubu traps and two Bajo fishers in Sama Bahari have now started using baited bubu traps to catch mangrove crabs. The highest numbers of bubu traps are in Sombano (95) and Darawa (89), with few in Lentea (23) and Sama Bahari (38) (table 6.1). There are two main types of bubu trap to catch fish, both constructed in the traditional method from split bamboo: the standard Bubu trap has an internal volume of 0.162 m^3 and is used unbaited on the reef flat, or immediately behind the reef crest; a much larger trap is used by fishers in Darawa, where it is baited and used on the reef slope. In this report, only the use of standard bubu traps is discussed. Large coral fragments are used to weigh down and disguise the trap to encourage fish to enter. Bubus are moved once catches start to decrease leaving a ring of coral fragments which fishers retain an informal ownership for future use. Bubu fishers infrequently placed bubus in new areas but when they do they break off live coral to place around their traps.

On average six traps per fisher in each village are used, although individuals may use up to ten. The number of fishers who generate an income from bubu fishing was at least 3 times higher for Darawa (31) than the other village (table 6.2). Bubu traps are set locally in Darawa and Lentea but fishers from Sombano travel comparatively further to set their traps (appendix V). Traps are normally lifted on alternative days during high tides, thus giving a soak time of approximately 48 hours. Catches from Bubu trap fishing are mostly sold in Lentea (73%) and mostly consumed at home in Sombano (52%) (appendix V). Overall active Kaledupa bubu fishers surveyed during monitoring lifted their traps every second day catching 2.5kg per day (Rp5,857 per day), which was the lowest daily catch per technique. Generally, 16% of the catch from Bubus was not considered to be good eating, which is the second largest proportion of unwanted catch for all techniques (table 6.3).

Fish fences are placed in soft sediment on the reef flats, orientated with the cod end close to the reef crest, a long leader fence running towards the land and short fence wings on either side of the leader fence to guide fish towards the trap end and into the trap. Some fish fences are moved seasonally (approximately every 3 months) as in Darawa and are often removed for whole seasons. There are two fences in Darawa and Sombano, one in Lentea and none owned by fishers from Sama Bahari. Fences in Lentea (100m) and Sombano (120m) are shorter than Darawa (150m) due to narrower reef flats (appendix V). All fences are now made from 1.5” seine net material instead of traditional split bamboo. Overall active Kaledupa fish fence fishers surveyed during monitoring were emptied their traps every second day. Before emptying the traps, net fishing is sometimes performed adjacent to the fish fence, to increase the numbers driven into the trap and caught in nets. Fish fences surveyed during monitoring on average caught 17.1kg per day (Rp35,833 per day) with 94% of the catch considered to be good eating (table 6.3).

Net fishing can be divided according to the two main types of net used: gillnets (of which there are two drive-in and two set techniques) and seine nets (using scare lines or beach seining). The number of fishers generating an income from net fishing is highest in Sama Bahari (103), which is more than 5 times higher than the other villages (table 6.2). The number gill (85) and seine (9) nets in Sama Bahari was also approximately 8 times higher than the other villages, indicating the large potential net fishing effort within Sama Bahari (table 6.1). Gillnet mesh sizes varied between 1.5 and 2.5”, seine nets varied between 2.5 and 4”, with larger meshes (5-30”) being used for sharks and rays by fishers from Sama Bahari (table 6.1). However within these broad groups there are many different techniques which target specific species and therefore have been recorded and described separately.

Set gillnets parallel to the reef are used in all villages except Darawa. Nets are set on the reef flat for short periods (2-4 hr) or often over night (6-7hr), though this was not recorded during these surveys. Nets are placed at high tides in areas where fish are believed to migrate back to the reef crest from the reef flat, and are lifted just after the low tide. All nets had a mesh size of 2.5”, however nets were almost twice as long in Sama Bahari (250m) as in Lentea and Sombano (135m). Fishers using set gillnets parallel to the reef are strongly commercially driven in all three villages, fishing with an almost daily frequency and selling the majority of their catch (78-90%). Overall active Kaledupa fishers using set gillnets parallel to the reef surveyed during monitoring fished for 6 days per week catching on average 11.6kg per day (Rp34,00 per day) with 99% of the catch considered good eating (table 6.4).

Set gillnets perpendicular to the reef use a 2” mesh size and are only used in Sama Bahari. The net is set on the reef flat for 6 hours and is not tide specific though it requires a certain depth of water, and again the majority of the catch is sold (83%). Overall active Kaledupa fishers using set gillnets perpendicular to the reef surveyed during monitoring fished for 4 days per week catching 26.7kg per day (Rp124,167 per day) with 99% of the catch considered good eating (table 6.4).

Drive-in encircling gillnets are used in all villages except Sombano and most frequently in Sama Bahari where they fish almost every day, often setting the net twice and therefore spend the longest time fishing. Nets are set on the reef flat in large circles or spirals around shoals of fish, which are scared into the net by smacking the surface of the water with bamboo poles or banging the side of the canoes with oars. Fishers in Sama Bahari use the smallest mesh size of 1” compared to 1.75” in Darawa and 2.25” in Lentea, the longest nets (140m vs. 76m in Darawa and 100m in Lentea) and are the most economically driven (70% sold vs. 50% Lentea and 46% Darawa). Overall active Kaledupa fishers using drive-in encircling gillnets surveyed during monitoring fished for 5 days per week catching on average 9.9kg per day (Rp25,119 per day) with 99% of the catch considered good eating (table 6.4).

Drive-in gillnets parallel to the reef are only used in Sama Bahari with a mesh size of 2” and an average length of 155m.. Nets are set on the reef flat in U-shapes around shoals of fish which are driven into the ‘U’ by hitting the water with bamboo poles. Again these fishers are economically driven selling 68% of their catch. Overall active Kaledupa fishers using drive-in gillnets parallel to the reef surveyed during monitoring fished for 5 days per week catching on average 20.4kg per day (Rp72,000 per day) with 97% of the catch considered good eating (table 6.4).

Table 6.3. Summary of fishing operations surveyed on Kaledupa during the Easterly season 2005. Percentages eaten, sold or gift were fisher estimates based on total weight of catch. Estimates of the percentage of fish that were considered good eating were based on the total number of fish.

	Fishing Gear				
	Hand line	Hand trawl	Speargun	Bubu	Fish Fence
Sample size	15	14	6	35	9
CPUE	1.46 kg/hr	1.33 kg/hr	1.19 kg/hr	0.44 kg/trap/day	17.07 kg/day
Kg/day	5.1	3.5	3.4	2.5	17.07
VPUE	4,828 Rp/hr	3,729 Rp/hr	4,167 Rp/hr	1,082 Rp/trap/day	35,833 Rp/day
Rp/day	16,733	10,000	13,333	5,857	35,833
Duration travel	1:24 hr	1:02 hr	0:40 hr	1:18hr	1:00hr
Duration fishing	3:28 hr	2:55 hr	2:30 hr	1:46hr	2:00hr
Days fished/week	5	4	4	Every 2nd day	Every 2nd day
Operation/day	1	1	1	-	-
Length	-	-	-	-	153m
Inch	-	-	-	-	1.5”
No. Traps	-	-	-	6	1
Soak time	-	-	-	48	48
% Eaten	27	58	72	42	32
% Sold	63	41	28	53	61
% Gift	9	1	0	5	7
% Good eating	89	99	99	84	94

Seine nets with scare lines are used by fishers from Sama Bahari, Darawa and Lentea, though it was only recorded in catch surveys in Lentea. This method is used occasionally by groups of between 6-10 fishers who agree to work together either to supply fish for special occasions, such as village ceremonies, or for economic gain. In Lentea it was used twice per week and was mainly to meet family food requirements (70% home consumption). These nets are deeper (2-4m) than gillnets and are set on deeper sections of reef flat where large fish are known to gather or pass through. Nets are set at high tide in a shallow U-shape and long scare lines (50-100m) that are attached to each end of the net (often with pieces of wood attached) are dragged through the water by boats in arcs to eventually cross each other. Lines are then hauled in to close the net in a circle, which is drawn tighter until all fish are forced into a 'cod end' and hauled into boats. A mesh size of 2.5" was used in both villages. In the one catch that was recorded 29% of the catch was not considered to be good eating, the largest proportion of unwanted catch for all techniques surveyed. Seine nets with scare lines were found to have the highest catch weight per day (80kg) and the highest catch value per day (Rp 300,000). Although only one operation was recorded during catch surveys the catch size and value are thought to be accurate, though catches as large as 2 ton have been observed from personal experience.

Catch per unit effort and value per unit effort

Beach seine nets were only recorded in catches from Sombano where 3"mesh nets of 420m in length were used every day to catch fish for sale in the village (90%). Nets are set at high tide on the reef flat and dragged in towards the beach where it is closed and the catch is hauled into canoes. Beach seine nets surveyed during monitoring fished for 7 days per week and caught the second highest catch weight (34.0kg per day) and catch value (Rp101,667 per day) with 98% of the catch considered good eating (table 6.4).

Where sample sizes were sufficiently large, statistical comparisons of Catch per Unit Effort (CPUE) and Value per Unit Effort (VPUE) for hand line, hand trawl, Bubu drive-in and encircling gillnets were made between villages. All comparisons of, showed no significant difference between villages for each technique with the exception of CPUE and VPUE for fish fence catches between Darawa (32.9kg/d, SE 18.03: Rp 69,166/d, SE 42,237), Sombano (13.5kg/d, SE 2.95: Rp 25,833/d, SE 6,508), and Lentea (4.8kg/d, SE 1.91: Rp 12,500/d, SE 5,204). Furthermore, habitat was not found to significantly affect CPUE or VPUE in bubus trap catches, as was previously expected. With the exception of fish fences, the similarity of CPUE and VPUE within each gear type indicates that catches for individual techniques can be combined to represent an overview of the Kaledupa fisheries which can then be compared to other fisheries in the world.

Table 6.4. Summary of net fishing operations surveyed on Kaledupa during the Easterly season 2005. Percentages eaten, sold or gift were fisher estimates based on total weight of catch. Estimates of the percentage of fish that were considered good eating were based on the total number of fish.

	Fishing Gear					
	Gillnet drive-in encircling	Gillnet drive-in parallel to reef	Beach Seine	Seine net with scare lines	Set gillnet parallel to reef	Set gillnet perpendicular to reef
Sample size	21	5	3	1	18	3
CPUE	0.08 kg/m/set	0.20 kg/m/set	0.04 kg/m/set	0.40 kg/m/set	0.03 kg/m/hr-soak	0.03 kg/m/hr-soak
Kg/day	9.9	20.4	34.0	80.0	11.6	26.7
VPUE	205 Rp/m/set	557 Rp/m/set	121 Rp/m/set	1,500 Rp/m/set	100 Rp/m/hr-soak	151 Rp/m/hr-soak
Rp/day	25,119	72,000	101,667	300,000	34,000	124,167
Duration travel	1:02hr	1:46hr	1:00hr	1:00hr	1:30hr	1:40hr
Duration fishing	2:20hr	1:48hr	2:00hr	2:00hr	1:26hr	2:20hr
Day fishing/week	5	5	7	2	6	4
Operation/day	1	1	2	2	1	1
Length	109	155	420	100	142	125
Inch	2	2	3	2.5”	2.5”	2”
Soak time	-	-	-	2hr	3hr	6hr
% Eaten	33	24	10	70	19	13
% Sold	58	68	90	10	79	83
% Gift	10	8	0	20	2	4
% Good eating	99	97	98	71	99	99

Species composition and sexual maturity

Generally, hand line fishers targeted Lethrinidae (68%) which feed on echinoderms, crustaceans and other small invertebrates but targeted few piscivore species (Labridae and Serranidae) (table 6.5). Catches of hand line fishers in Sama Bahari comprised mainly Lethrinidae (98%) (appendix V) with the majority of all fish being above the size of maturation (95%) with the exception of *Lethrinus harak*. Line fishers’ catches from Darawa were 84% mature (all *Lethrinus obsoletus* caught were immature) and also mostly composed of Lethrinidae (78%). In Lentea, hand line fishers’ catches were 50% mature due to the fact that most Lethrinidae (*Lethrinus amboinensis, L. erythropterus, L. lentjan* and *L. rubrioperculatus*) were below the size of maturation and represented 50% of the catch. A high abundance of Serranidae and Labridae were also present in the catches in Lentea. Overall hand line catches were 72% mature with the majority of immature species belonging to the family Lethrinidae (table 6.5).

Species composition of hand trawls varied greatly between Darawa, where only 62% of the catch was mature, and Sama Bahari, where 91% of the catch was mature (appendix V). This reflects the dominance of Lethrinidae (98%) in catches from

Darawa, where most *L. harak* were immature compared to a broader range of families caught by Sama Bahari fishers. Again there were surprisingly few piscivore species in catches and overall 74% of the catch was mature with the majority of immature species coming from the family Lethrinidae.

Spear-gun catches composed mainly of Labridae (47%) and Siganidae (31%) and catches showed the highest percentage of mature fish caught of all gear types (89%).

Table 6.5. Catch composition of hand line, hand trawl, Speargun, bubu traps and fish fence fishing gears for all villages combined based on abundance over the 6 week period. Families with abundance of less than 5% were grouped as 'other fish'.

	Fishing Gear				
	Hand line	Hand trawl	Speargun	Bubu traps	Fish fence
Sample size	15	14	6	35	9
Belonidae		13			
Gerridae		8	8		
Hemiramphidae					14
Holocentridae					5
Labridae	10		47	15	
Lethrinidae	68	61		7	10
Mullidae				39	26
Nemipteridae				9	
Scaridae			5	19	15
Serranidae	7	8			
Siganidae		8	31		6
Other fish	15	13	9	11	24
% mature	72	74	89	42	69

Table 6.6. Catch composition of drive-in encircling gillnet, drive-in gillnet parallel to reef, beach seine, seine net with scare lines, set gillnet parallel to reef and set gillnet perpendicular to reef fishing gears for all villages combined based on abundance over the 6 week period. Families with abundance of less than 5% were grouped as 'other fish'.

	Fishing Gear					
	Drive-in encircling gillnet	Drive-in gillnet parallel to reef	Beach Seine	Seine net with scare lines	Set gillnet parallel to reef	Set gillnet perpendicular to reef
Sample size	21	5	3	1	18	3
Acanthuridae				58		
Caesionidae						30
Carangidae					5	
Clupeidae	67					14
Gerridae			46			
Hemiramphidae	10	76				
Holocentridae						38
Kyphosidae						8
Lethrinidae	8		30		29	
Mullidae					8	
Nemipteridae					11	
Scaridae				33		
Siganidae		12	12		13	
Sphyraenidae					7	
Other fish	15	12	12	9	27	10
% mature	93	93	73	90	49	80

Species composition of bubu trap catches from all villages included Labridae (15%), Mullidae (39%) and Scaridae (19%) families (table 6.5), though there was a high proportion of Lethrinidae in Lentea (43%) (appendix V), though this may be due to the small sample size. Overall, bubu trap catches contained the lowest number of mature species in catches (42% mature) compared to other gear types (table 6.5), with Darawa having the lowest percentage of mature fish (37%) in the catches (appendix V). Species which were most commonly caught before reaching sexual maturity were *Lethrinus harak, L. obsoletus, L. nebulosus, L. rubrioperculatus, Parupeneus barberinus* and *Scarus ghobban.* Though bubu traps were placed in both seagrass and reef crest habitats the relative abundance of families was not affected.

Catch composition of fish fences varies greatly depending on their physical position around Kaledupa, in relation to migration routes of coastal pelagic species, aggregation sites of reef associated species, and the time of shoaling or aggregation. Generally fish fences target a wide range of species (table 6.5), including shoaling species such as Hemiramphidae which migrate along the west coast of Kaledupa during the easterlies and are caught in Sombano but not in Lentea or Darawa which are situated in the south-east and are not on main migration routes. During fisheries monitoring, fish fences in Sombano caught many Hemiramphidae, all of which were mature, giving an overall impression that the majority of fish, were mostly mature (69%) (Appendix V). However, the large seasonal catch of Hemiramphidae masks the relatively high number of immature reef fish (50%) caught by this technique in Sombano, specifically *Lethrinus nebulosus* and *Parupeneus barberinus.* In Lentea the catch was dominated by Plotosidae (*Euristhmus nudiceps*) all of which were mature Overall 69% of fish in the catches were above the size of maturation (appendix V) with immature species including *Carangoides chrysophrys, Carangoides malabaricus, Lethrinus harak* and *Mugil cephalus.* Fish fences in Darawa caught species that were generally mature (78%) (Appendix V), although all individuals of *Caranx sexfasciatus, Parupeneus barberinus, Scarus ghobban* and *Valamugil buchanani* are being caught immature. Overall species caught by fish fences were 69% mature (table 6.5).

Drive-in encircling gillnets were used by fishers from Sama Bahari to target small coastal pelagic species of the families Hemiramphidae (10%) and Caesionidae (86%), with 99% of the catches were mature (appendix V) as these species mature at a small size compared to reef-associated species. However, in Lentea drive-in encircling gillnets are used to target aggregating species of the families Gerridae. Catches were 57% mature (appendix V) with species below the size of maturation including *Carangoides chrysophrys, C malabaricus, Lethrinus amboinensis, L. harak* and *Mugil cephalus* which tend to mature at a larger size. In Darawa, drive-in encircling gillnets are used non-specifically and catch a broad range of species which were 79% mature (appendix V), with all individuals of the species *Lethrinus lentjan L. obsoletus* and *Parupeneus barberinus* being immature. Drive-in encircling gillnets are not used in Sombano.

Set gillnets used perpendicular to the reef by fishers from Sama Bahari mostly caught Caesionidae (30%), Clupeidae (14%) or Holocentridae (38%) (appendix V), all of which mature at small sizes and thus 80% of the catches were mature. This technique is used to target mostly costal pelagic species of the families of Caesionidae and Clupeidae which travel parallel to the reef though it also captures Holocentridae which perform diurnal migrations onto the reef flat at night. Thus the catch composition during this season reflects the use of set gillnet used perpendicular to the reef at night.

Set gillnets used parallel to the reef target 3 main families, Lethrinidae, Mullidae and Siganidae, though generally there was a high diversity of families in the catches (table 6.6). The percentage mature is lowest in Lentea (38%) (appendix V), with individuals of *Lethrinus amboinensis* all being immature. Most of the catches from Sombano are mature (56%) (appendix V), though it contains a mix of large species, all of which were below the size of maturation (*Carangoides malabaricus, Caranx ignobilis, Lethrinus harak, L. obsoletus, Naso annulatus* and *Sphyraena barracuda*). The percentage of mature individuals in catches using set gillnets used parallel to the reef was highest in Sama Bahari (76%) (appendix V) where the catch composed mostly of Mullidae and Lutjanidae but this may reflect the bias of the small sample size. These gillnets are not used in Darawa.

Catches using beach seine nets were only recorded in Sombano were 73% of species were mature, although all individuals of the species *Carangoides malabaricus, Choerodon anchorago, Lethrinus harak* and *L. obsoletus* were immature. The beach seine was used to target shoaling Gerridae, Lethrinidae and/or Siganidae. Seine net with scare lines were only recorded once Lentea and thus generalisations about this technique can not be made.

When catches of all gear types/techniques in all villages are combined and species abundance is examined (table 6.7), species at most at risk from recruitment overfishing are identified as those abundant in catches but with a mean size below the size of maturation. These species are: *Parupeneus barberinus, Lethrinus harak*, *Siganus fuscescens*, *Lethrinus obsoletus*, *Lethrinus amboinensis* and *Parupeneus indicus*. The coastal pelagic species *Herklotsich quadrimaculatus* dominates the catch composition (20.1%) and there is a high component of *Hemiramphus far* (3.1%) due to seasonal migrations of these species round Kaledupa during the Easterlies. Catch of reef associated species are dominated by the families Lethrinidae and Mullidae, and all species of which are benthic invertebrate feeders.

Section 7: Focus Groups

The purpose of technique-specific focus groups was to develop a mechanism for the creation of new fisheries regulations from the grass-roots level up. These focus groups address problems raised by fishers during socio-economic monitoring and issues of biological sustainability identified during fisheries monitoring. These issues were explained to fishers in conjunction with biological information in a cultural context. It is hoped that these focus groups can establish fisher agreements suitable for the protection of fisheries from over exploitation and also protect the needs of fishers. This process is believed to install legitimacy to regulations and improve compliance and community policing, as well as general pro-activeness, commitment, ownership and empowerment.

Focus groups were held in Darawa, Lentea, Sama Bahari and Sombano, and feedback and solutions suggested by the project and community members was recorded. Attendance was high in Darawa, Lentea and Sombano, but only 27% of net fishers and 53% of octopus fishers attended focus groups in Sama Bahari (table 7.1) (see appendix VI for attendants' signatures). The difference in the attendance levels was thought to be due to the higher pro-activeness of ethnic Pulau villages, their homogeneity in making village decisions and the higher individualism of ethnic Bajo fishers. However, those that attended focus groups in Sama Bahari were important and active members of the fishing community, and it was felt that without visiting individual fishers in Sama Bahari this was the most efficient method of transferring information via word of mouth.

Table 7.1. Attendance at focus groups held in the villages of Darawa, Lentea, Sama Bahari and Sombano during October and November 2005, to discuss user group issues. The number of fishers is based on census data on the number of fishers who obtain an income from that fishing technique.

User groups	Village	Date	Number of fishers	Number of attendants
Octopus	Darawa	21/9/05	23	43
Bubu Fish fence	Darawa	12/10/05	31 2	25 2
Net	Darawa	17/10/05	18	20
Octopus	Lentea	15/9/05	13	12
Net Bubu Fish fence	Lentea	6/10/05	17 2 1	45
Net	Sama Bahari	18/10/05	103	28
Octopus	Sama Bahari	28/9/05	74	39
Octopus	Sombano	19/9/05	6	18
Bubu Fish fence	Sombano	10/10/05	8 2	17
Net	Sombano	19/10/05	7	5

Outcome of focus groups with Octopus fishers

All fishers agreed there had been a decline in octopus catches and size in the last few years. This was attributed to intensive fishing by Bajo in Lentea and Darawa and fishers from outside Kaledupa by Sama Bahari fishers. Fishers in Sama Bahari believed reduced catches were not due to bomb and cyanide use, as octopus are found in different habitats. Fishers from Darawa, Lentea and Sombano were concerned about ownership and protection of their fishing grounds, but understood that traditional and current legislation does not restrict fishers from any area. Fishers from Lentea and Sama Bahari wanted to patrol against non-Kaledupa fishers but had no facilities to do so.

A minimum capture size and size accepted by traders of 500g was discussed in each village. In Darawa an informal agreement already exists for a minimum capture size of 500-600g and in all other villages fishers understood the need for a minimum capture size. Fishers in Lentea and Sombano wished to form octopus fisher groups and have discussion between groups on agreements/regulations at an island level. In Sama Bahari traders and fishers said they would work together to set limits if an agreement can be made. Fishers expressed a concern for a loss of revenue due to size limits but understood the rapid growth of octopus and capture at a larger size would have long-term economic benefits if a size limit is maintained.

Problems fishers identified as needing addressing at an island level were awareness of marine resource management, the destruction of habitat by abalone fishers, use of crowbars to dig octopus out of their dens, and standard octopus fishing techniques that do not damage octopus habitats. In Darawa, fishers have agreed to only use a two stick fishing method, believing this to be environmentally friendly. Fishers in Lentea and Sombano wanted to know which technique was the least damaging to the environment. Octopus lures used by Bajo were suggested to fishers in Darawa, Lentea, and Sombano as a good technique to use and were supplied to fishers to test them. Octopus lures were suggested as they target large octopus and do not target brooding female octopus.

Outcome of focus groups with gillnet fishers

All fishers in each village complained strongly about reduced gillnet catches in the last few year. This was attributed to reduction of fishing grounds available to fishers from Sama Bahari by the placement of new fish fences and seaweed farms (particularly in their main net fishing ground) and a reduction in catches caused by new fish fences. In Darawa reduced catches were attributed to the high intensity of net fishing of reef fish spawning sites. And in Lentea reduced catches were attributed to constant use of trawl nets by fishers who came over from Tomia and destructive fishing by outsiders. Though all fishers understood the need and benefits of using larger mesh sizes and standard net lengths, fishers form Sama Bahari said that they had no choice but to use smaller mesh sizes (a change from 3” to 1.5”) and longer nets to maintain their incomes. Fishers from Sama Bahari said that they would continue to do so without consideration for the maintenance of long-term resources, as the size of fish is decreasing and there have no economic alternative available, like farming. In Darawa, fishers were willing to use small meshes (1.5”) only to seasonally target costal pelagic species and use larger mesh sizes (3”+) for the rest of the year for reef fish. In both Lentea and Sombano, fishers were willing to make agreements on mesh size and net length but, as in Sama Bahari, there was concern that fish fence fishers would have to change their mesh sizes at the same time.

All villages agreed that some form of local management was needed and that discussion were needed between all fishers on Kaledupa and hoped that NGOs and government could find solutions for these issues. Ownership of marine resources or fishing grounds was particularly worrying to fishers from Sama Bahari as fish fences and Seaweed farms clamed ownership even though there is no law supporting this, which they believed was a conflict the local government should deal with. Ownership of marine resources was also of importance to fishers from Lentea who felt unable to protect their traditional fishing areas form trawling, and wished for support to patrol against this.

Outcome of focus groups with bubu fishers

Fishers all agreed that bubu traps caught many small fish of low value and that catch larger fish sizes would be beneficial, both economically and for sustainability of catches. Some fishers suggested that fishers could just release the small fish when they empty the traps. They also believed that there had been a reduction in catches and attributed it to use of many traps with small mesh sizes, and reduced habitat conditions due to bomb and cyanide use (especially in Sombano) and abalone fishers. In Darawa and Lentea fishers identified abalone fishers in their traditional fishing grounds to be from Darawa and Bajo. When mentioned that some fishers take live coral to place on and around their traps, fishers said that this could be avoided if traps were bigger (heavier) or weighed down some other way. Large baited traps are used on the reef wall, which have larger fish catches due to their volume and different target species but few fishers used them due to the cost of manufacture.

There was a general belief that increasing mesh size would increase size of fish in the catch, but it was pointed out by those that made traps that there might be structural difficulties with such traps and that the entrance size was also important. Fishers agreed that the Trust should carry out experiments into designing new traps in the future. There was also interest in the optimal density of traps for catches, more information on fisheries management, and a belief that local government should take an active role in making fishers aware, help management and organise surveillance.

Outcome of focus groups with fish fence fishers

Most fish fence owners understood that the small mesh sizes they used (1.5”) was causing them to catch many immature fish and supported the idea to try 50mm mesh sizes in the hope to catch more larger fish. They wanted more information on marine resource management to help maintain good catches in the future. It was understood that on the West coast of Kaledupa the Hemiramphidae season required mesh sizes of 1.5” and that mesh sizes could be changes seasonally if a program to supply larger mesh sizes was available. Though there were few fish fences in the Darawa, Lentea and Sombano but fish fence owners were aware that many new fish fences have been built in other areas in the last few years and that the number of fences would probably be of concern in those areas.

Outcome of focus groups with Traders in Sama Bahari

All traders agreed there needed to be a standard minimum size for seacucumbers, as they already know that collection of small seacucumbers has made them less abundant (they know that some species of *Stichopus* are already very rare) and if they continue they will make them extinct. Traders all agreed that agreements on collection sizes between fishers and traders are needed, and believe it should be endorsed by village law. Currently, traders accept seacucumbers down to 400/kg, though some traders only accept 250/kg.

Traders wanted fishers to have growout facilities for undersized seacucumbers and were interested in the possibilities of mariculture.

Section 8: Motor Boat Registration Scheme and Surveillance

Boat types

Currently, there are 6 different boat types used around Kaledupa (table 8.1): TS (engine type) - a 1.5 ton wooden skiff with inboard one cylinder diesel engine used mostly by ethnic Bajo for tuna fishing; Katinting – a large canoe with inboard petrol engine used mostly by ethnic Palo; 5+ ton - wooden boat with crew of 5-10 with inboard diesel engine used mostly to reach atolls or for trading; canoe – wooden dugout; Kayak – wooden closed canoe used for fishing deep sea or large pelagic species; and Mod. Canoe – canoe with built up sides. TS, Katinting and 5+ ton boats all have the capacity to cross between islands and access areas where it is difficult to police against illegal fishing practices and therefore were the target for motorboat registration trials.

Table 8.1. Boat types and numbers in Darawa, Lentea, Sama Bahari and Sombano form census data.

Village	TS	Katinting	5+ Ton	Canoe	Kayak	Mod. canoe
Darawa	0	59	0	14	0	0
Lentea	4	12	0	30	0	0
Sama Bahari	75	15	1	159	24	8
Sombano	1	2	0	63	0	0

Primary village meetings

Meetings were held in all four villages to discuss the concept of registering small motorised boats capable of crossing between islands. It was put forward to villagers that problems with external or Kaledupa fishers using destructive or commercial techniques impacting on their fisheries could be addressed by registering all motorised in Kaledupa boats. This was presented as a means of improving the identification of fishers using illegal fishing techniques as boat codes could simply be referenced to lists with registration details of all boats held by the park rangers, Village heads, Camat, Police and Army. This information, in conjunction with a SSB radio network, (which COREMAP plans to implement in the 4 villages), will allow direct and rapid notification of the park rangers of violations. Boat registration will therefore help to address difficulties of surveillance and enforcement and will help to develop local control of fisheries resources at an island level. It was made clear to communities during the meetings that the proposed scheme was a voluntary trial in four villages, with no legal basis beyond local government permission to trial the scheme. It was also explained that if the trial was successful, the results of would be presented to the government with the recommendation that the scheme be extended to cover all villages in Kaledupa.

Response from all communities during primary village meeting was enthusiastic and the decision was made to commence interviews to assess the level of understanding in communities regarding the implications of a registration scheme, their level of agreement with the scheme and any concerns they might have.

Interview responses

The numbers of fishers interviewed in each village were: 23 Darawa, 15 Lentea, 56 Sama Bahari and 21 Sombano. All fishers had some level of understanding of the registration scheme, although the level of interpretation varied across villages: the majority of fishers from Sama Bahari and Lentea understood that it "Helps to protect fishing grounds around Kaledupa"; fishers from Lentea and Sombano understood it "helps to identify local bomb fishers"; and fishers from Darawa and Lentea understood it "Helps to identify external fishers" (figure 8.1). Overall, the general level of understanding was deemed acceptable.

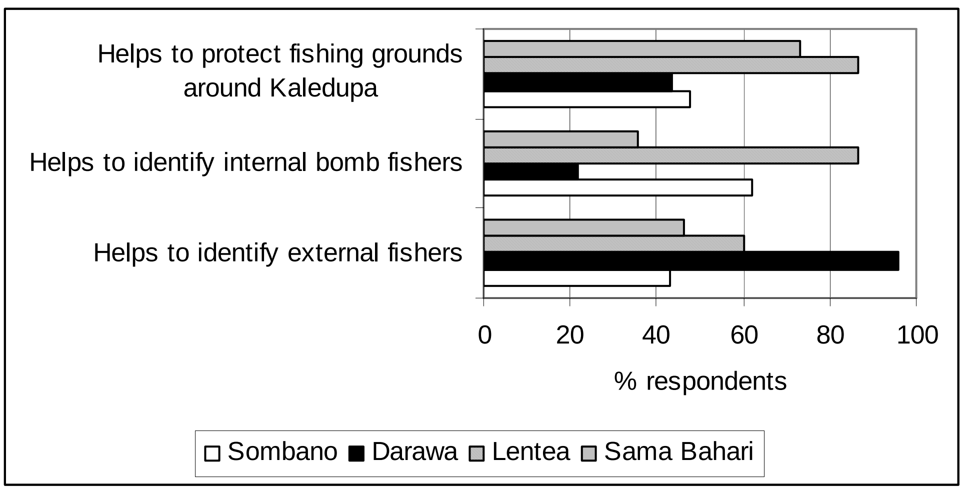

Figure 8.1. Level of awareness of fishers to the impacts of the small motorized boat registration scheme.

When fishers were asked whether they agreed with the scheme the response was greatly in favor of registration in all villages with between 70% of respondents in Sama Bahari and 93% of respondents in Lentea strongly agreeing with the scheme (figure 8.2). Sama Bahari was the only village where some respondents (5%) did not agree with the registration scheme.

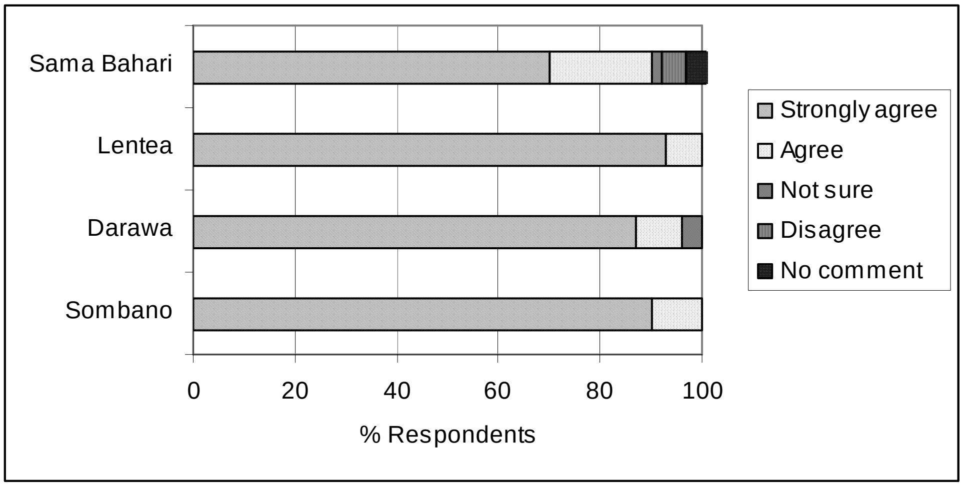

Figure 8.2. Level of agreement with the motor boat registration scheme.

There is a general feeling that fishers in Kaledupa do not like fishers from outside Kaledupa fishing their nearshore waters, mostly due to the excessive level of exploitation used by external fishers and the frequent use of destructive or commercial fishing techniques. To examine this perception, fishers were asked during socio-economic interviews whether there was a problem with external fishers, to which 100% of respondents in every village answered 'yes'.

Enforcement

In the past, enforcement strategies and levels of policing have met with limited success due to the size of the areas that require patrolling, lack of funding and limited resources of BTNKW. However the national park and specifically it's enforcement department is now receiving serious investment from both TNC/WWF and COREMAP with the aim of improving facilities and increasing levels of patrolling. As a result, National Park Rangers have been more active in patrolling and have increased socialisation with communities, including taking community members from each village on patrols. Another way of improving surveillance and enforcement at a local level, which both Operation Wallacea Trust and COREMAP are interested in, is to utilise the capacity of communities to survey and patrol their coastal areas. In order to ascertain the willingness of fishers to participate in enforcement of violations by both external fishers (figure 8.3) and Kaledupa fishers (figure 8.4), fishers were asked to select responses from a list.

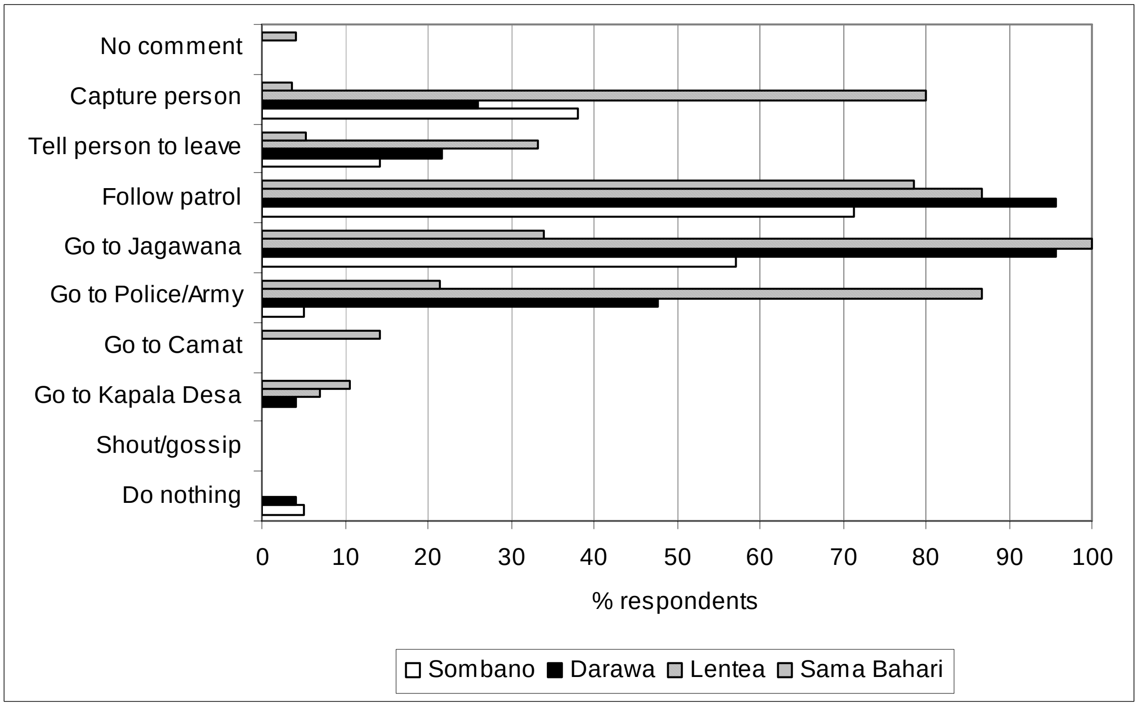

Figure 8.3. Level of community participation in policing of **external fishers** using illegal fishing techniques.

Fishers showed a range of responses when interviewed about enforcement of violations committed by **external fishers**. A large majority of fishers said they would follow ranger patrols (71-96%), which indicates a high level of commitment to enforcement against external fishers across all villages. Strong responses were also seen in Lentea with 80% willing to capture perpetrators and take them to the police and "go to police/army" with information indicating a degree of local autonomy and possibly serious problems in with external fishers in Lentea. Reporting violations to Park Rangers "go to Jagawana" was also a strong response by fishers from Lentea and Darawa. The lack of strong responses by fishers from Sama Bahari, and to a lesser degree Sombano, indicates a degree of apathy towards direct enforcement against external fishers. Interestingly, a very low number of fishers said they would report incursions to village or sub-district level government: only fishers in Sama Bahari (14%) said they would go to the Camat and 0-11% said they would go to their village headman. However, overall pro-active responses were very high with no-one just gossiping about it and only 5% of fishers in Sombano stating they would do nothing.

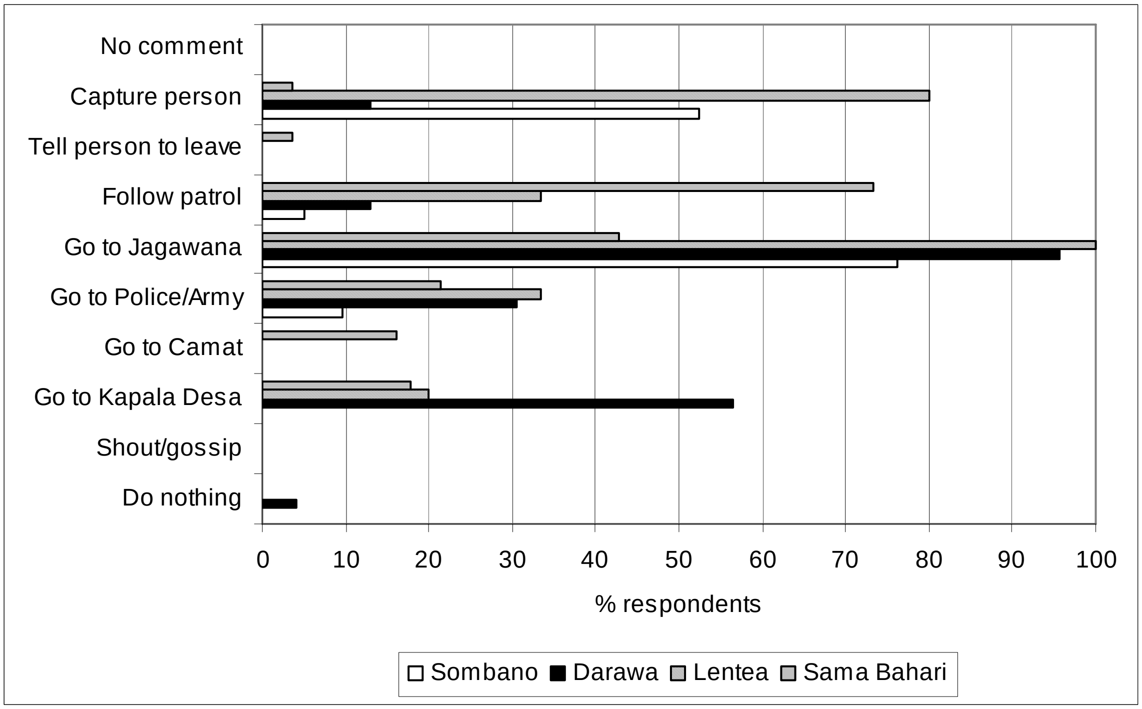

Figure 8.4. Level of community participation in policing of **Kaledupa fishers** using illegal fishing techniques.

When fishers were interviewed about enforcing violations committed by **Kaledupa fishers**, the majority of respondents were less confrontational, preferring to report incident to the Park Rangers (Jagawana) rather than joining patrols, (although a high percentage fishers in Sama Bahari (73%) continued to want to join patrols) with only a few people in Sombano being prepared to tell illegal fishers from Kaledupa to leave. The willingness to capture illegal fishers whether they were from within or outside Kaledupa varied little among respondents.

Final meetings

After the socio-economic monitoring was completed, additional village meeting were held in the four villages to present the results from interviews, which included main threats to marine resources and feedback from community about the registration process. The communities and village leaders were then asked whether they agreed to trial the motor boat registration scheme in their village – in each case they agreed. During each meeting, minutes were taken and questions posed by communities with answers from program facilitators were noted. The meeting proceedings are summarized below and attendance signatures can be found in appendix VII.

Darawa

Q 1: Village Head man

a) **Q**: To register and number boats is the community expected to pay for the costs of this activity? **A**: All costs of registration (i.e. paint and labor) will be paid for by OPWALL Trust.
b) **Q**: After registration, if a fisherman in Darawa sees an outsider fisherman fishing in Darawa fishing grounds, what can they do, especially if the fisher is using dynamite and cyanide? **A**: The incident should be reported to the authorities to deal with. Registration does not mean that fishers should take the law into their own hands, but to assist in determining the facts of who is using illegal techniques. The OPWALL Trust does not make the law but wishes to assist communities to address problem they faced by supporting communities, local government and other related institutions.

Q2: La Anisi

a) Q: Is the numbering just for boats with engines and how will new boats be numbered? **A**: This program only wishes to register motorised boats and does not apply to canoes. If a new boat is purchased or built, the owner should report this to the Village head to obtain a number. It is the responsibility of the Headman to keep up-to-date lists. The registration numbers will be gathered by the Camat for distribution to village heads, Police and Park Rangers. Although the registration program is only being trialled in 4 villages, it is expected in the long term program, registration can be extended to all villages on Kaledupa. In this case, community agreements would be sought and legislation developed with island level government, to make it the law for boat owners to be registered and display registration numbers on their boats.

Q3: Adinuru

a) **Q**: If the numbered boat was broken could the new boat from the same owner use a new number or same number? **A**: If the boat broken is replaced by a new boat, it is suggested to continue to use the same number unless the new boat is very different in size or type.
b) **Q**: What is the benefit of this boat numbering? **A**: The benefit of the boat registration is to assist fishers and Park Rangers to identify fishers using illegal fishing techniques and avoid the misunderstanding and wrongful blame between the fishers form different villages. The program will also make it easier to identify destructive fishers both from Kaledupa and those fishers who have entered the Wakatobi Park illegally; generally it will help the security institutions to perform patrolling in Wakatobi.

Sama Bahari

Q1: La Dasi

a) **Q**: As stated before we will be able to recognize inside or outside fishers, and especially fishers using destructive fishing by registration numbers. We agree with what the OPWAL Trust has explained, but the program should give benefits to everybody living on Kaledupa. **A**: We hope to expand the registration scheme to all villages on Kaledupa next year in the long-term program.

Q2: La Maronta

a) **Q**: Now that most of the reef flats are covered in agar farms the Bajo can not fish or even just pass over these areas as they used to and sometimes octopus fisherman are treated badly by agar farmers. Will registration numbers that identify us make this worse? **A**: All these problems are related sea ownership and should be raised in the BTNKW consultation forum by the village representative that has been elected by the community of Sama Bahari. Furthermore, such issues could be discussed during village meetings and brought to the attention of local government. However under national law, the sea is open access so agar fishers have no legal rights to keep fishers out.

Lentea

Q1 La Sudi

a) **Q**: The community needs support facilities for surveillance such as a SSB radio and patrol boat. **A**: Opwall Trust has new plans to provide support facilities to communities to assist with surveillance and together with the COREMAP program will make serious efforts to find solutions and realise them in the field. COREMAP will also have activities in this village. The Opwall Trust project has just started and in still in the assessment phase. We hope that community will support this process and that we can work well together.

b) **Q**: He agrees with the registration scheme but would like to know how the community will deal with bomb or cyanide fishers if they catch them red-handed. **A**: The purpose of this program to make the surveillance of coastal areas by communities easier and help them detect people using destructive fishing methods. If a bomb fisherman has been discovered, communities should not take the law into their own hands but should report the facts to the police or park rangers.

c) **Q**: We hope that Opwall Trust does not just make promises, but the results of this research are realised in the community, as research has already been conducted in Lentea by Opwall Ltd and other NGO's which has had no benefit for the community. **A**: The OPWALL Trust program is in the assessment phase for a long term program that is expected have a good cooperation from the community. OPWALL Trust is different than OPWALL Ltd. This is a community project and so the results of all research will be fed back to the community and used to work together to find solutions to problems raised by the community.

Sombano

Q1: La Roman

a) **Q**: The community supports the aim of the registration scheme and hopes that Operation Wallacea Trust will distribute the registration numbers to each motorboat in Sombano quickly. **A**: Boat registration will commence as soon as possible (next week) and will only take two days to complete in Sombano.
b) **Q**: He also hopes that Opwall Trust will give training to groups of fishers during the long-term program. **A**: The Trust program plans to give information and training to groups of fishers during focus groups. This process will start after the socio-economic and fisheries monitoring is completed.

Q2 La Diy

a) **Q**: Can Operation Wallacea Trust can give training to the community about fishing techniques so they are compatible with the status of marine resources at present. **A**: Giving information and training on developing sustainable fishing practices would be one of the aims of a long-term fisheries program and a process that we are starting to test now. The results from fisheries and socio-economic monitoring will be discussed with groups of fishers using different techniques to try and find solutions to make their techniques more sustainable and decrease their impact on the marine environment.

Registration process and results

Once the community agreed to the trial registration scheme and letters of approval were obtained from village leaders and the Camat, registration codes were allocated.

Codes were successfully applied to 100% of boats each village and registration lists were given to Village leaders, Camat and Kaledupa sub-district BTNW personnel. Registration numbers can be found in appendix VIII.

Section 9: Discussion

Introduction

One of the main purposes of the pilot project was to develop methodologies for socio-economic and fisheries data collection, from which indicators could be established to accurately determine the status of the Kaledupa fisheries. In the long term project, these indicators can then be compared annually and seasonally to determine a decline or improvement in both the fisheries and community livelihoods and identify further areas for management.

Limitations of the study

It is important to note that there are limitations to this study in determining the status of the fisheries as surveys were only conducted in 4 villages over one season (Easterlies). It is suggested that the long term program should sample continuously throughout the year, including a total of 9 villages (Ambeua, Buranga, Darawa, Langge, Lentea, Kaswari, Horua, Sama Bahari and Sombano) which account for 75% of the fishers in Kaledupa. It is clear that the values for each indicator will change due an increased sample size, differences in village fishing characteristics and village-specific seasonal variations, however the proposed sampling program should give an accurate overall picture of the Kaledupan fisheries. Furthermore, the greatest value of the data collected during this project is to provide a baseline, allowing clear comparisons in the future and allowing management to be based on explicit data.

Even under the above limitations, the results of this study in comparison to other similar tropical fisheries round the world clearly indicates that the present levels of exploitation the fisheries may be at biologically unsustainable levels, which is of economic disadvantage to fishers in the long term.

Indicators of the status of the Kaledupa fisheries

CPUE

CPUE is an estimate of the relative abundance of fish stocks. Maximum CPUE is attained when fishers obtain a maximum catch with minimum effort - at this level, fish stocks remain stable with enough fish to reproduce, replenishing stocks and maintaining catches for future years. This theoretical situation is one of the targets of sustainable fisheries management - as long as CPUE does not start to decline as fishing effort increases, it is likely that fishing can remain sustainable into the future. In the short term, increased fishing effort beyond the point of maximum CPUE will still produce high catches however this will not continue for long, as stocks will be depleted below a level whereby they can be replenished and eventually will collapse to unfishable levels. Travel time can also be used as an indicator of stock abundance, where fishers who have to travel further to fishing grounds each year indicates stocks nearby have declined. Additionally, value per unit effort (VPUE) can also be used as an indicator of the status of the fisheries, as changes in VPUE can reflect changes in species composition or size of fish.

Table 9.1. CPUE and kg/day for fishing techniques used by Kaledupa fishers with comparative values for tropical fisheries and specific case studies from around the world.

Fishing technique or Gear type	Kaledupa CPUE and Kg/day	Average values and range of CPUE and Kg/day for tropical fisheries	Specific case studies
Hand Line	1.46kg/h	2.5kg/h 0.59-5.1kg/h	New Caledonia 3.37kg/h, where habitat conditions and management are considered to be good
Hand Trawl	1.33kg/h	5kg/h 0.9-8.2kg/h	No case study
Speargun	1.19kg/h	2.4kg/h 0.4-8.5kg/h	Malalison Island, Philippines 1.1kg/h, where conditions and management are considered to be poor (Monthly variation 0.2-1.5kg/h)
Bubu traps	0.44kg/trap/d 2.5kg/d	0.1-3.3kg/trap/d	2.25-5kg/d in the heavily fished Spermonde Archipelago
Encircling drive-in gillnet	0.08kg/m/h or 9.9kg/set	4.2-43.4kg/set depending on net length and quality of fishery. 0.0046kg/m/h reef fish. Catches as high as 0.22kg/m/set or 55.7kg/set have been recorded for shoaling coastal pelagics.	In the Malalison Island, Philippines Drive in 0.024kg/m/h.
Gillnet set parallel to the reef	0.03kg/m/h or 11.6kg/set	Insufficient data	Malalison Island, Philippines, set gill net 0.004kg/m/h (Seasonal variation 0.001-0.007kg/m/h) Spermonde Archipelago low fishing pressure 24.05kg/d and high fishing pressure 4.34kg/d.
Fish fences	4.83-32.92kg/d NB: Catches of *Hyporhamphus affinis* in the Easterly season produce catches of 20-50kg/d	No data	No case study

NB: Sample size for seine nets, drive-in gillnets parallel to reef and set gillnets perpendicular to reef were not sufficient. No comparative data for fish fences could be found in the literature.

While CPUE will vary seasonally, these variations are not expected to lead to the annual mean CPUE for Kaledupa to be more that double the values recorded in this study for the following reasons: 1) seasonal values for CPUE to not vary greatly from annual mean CPUE for fisheries in the Spermonde Archipelago, SW Sulawesi and

Malalison Island (Philippines); 2) although net catches are known to be higher during the Westerlies, several reef fish spawning aggregations occurred during the survey time, and net and fish fence catches are greatly affected by costal Clupeidae and Hemiramphidae migrations which occurred during the survey time; 3) monitoring of hand trawls did not record catches of Tuna (*Thunnus obesus* and *Katsuwonis pelamis)* which come close to the east coast of Kaledupa during the Easterlies and west coast during the Westerlies; and 4) hand line and hand trawls were not affected by Frigate mackerel (*Auxis thazard*), which come close to the coast between February and April.

As there was no significant difference in CPUE and VPUE between villages for hand line, hand trawl, bubu traps and drive-in encircling gillnets techniques, the overall values can be compared to other fisheries in the world to determine the relative level of exploitation of the Kaledupa fisheries (table 9.1). The similarity of CPUE and VPUE between the 4 villages also suggests that that both standing stocks and levels of exploitation are similar around Kaledupa. However values for CPUE and VPUE from fish fence catch data suggests that fish stocks are highest in Darawa, followed by Sombano and then Lentea – this pattern is also reflected by species diversity in fish fence catches.

CPUE and kg/day for all fishing techniques used by Kaledupa fishers were within the anticipated range for tropical fisheries but were below average values

Species composition

Change in species composition can provide an approximate indication of the level of exploitation and can indicate ecosystems shifts that have resulted from fishing which may be irreversible. Tropical multi-gear fisheries typically exhibit three stages of progressively increasing exploitation levels where: 1) low to moderate exploitation expected in a traditional fishery is indicated by high CPUE, with fish from the Acanthuridae family dominating speargun and net catches and large predators of the families Serranidae and Lutjanidae dominating hand line catches; 2) moderate exploitation indicated by lower CPUE, where net fishing is the predominate technique as fish sizes become smaller; and 3) high exploitation expected in a unsustainable fishery indicated by very low CPUE, where all hand line fishing is replaced by net fishing and small herbivorous fish (e.g. Siganidae) dominate all catches.

It has also been suggested that the abundance of Lethrinidae increases in response to the removal of their predators (Lutjanidae and Serranidae), indicating a large shift in relative species abundance and a degree of overfishing. Loss of other nearshore predators such as Carangidae, Sphyraenidae, and seasonal nearshore pelagic Scombridae are also good indicators that levels of exploitation are high. Loss of predators represents a loss of high value fish and revenue to hand line fishers which is normally compensated for by gillnet fishing for planktivorus species from the family Caesionidae and herbivorous species from the family Siganidae that have a lower economic value.

Catches from hand lines and hand trawls indicate that the above situation is occurring as Lethrinidae dominated the catches (68% and 61% respectively) with very low abundance of nearshore predators: Serranidae 7% and 8% respectively, with Carangidae and Lutjanidae each representing less than 5% of total number of fish. In a well managed fishery in New Caledonia with good habitat conditions, hand line catches comprised Lethrinidae (47%), Lutjanidae (39%) and Serranidae (14%). On Malalison Island in the Philippines, which is considered to be overfished, speargun catches composes of 33% Acanthuridae, however in Kaledupa speargun Acanthuridae comprised less than 5% of the total catch. Due to seasonal variations in net catches, caused by migration of coastal pelagics and spawning seasons of reef fish, it is difficult to make comparisons of catch composition without examining the annual means.

Based on the above definitions, the Kaledupan fisheries are being subjected to medium to high levels of exploitation, with extremely low abundance of predatory species in catches.

Fish sizes and percentage of sexually of mature individuals in catches

The percentage of sexually mature individual per species in catches indicates the impact of fishing techniques on the reproductive capacity of fish stocks, particularly if the technique is used frequently over many years. Some caution must be made on judgements based on percentage of mature individuals in catches based on one season. In reef associated species there is a gradual movement towards the reef crest as species mature and species with annual spawning patterns will show a bias depending on the timing of spawning season and monitoring (further indicating the need for continual monitoring throughout the year). However, most fishing techniques are used close to the reef crest and take advantage of the daily migration of adult fish from the reef crest onto the reef flat. Moreover, most reef fish species mature between 2-5 years and thus seasonal variation on the average percentage of mature individuals in catches should represent a good estimate, however as stated before, **estimates are based on the minimum size of maturation, which may lead to an underestimation of the percentage of immature fish caught**.

Important note:
Maturation sizes are based on a robust empirically tested theoretical relationship between size and maturity. Ongoing analysis using the mean size of maturation consistently finds the majority of catches to be below the size of maturation, suggesting sever recruitment overfishing - though without evidence of a total collapse. Thus the minimum size was chosen as an initial starting point for analysis and results should be considered to be marginally worse than indicated.

In general 28.9% of reef fish caught were below the minimum size of maturation, with most of the immature reef fish coming from 6 species indicated in table 9.2. Techniques that contribute to this are bubus for both Mullidae and Lethrinidae families, and hand line, hand trawl, beach seine and gillnets set parallel to the reef specifically for Lethrinidae. Bubus had the most negative impact on fisheries, followed by set gillnet parallel to the reef, and then fish fences. The impact of fish fences in Sombano (west coast) is obscured by the abundance of mature coastal pelagic species in catches, as when reef fish are examined on their own only 50% of the reef fish caught were mature. This situation is expected to be similar along the west coast of Kaledupa where catch compositions are similar, including coastal pelagic species, and there are is a high number of fish fences (Kaswari alone approximately 30 fish fences). Though catch compositions varied between Darawa, Lentea and Sombano, this is presumed to be due to species migration routes and habitat variation.

Species in table 9.2 will serve as good indicator species of levels of exploitation by monitoring annual changes in mean size, as every species on the list is important for daily consumption on Kaledupa.

Table 9.2 indicates that all coastal pelagic species from the families Hemiramphidae and Clupeidae are being caught by nets and fish fences at a mature size and if CPUE levels remain high, fishing of these species will be sustainable. However, for reef fish, particularly within the families Mullidae and Lethrinidae, there are potentially serious threats to the sustainability of stocks of certain species due to recruitment overfishing.

Table 9.2: The most abundant species caught by all fishing gears in all villages with mean size of capture, minimum size of maturation (Fishbase 2000) and percentage contribution to total catch. All species with an abundance of less than 1% are grouped under 'other species'. Species most at risk from recruitment overfishing are underlined.

Family	Species	Mean Length	Min. size of maturation	% of catch
Reef associated species				
Gerridae	*Gerres oyena*	16.5	13.8	2.4
Labridae	*Choerodon anchorago*	19.6	17.0	1.4
Labridae	*Cheilinus chlorurus*	22.0	19.8	2.3
Lethrinidae	*Lethrinus amboinensis*	19.2	29.2	1.6
Lethrinidae	*Lethrinus obsoletus*	17.6	25.5	1.6
Lethrinidae	*Lethrinus genivittatus*	15.7	11.7	4.3
Lethrinidae	*Lethrinus harak*	19.3	21.7	2.7
Lethrinidae	*Lethrinus variegatus*	15.0	9.6	2.9
Mullidae	*Mulloidichthys flavolineatus*	19.3	13.9	1.1
Mullidae	*Parupeneus barberinus*	16.7	25.5	5.4
Mullidae	*Parupeneus indicus*	16.1	17.8	1.5
Mullidae	*Mulloidichthys vanicolensis*	20.9	15.7	3.3
Nemipteridae	*Scolopsis lineatus*	14.9	10.9	1.6
Nemipteridae	*Scolopsis trilineatus*	14.3	9.6	2.4
Scaridae	*Scarus psittacus* (IP: female)	16.5	11.5	1.2
Scaridae	*Scarus globiceps* (IP: female)	14.2	12.6	1.9
Siganidae	*Siganus fuscescens*	17.4	17.8	2.1
Coastal Pelagic				
Hemiramphidae	*Hemiramphus robustus*	24.9	14.4	1.3
Hemiramphidae	*Hyporhamphus quoyi*	20.5	15.8	2.0
Hemiramphidae	*Hemiramphus far*	29.9	19.8	3.1
Hemiramphidae	*Hyporhamphus affinis/archipelagicus*	26.5	15.4	4.1
Clupeidae	*Amblygaster sirm*	17.6	11.3	2.0
Clupeidae	*Herklotsich quadrimaculatus*	10.4	7.3	20.1
n/a	Other species	n/a	n/a	27.8

In summary, if Bubus, gillnets and fish fences were used infrequently they are unlikely to have a high impact on the fishery but in the 4 villages alone there are 245 bubus, 12 seine nets and 114 gillnets all being used on a regular basis. In 2003 a rapid census of marine resource users that was undertaken to determine the level of fishing effort in Kaledupa (Appendix IX) identified 883 fishers, including 135 bubu fishers (with an estimated 810 bubu traps) and 35 fish fence owners. At present, the total number of fish fences around Kaledupa is estimated to be over 100.

Considering fishing effort will only have increased in 2005, the level of intensity of traditional fishing around Kaledupa, the low CPUE and poor size selectivity of certain techniques indicates that overfishing should be considered to be a significant threat to the long-term sustainability of fisheries resources.

Socio-Economic impact of resource decline

In the long term project socio-economic indicators will include monitoring of average weekly income from each economic activity (compared seasonally), percentage of people involved in land based and marine-based occupations, ratio of subsistence to commercial based fishing, levels of contentment with income and levels of savings/debt. In the absence of comparative data, the socio-economic status of fishers and the impact of resource decline are discussed generally below.

The Kaledupa fisheries are of vital importance to the Kaledupa communities as the main source of protein for subsistence living and local markets, income, and socio-cultural value. The relative importance of fishing for communities was estimated in 2003 (Appendix IX) which identified 883 Kaledupa fishers, with 585 fishers depending on fishing for subsistence or income. Most of these fishers came from the Bajo villages of Mantigola (where out of 310 households there were 140 fishers of which 138 depended on fishing) and Sama Bahari (where out of 251 households there were 185 fishers of which 132 depended on fishing). However, there are 558 non Bajo fishers of which 315 depend on fishing thus fishing effort is split roughly between the two ethnic groups, however solutions will be more difficult to find for the Bajo who own relatively little land and have no defined fishing grounds.

The income generated by fisheries per household is undoubtedly higher in Sama Bahari than in Darawa, Lentea and Sombano, although fishing is an essential source of income in all villages. Inversely, seaweed farming has the most significant contribution to household incomes in Darawa, Lentea and Sombano. The highest gross incomes in descending order excluding traders, are fish fence, seaweed farming, gleaning, octopus, net, hand trawl (including pelagics), hand line, speargun and bubu, though this does not represent the subsistence value of each fishery.

The dependence on fisheries for food is highlighted by the fact that only a small proportion of the fish caught is exported from Kaledupa, in the form of live grouper and lobster (December to March), fresh Octopus, dried sea cucumbers, Tuna (only when catches are good), and a range of molluscs. The vast majority of the catch contributes to subsistence living of communities on Kaledupa with 22-70% of catches being consumed at home, 28-90% sold in villages or local markets and 0-20% of the catch being given away as gifts. *At present, fishing just meets the food requirements of the Kaledupan population, with surplus catches only occurring infrequently, for example due to catches of Hemiramphidae in fish fences on the west coast during the Easterlies. Fish is the preferred food on Kaledupa, with few other protein options as* *livestock production is restricted by disease in chickens and availability of grazing for cows and goats during the dry season. Without alternatives, the marine environment will be unable to meet the demands of the population (currently 20 000) if fisheries decline significantly.*

The first questions to be asked are: in the current situation, what is the economic and biological impact of declining fisheries on the fishers of Kaledupa? Who will gain and who will lose out if conditions continue to decline? In this scenario, subsistence fishers will find it increasing difficult to meet food requirements or generate income unless they improve the efficiency of fishing gears or change to more efficient techniques. For example, hand line fishers will be forced to change to nets, fish fence catches will drop as their numbers increase as mesh size can not be decreased further, bubu catches will drop forcing fishers to use more traps, and net fishers will be forced to use longer nets of smaller mesh sizes. Those fishers who can not afford to increase the number or size of their fishing gears will be forced to stop fishing or turn to the use of destructive techniques in the absence or alternative. Those that can afford to change fishing techniques, will generate less and less profit and generally there will be an uncontrolled proliferation of nets, bubus and fish fences as fishers try to extract fish from dwindling stocks.

This scenario is a frequent occurrence in tropical fisheries, resulting from open-access policies and is termed ‘The Tragedy of the Commons’ - wherein individuals stand to gain by exceeding equitable levels of use of a common resource. This effect is exacerbated by in areas where lack of alternative livelihoods, population expansion and poverty has led to Malthusian overfishing, where fishers initiate wholesale resource destruction in order to maintain their livelihoods. Fishers will fish past the point where an increase in fishing effort no longer maintains catch levels due to 1) increase in price of fish as stock decline, 2) the low cost involved in traditional fishing and 3) the overwhelming need to feed their families. Fisheries data demonstrates that this situation is starting to occur on Kaledupa. *Overfishing of this nature will cause a substantial loss of revenue to Kaledupa and depending on the severity, may lead to an irreversible loss of certain fish stocks and their replacement by unfished low value species.*

The socio-cultural effect of overfishing will cause those who rely on fishing to migrate for work removing a defining cultural and historical component of Kaledupa community. Overfishing will specifically disrupt the Bajo communities of Sama Bahari and Mantigola to whom fishing defines their lives and cultural identity and whom have less alternative options that land based communities.

As fishery resources are in decline and many communities have an extremely high or complete dependency on fisheries for food and income, the revenue generated by commercial fisheries, sustainable livelihoods, cultures and food sources are threatened by overfishing and this issue should be of great concern to communities of Kaledupa and Wakatobi as a whole.

Factors contributing to resource decline and suggested management approaches

The majority of fishers using nets, bubu and fish fences or fishing for octopus, agreed that the main problems they were facing was low numbers of stock affecting their catches. This corroborates with the perception of 315 Kaledupa fishers interviewed in 2003 and 2004 of a decline in fish species, numbers and sizes caught over the last 5 years. Fisheries and socio-economic monitoring identified causes for the decline in stocks and focus groups were used to generate agreements to solutions with high legitimacy among fishers. The main factors contributing to stock decline together with other problems facing fishers, identified during socio-economic surveys and focus groups, are discussed below, approaches to management are suggested and associated potential legislation is summarised in Appendix XI

Destructive fishing techniques

Bomb and cyanide fishing were identified as one of the most serious problems threatening fishers' livelihoods and also impacting agar farmers. (Note: cyanide was perceived as killing agar and both cyanide and bombs were perceived as destroying coral reefs which protected agar farms from storms). Fishers in Sombano directly correlated the use of bomb and cyanide fishing to declines in catches and observations in the decline of coral habitat. The question has to be asked whether if fishers understand the seriousness of the impact of destructive fishing on fish stocks and their livelihoods why is there no direct community action? Certainly in Darawa, Lentea and Sombano there is strong resentment of fishers who use destructive techniques but in Sama Bahari and other Kaledupa villages where there are still bomb and cyanide fishers, such community pressure does not appear to exist. The individualism of fishers in Bajo communities partially answers this in Bajo villages (as indicated by the majority percentage of fishers who would not comment on the use bomb and cyanide), and possibly there is a low awareness of the issues in many Kaledupa villages. The economic conditions driving fishers to use bomb and cyanide and the reasons they will use to justify their actions among communities is one issue that has not been addressed. It is commonly stated that bomb and cyanide fishing is a fast and easy way to earn money, and now it is frequently associated with comments on the difficulties maintaining catches using traditional fishing techniques. *Thus it can be summarised that fish stock decline is the root cause of destructive fishing at present, and maintaining traditional catches will only be achieved through fisheries co-management and more effective patrolling.*

Suggested management approach:
The perceived ease of stopping bomb and cyanide fishers is low in Darawa, Lentea and Sombano who are threatened by destructive fishing practises of outside fishers. Fishers in Sama Bahari, where active bomb and cyanide fishers are known, indicated that it would be easy to stop destructive fishing, indicating the potential value of social pressure within communities. All respondents wanted increased awareness, alternative incomes, harder policing and collaboration between communities and government bodies, particularly for surveillance. Thus if a ban on bomb and cyanide fishing is to be successful on Kaledupa, a four pronged approach is needed. First, the level of awareness needs to be raised but should focus specifically on the economic losses and impacts on others livelihoods, stressing the selfish and socially unacceptable behaviour of bomb and cyanide fishers. This should be accompanied by a 'name and shame' policy of known bomb and cyanide fisher if communities understand the seriousness of these issues. Secondly, a harder policing and patrolling

strategy is needed in collaboration with communities. Thirdly, alternatives must be offered as a 'way out', so that there is no economic or social excuse for the continuation of bomb and cyanide use. And lastly, management of traditional fisheries to generate sustainable catches is essential to eliminate socio-economic justifications for bomb and cyanide use. Issues with external fishers using bomb and cyanide are discussed below.

Habitat destruction

The use of destructive fishing techniques such as bomb and cyanide has seriously damaged coral reef habitats around Kaledupa, which has lowered the carrying capacity of reefs to support fish stocks. There are also a number of non-fishing related activities such as destruction of mangroves for firewood, coral mining and the collection of beach sand, which are degrading habitats that are integral to Kaledupan fishing grounds. Commercial trawling damages the habitat that nets are dragged over, however even traditional fishing practices are also having an impact on habitat quality. Coral destruction is also occurring by fishers searching for abalone and the collection of live coral for bubu traps. The use of crowbars to extract lobsters and octopus from their dens can cause irreversible damage to habitats essential for these species - lowering the carrying capacity of habitats and therefore lowering future catches.

Suggested management approach
Although certain fishers were aware of the impact of certain gear types or fishing techniques, awareness was found to be low for many fishers in focus groups. Issues of habitat destruction firstly need to be addressed through raising awareness. There was a particular lack of awareness of the interconnectivity of habitats (super-ecosystem) and the need to maintain a healthy ecosystem to ensure the carrying capacity for stocks of fish and invertebrates remains high. This super-ecosystem includes mangroves, seagrass, sand and coral to the outer limits of the reef to 200m. Habitat damage caused by current fishing techniques need to be addressed on a per technique basis. The use of crowbars (which are specifically used for octopus, abalone and lobster collection) should be banned outright in all communities. More environmentally friendly techniques, such as using lures to catch octopus have already been suggested to fishers and examples give for them to trial. The use of lures does not require contact with the reef (which inevitably happens when free diving), does not destroy octopus burrows and protects females brooding eggs which is of vital importance for the sustainability of stocks. The question of habitation destruction caused by abalone fishers is vital to address, particularly in communities such as Sombano where as many as 90% of the village is involved in the fishery. Clearly discussion in needed among communities to raise awareness of the impact of this fishery and develop use and no-take areas. Collection of live coral when bubu traps are moved to new locations also needs to be addressed. The use of stone or concrete was discussed with fishers however artificial materials would have to be left in the sea for a period of time to acquire algal growth to disguise the trap. Finally, trawling is commercial, non-traditional fishing technique that severely damages benthic habitats and therefore should be banned and users prosecuted.

Gear selectivity

Bubu traps are the least selective of all fishing techniques and the capture of undersized fish was well recognised by fishers. Net fishers acknowledged that net length and mesh sizes were an issue and in all villages except Sama Bahari, the idea of setting length and mesh standards were acceptable. Without the supply of alternative incomes to Sama Bahari, legislation will not force an agreement without substantial policing and social disturbance, which would be a costly and counterproductive exercise. Fish fences fishers understood that the mesh size they used was detrimental to sustainability of catches and were open to suggestions on changing mesh sizes. Octopus fishing techniques that target octopus in their dens (using spears, curved pieces of wood or iron bars to extract the octopus) are more likely to be more selective of brooding females during certain times of the year. During spawning periods mature females barricade themselves inside dens for 1 month, never leaving to feed, putting all their resources towards caring for their eggs. Due to the large size of mature females, dens are larger and thus the entrance is more obvious to fishers. A few days after the eggs hatch, the female dies, however it is essential that she remains protected as without parental care the eggs will die too.

Suggested management approach: Much can be done to improve sustainability of fishing practices by adjusting techniques or moderating gears to target larger fish which have already made their reproductive contribution and therefore maintain stocks at a sustainable level. As most reef fish have a relatively fast growth rate and reach maturity after 3-5 years, this could be achieved with minimal short term economic loss to fishers with considerable long-term economic gain. Problems with bubu selectively was already known to many fishers, who suggested a change to larger mesh size and release the small fish when they empty the traps. However, the effects of bubu trap mesh size, entrance size and trap density are not clear at present and furthermore are specific to trap design and use. Therefore collaborative experiments by researchers, bubu fishers and trap manufacturers are required to establish the most effective design to maintain sustainability of stocks.

Standard mesh sizes of seine nets and gillnets should be at least 3” for general reef fish and 1.5” for coastal pelagic species. However, policing of such regulations will have to be achieved through internal enforcement by community members due to number of nets in use and the difficulty in checking compliance. It is logical that if net mesh sizes are going to be standardised, fish fence mesh sizes would have to change accordingly as both nets and fish fences compete for catches of similar species. In focus groups all fish fence owners agreed that changing mesh sizes was beneficial and could change from 1.5” to 3”. However, such a change was not found to have a large impact on the percentage of mature fish caught by fish fences during experiments conducted in Kaswari in 2004. This was attributed to the direction that nets are hung (square as opposed to diamond) and the fact that only a small section of the head of the trap was changed. Further experiments adjusting mesh size are required to give clear indication of their effects and make management recommendations. Furthermore, changing to a 3” net will affect catches of Hemiramphidae during the easterlies, which have a large economic importance to fish fence owners on the west coast. During this season, a 1.5” net could be simply be placed inside the capture end of the trap. In terms of octopus sustainability, an alternative fishing method using a lure (fake octopus) was suggested to octopus fishers and examples given to them to trial. As this technique only catches octopus actively foraging on the reef, it is not possible that brooding females that are completely barricaded in their dens will be caught.

High number of fishers

Another main factor contributing to reduced catches that fishers identified during socio-economic monitoring was the presence of too many fishers. These was extensive support for the exclusion on non-Kaledupa fishers from Kaledupa fishing grounds, as it was felt that external fishers mostly used destructive or commercial techniques. As destructive fishing is banned and commercial fishing in the National Park requires a licence, this issue concerns enforcement. From a fisheries management perspective, controlling the numbers of fishers (fishing effort) is one of the most important tools to ensure that stocks are not over exploited. As there is significant evidence for overfishing around Kaledupa and size selectivity of bubus, nets and fish fences is not optimal, this issue also needs to be addressed. The most recent change in the Kaledupa fishery is the proliferation of fish fences, which has large detrimental effects on fisheries sustainability due to their ability to catch vast quantities of fish below the size of maturation and is probably the most serious fishery issue around Kaledupa.

Suggested management approach: At present, reducing the number of Kaledupa fishers may not be appropriate due to the need to meet household food requirements. However, a reduction in general fisher numbers (potentially through exclusion of external fishers), would result in a relatively fast recovery of fish stocks, a subsequent increase in individual fishers catches and improvements in the target size of fish caught. However, there needs to be limits to the number of fish fences used around Kaledupa and their proximity to one another. Licensing of fish fences is strongly recommended firstly to stop their proliferation and secondly to reduce their numbers where they are in high density. The issue of bubu trap numbers is likely to have a serious effect on fish stocks unless trap design can make them more size selective. One solution may be to form agreements between fishers on the density of traps use in one area, as fishers requested information on optimal trap placement density.

Commercial export fishers

Species that are exported are: fresh octopus, live grouper, live lobster, fresh tuna and dried invertebrates including sea cucumbers and molluscs. Currently there is no management of commercial fisheries or minimum size limits for the capture of these species. This has led to the loss of lobsters, sharks and some species of sea cucumber from around Kaledupa; unsustainable octopus fishing and a general boom and bust cycle of commercial fisheries as one species is fished out before moving onto another. Furthermore, much of the profit is made by traders from outside Kaledupa and prices for fishers are low.

Suggested management approach:

Licensing of traders on Kaledupa and a ban of external traders will help to manage the fishery by controlling minimum capture sizes via local traders who appreciate the economic advantage and biological need for such controls. Record books and regular checks of traders can be easily achieved on Kaledupa, which provides invaluable information for management. The formation of Tuna fishing cooperatives would help to alleviate fishing pressure from reef fish stocks.

Spawning aggregation sites

There are two types of spawning aggregations, those occurring on points of the reef where most predatory fish such as groupers and Napoleon wrasse come to spawn, and those occurring on the reef flat where herbivorous and omnivorous species come to spawn. Spawning sites for groupers and Napoleon wrasse are heavily targeted by bomb and cyanide fishers during spawning seasons (December to March). Reef flat aggregations occur throughout the year for different species and are frequently targeted by net fishers using small mesh nets which is extremely effectively effective in removing large numbers of fish due to shoaling behaviour.

Suggested management approach:

As groupers and Napoleon wrasse must reach a large size before they are mature and their fecundity increases exponentially with size, it would be advantageous to fishers to protect these aggregations and introduce minimum size limits. It is recommended that at least one of the three main aggregation sites is closed during the spawning season, with increased patrolling against bomb and cyanide use, involving Park Rangers and the adjacent communities. Reef flat species such as Lethrinidae, Gerridae and Siganidae, are extremely important for local consumption on Kaledupa, there are large economic incentives to protect these stocks for the future. Legislation between adjacent villages or island level agreements should be made to use nets with larger mesh sizes.

Ownership

In all villages except Sama Bahari, there was a strong feeling of ownership of traditional fishing grounds based on traditional law, and a perception that fishers from outside the village should be limited or at least abide by specific village laws. However, under current legislation no such restrictions are possible for traditional fishers and village laws do not extend to resource use of the sea at present, with ownership and management of the shore out to 3 mile limit residing with district government. Marine resource management, together with zoning according to traditional fishing grounds and village regulations would appear to be the best solution. However, as fishers from Sama Bahari, Mantigola and La Hoa (who represent half the fishers on Kaledupa) do not posses traditional fishing grounds and have few alternatives to fishing, these communities would suffer greatly from changes from an open access system to village controlled management. Problems with ownership and conflicts are already emerging, as net fishers in Sama Bahari claim their best net fishing grounds have been closed by the placement of fish fences and seaweed farms. Similarly, octopus fishers from Sama Bahari said they are intimidated from fishing areas they previously used by the owners of newly placed seaweed farms.

Suggested management approach:

The issue of ownership requires island level discussion, zoning of village specific seaweed farms and licensing of fish fences to reduce their proliferation. Sea ownership and access by Bajo fishers urgently needs to be addressed as much of the community in Sama Bahari depends on net fishing for income. Furthermore, the Kaledupa community as a whole benefits from Bajo fishing activities in the supply of essential source of fish to local markets. Zoning of seaweed farms must take into account the desires of both fishers and seaweed farmers based on their proportional representation over the whole of Kaledupa, as opposed to village numbers which would lead to low legitimacy and future conflict. An open access policy for all Kaledupa fishers, though subject to the legislation installed by each village (perdes) would be one solution. However, for fisheries management to be fair, equitable and effective decisions need to be synchronised throughout the island which may be facilitated by the creation of an island level fisheries forum.

Proposed long-term Kaledupa fisheries program

For fisheries management to function effectively with maximum compliance, the management process must involve fisher communities in monitoring and decision making, to increase awareness and legitimise policy. Furthermore, the whole process must be able to function independently of external expertise and funding after an initial training and setup phase, therefore capacity building leading to the creation of a sound management mechanism that is capable of sourcing its own funding is of utmost importance. The proposed program made up of 4 integrated components: Monitoring, Focus groups, Kaledupa Fisheries Forum and Community surveillance which should be beneficial to DKP, BTNKW and other ongoing programs, as well as the communities and government of Kaledupa Sub-District.

Monitoring – fisheries and socio-economics

Monitoring during the pilot project clearly demonstrated the value of data collection for fisheries assessment, both as a base line and in the development of indicators for long term monitoring. Monitoring in local languages was performed by fishers and community members to a high level of competence and was deemed a great success, allowing large volumes of data to be collected. Moreover, the transfer of information between fishers and scientists is a process that will assist the management process by raising the awareness of both fishers and scientists.

In the long-term project, monitoring will be extended to 9 villages (Ambeua, Buranga, Darawa, Horuo, Kaswari, Langge, Lentea, Sama Bahari and Sombano) that account for 75% of the total fishers in Kaledupa. Fisheries monitoring will be conducted continuously throughout the year (one day per week per village), household censuses will be conducted seasonally and socio-ecomonic monitoring annual to monitor the success of the project. Fishers and community members in each villages will be trained to perform fisheries and socio-economic monitoring, based on methodologies developed in the field during the pilot project. All data will be stored on an ACCESS database, developed and used for the pilot project to facilitate analysis of time series data and monitor success of the project. The overall aim of monitoring is to provide a basis for discussion in fisher focus groups and to provide information on which management decisions can be based.

Role of fishers in legislation development and management - focus groups

The second aim of the pilot project was to establish a strategy for determining village-level fishing agreements which have high legitimacy among fishers on which potential island or district-level regulations can be based. The system and protocols for bottom-up legislation formation, based on fisher's focus group agreements, are an innovative approach that has proven successful in this project. The results of the focus groups demonstrated that fishers were willing to be involved in discussions about solutions to resource use issues and were receptive suggestions based on fisheries and biological data. Furthermore, fishers showed a strong desire to be involved in decision making and control of their resources. The focus groups proved that fishers could make agreements regarding fisheries management and could be used as the basis for village laws and draft legislation submitted to district government by a forum representing the desires of the Kaledupa fishers.

Role of communities and local government in legislation endorsement and control of resource management - Kaledupa Fisheries Forum

The recent decentralisation of Indonesian government has placed the responsibility of marine resource management on district government. This allows district governments' broad latitude to develop coastal resource plans which must be in close cooperation with village governing bodies, including all Stakeholders, private and public, independent of national programs. For fisheries management, the most logical and effective unit for management is at island level. This is due to 1) the home range of fished stocks being mostly confined to islands, 2) range of most local fishers to nearshore fishing grounds around Kaledupa island and 3) the effectiveness of patrolling and policing at island level. Such management has the added advantage of a higher level of communication between resource users and decision makers, facilitating rapid development of island level management of their resources.

This could be achieved by the creation of an island level forum tasked with managing Kaledupa fisheries and represent a co-management mechanism whereby communities can communicate with district government. The Kaledupa Fisheries Forum (KFF) would represent all Stakeholders including community representatives from each of the 17 villages, sub-district and village government representatives, sub-district government authorities including DKP, Police, Army and National Park Rangers. The KFF would have the power to represent the interests of Kaledupa fishing community by creating draft legislation for submission to district government for the creation of regional level legislation, specifically applicable to Kaledupa. In collaboration with local partners, the Trust will assist the KFF to create a strategic management plan, develop proposed district level legislation, and promote the concept of a fisheries management zone around Kaledupa. Island level management also has advantage for district government who remain in control of policy but have policy details developed for them by the forum which due to the democratic nature of the forum, will represent the desires of local communities.

Marine resource ownership, surveillance by communities and boat registration

Constitutional law 23/2004 article 18 (3) implies that actions of all fishers (including traditional fishers) can be restricted if their actions contribute to overexploitation of regional marine resources or present a threat to conservation. As there are many indicators of overexploitation and threats to conservation around Kaledupa from fishing, under this law it is recommended that the community of Kaledupa establish their own fishing territory with the assistance of district government. This would secure Kaledupa fisheries resources from the shore out to 3 miles for the exclusive use by fishers from Kaledupa. Ownership of exclusive fishing grounds will install a desire to conserve and sustainably manage the resources fishers depend on, placing responsibility for management on the Kaledupa community through a democratic body such as the KFF. Fishing effort, in terms of the number of fishers and techniques used, can then be managed, irrespective of whether they are traditional or not. Such zonation and fisheries legislation should be synchronised with BTNKW zones and legislation.

In the pilot project, the concept of a motorised boat registration scheme received overwhelming support together with a full understanding of the management implications and consequently was trialed in the four villages. Registration will help BTNKW to address difficulties of surveillance and enforcement of fishers using illegal fishing techniques and will help to develop local control of fisheries resources at an island level. Community patrolling and a surveillance network (Siswasmas) was strongly supported and requested in socio-economic interviews and focus groups. The Ministry of Marine Affairs and Fisheries decree 58/2001 supports the role of local institutions (such as the KFF) in the creation of community based surveillance systems for marine and fisheries resource management. Registration, in conjunction with community patrolling and a radio network between strategic villages and Park Rangers will allow direct and rapid notification of Park Rangers of violations. In addition, greater community involvement will facilitate relationships between fishers and National Park Rangers, and offers an opportunity to increase apprehension of illegal fishers where funds are limited.

Alternative incomes

With the limited fisheries resources available and increased economic demand on fisheries, there is an urgent need for alternative sources of income, particularly for Bajo communities and land based communities with little potential for agricultural development such as Darawa, Lentea and Sombano. Eventually, overall fishing effort will only be reduced if alternative sources of income are made available for fishers. Furthermore, alternative incomes could be targeted at destructive fishers or given to fish fence fishers in exchange for fishing gear to reduce effort.

Two alternatives to reef fishing that currently generate an important income based on the marine environment are seaweed farming and tuna fishing. However, seaweed farm expansion is becoming limited due to lack of space and tuna fishing is now restricted by the prohibitive prices of fuel due to the current oil crisis in Indonesia. Increasing the sale price of seaweed could be achieved by the formation of a seaweed cooperative which could supply farmers with advice on improving seaweed quality and if members can contribute funds a simple processing facility could be built to further increase the sale price. Tuna fishing requires the placement of fish aggregation devices (FADs) which again funds could be raising by the formation of fishers' cooperatives. FADs have been sabotaged in the past by certain members of the Bajo community who did not have access to FADs close to Kaledupa and thus could not compete by returning to local markets before those who used the nearby FADs. Thus construction of FADs must include all members of the tuna fishing community. Furthermore, the value for tuna could be improved by tuna filleting facilities similar to the one in Sama Bahari, which could again be associated to a tuna fishers' cooperative.

Other alternative incomes based on aquaculture and grow out are the development of abalone, pearl oyster and giant clam farming. These options will be examined during the long-term project, with assistance from local universities and specialists on Button. Coral Farming was trialed by Operation Wallacea Trust this year and may be a potentially lucrative alternative however problems concerning export licenses and transport to UK markets remain to be examined. Staff of the Opwall Trust program have successfully undertaken trials to grow out with the sea cucumber, *Holothuria* *scabra.* It is anticipated that communities can considerably increase the revenue in this way, in addition to contributing to recovery and sustainability of stocks. The long term program will give training to communities in grow out techniques.

Appendix I Census Sheet

Date: Village: Interviewer:

Name	Father	Sex	Age	Marital status	Ethnicity

Income source	%	Low Week	Med Week	High Week

Trader	List Species	Sold to who and where

Nets	Length	Inch
Bubus	Lanterns	Spearguns

Boat type	No.

Appendix II: Catch |Records sheet

Village: Date: Where do they sell their catch?

Fishers names:	Father:	Technique:	Details:	Boat types:	Boat Numbers:
		Estimated days fished using this technique in last 7 days:			
		Area:	Habitat:		
		Total weight:	Est. Value of catch:		
		% of catch eaten:	% of catch given away:		
		Time fisher left village:	Travel time:	Fishing time:	

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total

Appendix III: Questionnaire targeting User groups

Net, Bubu, Fish fence Octopus fishers and traders

Name	Fathers Name	User group (fishing technique or trader)

1. About user groups and opinion formers, potentials for conflict/collaboration

Question 1

Question: Social groups and opinion formers

Group of Technique/Trade 1:

Names of members in group	Relationship to the member	Technique/ Occupation	Meeting Place	The Opinion formers/advisors in the group

Group of Technique/Trade 2:

Names of members in group	Relationship to the member	Technique/ Occupation	Meeting Place	The Opinion formers/advisors in the group

Cross technique/trade groups:

Names of members in group	Relationship to the member	Technique/ Occupation	Meeting Place	The Opinion formers/advisors in the group

Informal Group:

Names of members in group	Relationship to the member	Technique/ Occupation	Meeting Place	The Opinion formers/advisors in the group

Notes:

Question 2

Technique/trade 1:

	Place/issue 1	Place/issue 2	Place/issue 3	Place/issue 4
Rights				
Agreements				
Conflicts				

Technique 2:

	Place/issue 1	Place/issue 2	Place/issue 3	Place/issue 4
Rights				
Agreements				
Conflicts				

Technique 3:

	Place/issue 1	Place/issue 2	Place/issue 3	Place/issue 4
Rights				
Agreements				
Conflicts				

Notes:

2. About perceptions of resource conditions/decline, human impacts

<u>Question 3</u>

In general:

What are the problems?	What causes the problems	How does this affect you	Possible solutions

Comments:

Question 4

Question: Problems and solutions relating to interviewee's techniques

Technique 1:

What are the problems?	What causes the problems	How does this affect you	Possible solutions

Technique 2:

What are the problems?	What causes the problems	How does this affect you	Possible solutions

Technique 3:

What are the problems?	What causes the problems	How does this affect you	Possible solutions

Notes:

3. About solutions to the problems

<u>Question 5</u>

Question: The solutions indicated above, are they possible? Problems relate to those listed before by the interviewee.

	Very difficult	Difficult	Don’t know	Easy	Very easy
Problem 1					
Problem 2					
Problem 3					
Problem 4					
Problem 5					

Comments (details raised by fishers):

<u>Question 6</u>

Question: Biological data

	Very	yes	Don't know	no	Definitely not
Interest in biological data					

List assessments and strategies mentioned:

4. About information and how to police

<u>Question 7</u>

Question: Level of Awareness and understanding of Registration Scheme

	They know that it helps secure a zone around Kecematan Kaledupa for all fishers that live within it	**They know that it helps stop internal bomb fishers**	**They know that it excludes external fishers**	**They know the registration scheme exists**
Tick the box				

List of wrong answers:

Question: level of agreement

	Agree strongly	Agree	Not sure	disagree	Strongly disagree
Level of agreement					

Question: What are they worried about? List of concerns with the registration scheme:

Question 8

Question: Is there a problem with outside fishers?

Yes No

Question: Why is this a problem?

Question: Level of participation to community police outside fishers

	Do nothing	Shout/gossip	Kepala Desa	Camat	Police/Army	Jagawana	Go on patrol	Tell person to leave	Fight themselves
What would you do?									

Question: Level of participation to community police illegal fishers

	Do nothing	Shout/gossip	Go to Kepala Desa	Go to Camat	Go to Police/Army	Go to Jagawana	Go on patrol	Tell person to leave	Fight themselves
What would you do?									

5. About alternative Incomes & Financial Management Capacity

Question 9

Question: Happy, yes or no?

	Very Happy	Happy	OK	Unhappy	Very unhappy
Level of contentment					

List Aspirations for the future

Question: Family finances

	Big Surplus	Some surplus	Stable	Some problems	Big problems
What is the financial situation					

Question: Savings

	Yes	No	How much?
Savings			

Question: Debt

	Very High	High	Medium	Low	Very Low	None
Level of debt						

Comments

Question; Interest in something different

	Very High	High	Medium	Low	Very Low	None
Interest in changing jobs						

What are the perceived opportunities?

What are the perceived barriers?

Question: Where informant gets advice on finances

	Who advises them on financial issues?	Type of assistance
Name 1		
Name 2		
Name 3		
Name 4		
Name 5		

Appendix IV:

Family	*Species*	Bajo Name	Name Kaledupa (*Darawa/**Lentea/***Sombano	Size of Maturation
Bivalvia				
Arcidae	*Anadara antiquata*		Fatu-fatu	
Arcidae	*Anadara ferruginea*		De u-deu tambogo	
Arcidae	*Anadara granosa*		Kimmoro	
Arcidae	*Arca* sp		Kisi calambatu	
Arcidae	*Arca ventricosa*		Kuku	
Arcidae	*Barbatia* sp	Bodade	Kee	
Arcidae	*Scapharca* sp		Deu-deu (b)	
Cardiidae	*Fragum* sp		Kansese	
Cardiidae	*Trachycardium orbita*	Koah kallo	Deu-deu (a)	
Cucullaeidae	*Cucullaea labiata*		Bakala (b)	
Fimbriidae	*Fimbria* sp		Kalantue bata	
Glycymerididae	*Glycymeris reevei*		Bakala mohute	
Glycymerididae	*Tucetona pectunculus*		Bakala meha	
Gryphaeidae	*Hyotissa hyotissa*	Kima	Pokonu	
Isognomonidae	*Isognomon* sp	Babade (a)	Kandamu-damu (a)	
Lucinidae	*Codakia* sp		Deu-deu (c)	
Malleidae	*Malleus* sp	Babade (b)	Kandamu-damu (b)	
Mesodesmatidae	*Atactodea striata*		Kalantue amba	
Mytilidae	*Modiolus* sp	Kukupah (a)	Ke-e	
Mytilidae	*Septifer bilocularis*	Kukupah (b)	Kukku rafu	
Ostreidae	*Saccostrea* sp	Lamai	Tira	
Pectinidae	*Chlamys squamosa*	Timbatu		
Pinnidae	*Pinna /atrina* sp	Sasaoh	Tobo	
Psannobiidae	*Asaphis violascens*	Koah bakala	Fatu-fatu	
Pteriidae	*Pinctada* sp	Kakapis	Kalapenda	
Pteriidae	*Pteria* sp		Kandamu-damu (c)	

Spondylidae	*Spondylus* sp		Paa olo
Tridacnidae	*Hippopus hippopus*	Kima totode	Buta/aenumonda
Tridacnidae	*Tridacna crocea*	Kima tinggoro (a)	Fangaro
Tridacnidae	*Tridacna derasa*	Kima sisilli	Fangaro sillu
Tridacnidae	*Tridacna maxima*	Kima tinggoro (b)	Fangaro koni nufatu
Tridacnidae	*Tridacna squamosa*	Kima redengang	Fangaro rigi
Veneridae	*Periglypta reticulata*	Koah jappang	Bakala (a)
Veneridae	*Tapes* sp	Tiran	Samari
Cephalopoda			
Octopodidae	*Octopus cyanea*	Kuta sillah	Simbuku
Sepiidae	*Sepia* sp.	Kala butan	Kulafuta
Sepiidae	*Squid* sp		Nu-u
Crustacea			
Palinuridae	*Panulirus femoristriga*	Kalorah mira	Loru
Palinuridae	*Panulirus pencillatus*	Kalorah setan	Loru
Palinuridae	*Panulirus versicolor*	Kalorah nyuloh	Loru
Portunidae	*Portunus pelagicus*	Karama sikuan	Koniki singkua
Echinoidea			
Echinodidae	*Diadematidae family*	Tayong (a)	Ne-e faola
Echinodidae	*Echinodidae*		
Echinodidae	*Echinothrix calamaris*	Tayong (b)	Ne-e meha
Echinodidae	*Mespilia globulus*	Tetahe biasa (b)	Kukure
Echinodidae	*Salmacis belli*	Tetahe bage (a)	Kukure
Echinodidae	*Toxopneustes pileolus*	Tetahe bage (b)	Kukure panamba
Echinodidae	*Tripneustes gratilla*	Tetahe biasa (a)	Kukure
Gastropoda			
Architectonicidae	*Architectonica*		Kambau (b)
Buccinidae	*Babylonia areolata*		Boro
Cassidae	*Cassis cornuta*	Taburi bunging	Tandaka tooge
Cassidae	*Cypraecassis rufa*	Taburi mira	Tandaka bahili
Cerithiidae	*Cerithium nodulosum*	Bajjau	Kea-kea (a)
Cerithiidae	*Rhinoclavis* sp	Babajjah	Kea-kea mohuti

Conidae	*Conus* sp	Baloso	Gogori/bolusu
Costellariidae	*Vexillum* sp		Kotti moane
Cypraeidae	*Cypraea* sp	Bole	Fulle (a)
Dolabellidae	*Dolabella aricularia*	Bontolaha	Tiveleka
Haliotidae	*Haliotis asinia*	Toto pando	Mata tuju
Littorinidae	*Littoraria/tectarius* sp.		
Melampidae	*Ellobium* sp		Kailu-ilu (a)
Mitridae	*Mitra* sp		Kea-kea (c)
Muricidae	*Chicoreus ramosus*	Karagingi	Pudu
Nassariidae	*Nassarius* sp	Kikidde	Bebeb-bebe/baa bululu
Naticidae	*Natica sp / Polinices sp*		Kailu-ilu (b)
Neritidae	*Nerita* sp		Fembe-fembe (a)
Olividae	*Oliva sp*		
Ovulidae	*Ovula ovum/volva volva*		Fulle (b)
Potamididae	*Cerithidae* sp	Omah (a)	Koroe patu
Potamididae	*Telescopium telescopium*	Burungang	Burungo
Potamididae	*Terebralia* sp	Omah (b)	Koroe biasa
Ranellidae	*Charonia tritonis*	Lagah bulo (b)	Toburi huppu
Ranellidae	*Cymatium* sp		Pudu
Strombidae	*Lambis chiragra*	Babardoh sumanga	Kempa olo
Strombidae	*Lambis crocata*	Babadoh gusoh	Kempa (b)
Strombidae	*Lambis lambis*	Babadoh biasa	Kempa rondo/biasa
Strombidae	*Lambis millepeda*	Babardoh sibbo	Kempa olo
Strombidae	*Lambis scopius*		Kempa (a)
Strombidae	*Strombus aurisdianae*	Bolle bagai (a)	Loko
Strombidae	*Strombus bulla*	Bolle bagai (b)	Kivolu
Strombidae	*Strombus canarium*	Bolle bangkau (a)	
Strombidae	*Strombus epidromis*	Bolle bangkau (b)	
Strombidae	*Strombus lentiginosus*		Fembe-fembe (b)
Strombidae	*Strombus luhuanus*	Barubba	Kotti
Terebridae	*Terebra* sp		Kea-kea (b)
Tonnidae	*Tonna* sp		

Trochidae	*Tectus pyramis*	Lala sumanga	Kambau (a)
Trochidae	*Trochus niloticus*	Lala	Lola
Turbinidae	*Astralium calcar*		Fukku
Turbinidae	*Turbo* sp	Lagah bulo (a)	Kalauma/puddu
Turritellidae	*Turritella* sp		Suku one
Volutidae	*Cymbiola vespertitio*	Kokorus	Kivolu
Holothuroidea			
Holothuriidae	*Actinopyga echinites*	Bala ngarikka	Toiro kano
Holothuriidae	*Actinopyga lecanora*	Timpulu	Pullu-pullu
Holothuriidae	*Actinopyga mauritiana*		
Holothuriidae	*Actinopyga miliaris*	Bala loong	Fulu wawu
Holothuriidae	*Bohadschia argus*	Karido binti	Topulu kano
Holothuriidae	*Bohadschia mamorata/vitiensis*	Karido	Toiro kano meha
Holothuriidae	*Bohadschia similis*	Alolo gusoh	Toiro foleke
Holothuriidae	*Holothuria edulis*	Bubuta (hitam/merah)	Kifolu/laumate meha
Holothuriidae	*Holothuria fuscogilva*	Koro susu/bala koro	Toiro titi
Holothuriidae	*Holothuria leucospilota*	Lolosong	Pesuko
Holothuriidae	*Holothuria pervicax*	Alolo samo	Lesi-lesi
Holothuriidae	*Holothuria scabra*	Bala pote	Gogondo
Holothuriidae	*Holothuria (metriatyla)* sp.	Boto pandagah	
Holothuriidae	*Holothuria atra*	Bubuta (hitam)	Laumate biru
Holothuriidae	*Holothuria coluber*	Talengko	Lamba fatu
Holothuriidae	*Holothuria conusalba*	Bantunang	Toiro pudu
Holothuriidae	*Holothuria hilla*	Pepeta	Tadema nukoho
Holothuriidae	*Holothuria impatiens*	Bambaule	Topulu kokka (a)
Holothuriidae	*Holothuria nobilis*	Koro loong	Holu biru
Holothuriidae	*Holothuria pardalis or cavans*	Tambole	
Holothuriidae	*Holothuria rigida*	Tambaruno	Topulu kokka (b)
Holothuriidae	*Holothuria scabra versicolor*	Bubba /bala pote hitam	Balemba
Holothuriidae	*Holothuria* sp.	Tatarang	
Holothuriidae	*Pearsonothuria graeffi*	Bala donga	Topulu tokke
Stichopodidae	*Stichopus horrens*	Gama samo	Gama rondo

Stichopodidae	*Stichopus chloronotus*	Juppong		
Stichopodidae	*Stichopus herrmanni*	Gama batu	Gama fatu	
Stichopodidae	*Thelenota ananas*	Nanas/talipang	Sanggaratu	
Stichopodidae	*Thelenota anax*	Bala kunih /bala nado	Topulu olo	
Osteichthyes				
Acanthuridae	*Acanthurus auranticavus*	Dodah puteh ingko	Kuu Fadu	15.8
Acanthuridae	*Acanthurus leucocheilus*	Malelah (a)	Kenta kuu/*Kuu Fadu	18.0
Acanthuridae	*Acanthurus lineatus*	Dodoh igah	Kenta kuu ragi-ragi	17.0
Acanthuridae	*Acanthurus mata*	Malelah silah	Lutu-lutu/**Kuu Buri/***Kuu Buri	21.7
Acanthuridae	*Acanthurus nigricans*	Dodoh (pute mata)	Kenta kuu futa	10.2
Acanthuridae	*Acanthurus nigricauda*	Dodoh (hitam)	Kenta kuu fadu	17.8
Acanthuridae	*Acanthurus olivaceous*	Dodoh (tanda merah)	Kenta kuu tanda meha	15.8
Acanthuridae	*Acanthurus triostegus*	Kikida	**Kolli	11.6
Acanthuridae	*Acanthurus xanthopterus*	Malelah (b)	Kenta kuu fadu	29.2
Acanthuridae	*Ctenochaetus binotatus*	Dodoh loong (a)	Kenta kuu/**Kuu Buri	10.5
Acanthuridae	*Ctenochaetus striatus*	Dodoh loong (b)	Kenta kuu fiha/**Kuu Fadu/***Kenta Kuu	10.9
Acanthuridae	*Naso annulatus*	Kumai kubah	Onga Onga	40.0
Acanthuridae	*Naso brachycentron*	Kumai bukku	Tui-tui bungku	36.4
Acanthuridae	*Naso brevirostris*	Kumai (a)	Tui-tui mohute	25.5
Acanthuridae	*Naso hexacanthus*	Kumai belawis	Onga-Onga	13.0
Acanthuridae	*Naso lituratus*	Kutiteh	Tui-tui kangka/***Kandetimu	18.0
Acanthuridae	*Naso lopezi*	Kumai belowis (b)	Tui-tui iba	23.2
Acanthuridae	*Naso thynnoides*	Kumai belowis (c)	Tui-tui iba/***Onga-Onga	17.8
Acanthuridae	*Naso tuberosus*	Kumai (b)	Dakke/*Onga-Onga/**Onga-Onga	25.5
Acanthuridae	*Naso unicornis*	Kumai tumbo	Tui-tui sahi/**Onga-Onga	27.0
Acanthuridae	*Naso vlamingii*	Kumai kumai randah	Dakke/*Onga-Onga	25.5
Acanthuridae	*Zebrasoma scopas*	Dodoh tambanko	Kenta kuu mohato	9.6
Apogonidae	*Apogon bandanensis*	Gogombel (a)	Karangka	5.2
Apogonidae	*Apogon trimaculatus*	Gogombel (biasa)	Karangka akka	7.9
Apogonidae	*Cheilodipterus macrodon*	Gogombel (batu)	Karangka Fatu	11.3
Apogonidae	*Cheilodipterus singapurensis*	Gogombel (b)	Barusa	8.6
Atherinidae	*Atherinomorus endrachtensis*	Babalombah silah	Opuru/***Kapabatu	4.8

Atherinidae	*Hypoatherina temminckii*	Babalombah	Opuru ole/***Opuru	6.2
Balistidae	*Balistapus undulatus*	Pogo loong	Pogo meha/**Pogo Biru/***Pogo Biru	13.8
Balistidae	*Balistoides conspicillum*	Pogo panau	Pogo buri	21.7
Balistidae	*Balistoides viridescens*	Ampala kubah/batu	Komparu fatu	31.0
Balistidae	*Melichthys niger*	Pogo rambai	Pogo olo biru	21.7
Balistidae	*Melichthys vidua*	Pogo kambose (a)	Pogo biru/**Pogo Olo	17.8
Balistidae	*Odonus niger*	Pogo nyuloh	Pogo olo ijo/***Pogo Holippi	21.7
Balistidae	*Pseudobalistes flavimarginatus*	Ampala mira/boah	Komparu	25.7
Balistidae	*Pseudobalistes fuscus*	Pogo (a)	Komparu ndokke	23.6
Balistidae	*Rhinecanthus aculeatus*	Pogo pote	Pogo mohute mata kinda/**Pogo Namo	13.8
Balistidae	*Rhinecanthus rectangulus*	Pogo mankuri	Pogo	13.8
Balistidae	*Rhinecanthus verrucosus*	Pogo (b)	Pogo tanda biru/*Pogo Mohute/**Pogo Osofatu/***Pogo Mohute	10.9
Balistidae	*Sufflamen chrysopterus*	Pogo (c)	Pogo biru	13.8
Balistidae	*Sufflamen fraenatus*	Pogo kombose (b)	Pogo kombose	17.0
Belonidae	*Platybelone platyura*	Timbaloah silah (a)	Sori urapi/*Sori Olo	17.1
Belonidae	*Strongylura leiura*	Timbaloah tampae (a)	Sori gonggo	40.0
Belonidae	*Tylosurus crocodilius*	Timbaloah	Sori gonggo/*Sori Bale/**Sori Rondo	57.2
Belonidae	*Tylosurus gavialoides*	Timbaloah silah (b)	Sori olo	31.0
Bothidae	*Bothus pantherinus*	Kalampede dayah	Kaleppa (a)	17.4
Bothidae	*Pseudorhombus jenynsii*	Kalempede dayah aloh	Kaleppa (b)	15.4
Caesionidae	*Caesio caerulaurea*	Kakambule	Andou	15.8
Caesionidae	*Caesio cuning*	Kakambule ecor cunning	Kenta opa iku makuri	25.5
Caesionidae	*Caesio lunaris*	Kambule lempes (hijau)	Kenta opa	17.8
Caesionidae	*Caesio teres*	Kambule lempes (ekor kuning)	Kenta opa iku makuri	17.8
Caesionidae	*Pterocaesio lativittata*	Bambangan Kambuleh	Andou	6.6
Caesionidae	*Pterocaesio tile*	Kambule (garas)	Andou meha	13.8
Carangidae	*Alectis ciliaris*	Baddoh	Simba lili bonua	57.2
Carangidae	*Alectis indicus*	Badduh	SIMBA ONE	62.3
Carangidae	*Alepes* sp.	Dayah nybba lempes	Simba Simba	
Carangidae	*Atule mate*	Dayah nyubba bubuloh	Simba-simba bungku	14.5

Carangidae	*Carangoides caeruleopinnatus*	Tudah tobah (a)	Simba-simba lili bonua	17.8
Carangidae	*Carangoides chrysophrys*	Dayah nyubba tudah toba	Simba Simba	25.5
Carangidae	*Carangoides ferdau*	Dayah nyubba biasa	Simba one nduru/*Simba-Simba Bungku	36.6
Carangidae	*Carangoides fulvoguttatus*	Landia silla	Simba bungku	47.0
Carangidae	*Carangoides malabaricus*	Tudah tobah (b)	Koa - Koa/**Simba-Simba Mohute	25.5
Carangidae	*Carangoides othogrammus*	Pipilli	Simba Simba	29.5
Carangidae	*Carangoides talamparoides*	Tudah tobah (c)	Simba opa	13.0
Carangidae	*Caranx ignobilis*	Meah pote	Simba moo/***Koa-Koa	71.2
Carangidae	*Caranx lugubris*	Meah mondo	Simba biru	38.3
Carangidae	*Caranx melampygus*	Langoang	Simba	38.3
Carangidae	*Caranx papuensis*	Dayah nyubba langko kape	Simba	35.7
Carangidae	*Caranx sexfasciatus*	Anggatang	Simba/*Koa-Koa Mata Meha	47.0
Carangidae	*Coryphaena hippurus*	Lamadah	Lamada	83.6
Carangidae	*Decapterus macrosoma*	Gagadeh	Moma	14.4
Carangidae	*Decapterus russelli*	Ruma-ruma or Roo-ruma	RUMA-RUMA	16.1
Carangidae	*Elegatis bipunnulata*	Ururoh	Uru-uru	67.2
Carangidae	*Pseudocaranx dentex*	Kalombe	Simba mohute	47.7
Carangidae	*Scomberoides lysan*	Dayah manu	Tangiri	43.5
Carangidae	*Selar boops*	Tandu tulai	Anggora	12.8
Carangidae	*Selar crumenthalmops*	Layah (a)	Ruma-ruma	25.5
Carangidae	*Selaroides leptolepis*	Layah (b)	Ruma-ruma	9.9
Carcharhinidae	*Rhizoprionodon acutus*	Kareo libbo	Kenta kodipo	65.6
Centropomidae	*Psammoperca waigiensis*	Talunsoh	Kaka	20.5
Chaetodontidae	*Chaetodon Adiergastos*	Tatape bellah loong	Kalibomba (abc)	7.9
Chaetodontidae	*Chaetodon auriga*	Tatape (a)	Kali bomba (a)	10.9
Chaetodontidae	*Chaetodon citrinellus*	Tatape (b)	Kali bomba (b)	6.6
Chaetodontidae	*Chaetodon kleinii*	Tatape (j)	Kalibomba Makuri	7.5
Chaetodontidae	*Chaetodon melannotus*	Tatape (h)	Kali bomba (e)	7.5
Chaetodontidae	*Chaetodon meyeri*	Tatape (c)	Kali bomba/***Kalibomba Bukuo	8.8
Chaetodontidae	*Chaetodon rafflesi*	Tatape kuneh/loong	Kalibomba	7.5
Chaetodontidae	*Chaetodon trifasciatus*	Tatape (d)	Kali bomba (d)	7.5
Chaetodontidae	*Chaetodon vagabundus*	Tatape (i)	Kali bomba (f)	10.9

Chaetodontidae	*Heniochus chrysostomus*	Tatape (e)	Kali bomba bukku femba (a)	8.8
Chaetodontidae	*Heniochus diphreutes*	Tatape (f)	Kali bomba bukku femba (b)	8.8
Chaetodontidae	*Heniocus varius*	Tatape (g)	Kali bomba bukku femba (c)	9.2
Clupeidae	*Chanos chanos*	Bala kebo	Kenta Bolu	20.1
Clupeidea	*Amblygaster sirm*	Tembah mancoh	Bete lalaki olo	11.3
Clupeidea	*Anodontostoma chacunda*	Kuasi	Kofasi	8.4
Clupeidea	*Elops hawaiiensis*	Bala kebo	Bulu tooge	29.2
Clupeidea	*Herklotsich quadrimaculatus*	Tembah	Bisuko	7.3
Clupeidea	*Spratelloides robustus*	Tatamban	Kenta kurung kurung/***Ole	6.2
Dasyatidae	*Taeniura lymma*	Rekengan (b)	Hai Komoa/*Hai Foti	13.8
Dasyatidae	*Taeniura meyeni*	Rekengan (a)	Hai lero	114.8
Diodontidae	*Chilomycterus reticulatus*	Konkeh silah	Nona'a	23.6
Diodontidae	*Chilomycterus spilostylus*	Konkeh	Lombe	15.4
Diodontidae	*Diodon liturosus*	Konkeh batu	Borutu	20.0
Ephippidae	*Platax batavianus*	Buna batu	Vuna Mohute	21.7
Ephippidae	*Platax orbicularis*	Buna biasa (c)	Vuna Biru	21.7
Ephippidae	*Platax teira*	Buna biasa (b)	Vuna	25.5
Ephippidae	*Zabidius novemacaleatus*	Buna biasa (a)	Funa	19.8
Exocoetidae	*Cypselurus* sp.	Tutueh	Kambala	
Exocoetidae	*Cypselurus spilopterus*	Tutue	Kambala	11.7
Fistulariidae	*Fistularia commersonii*	Tarigongoh igabuku	Hoppa (a)	60.6
Fistulariidae	*Fistularia petimba*	Tarigongoh tarusang	Hoppa/***Hoppa Makuri	73.8
Gerreidae	*Gerres acinaces*	Lamudo	Kenta pute	15.8
Gerreidae	*Gerres filamentosus*	Taboh	Ulu fatu	12.0
Gerreidae	*Gerres oyena*	Bansa	Ommu/***Ommu Melangka	13.8
Gerreidae	*Gerres subfasciatus*		Ommu	9.6
Gerreidae	*Pentaprion longimanus*	Bansa	Ommu/***Ommu Nggulu	8.8
Haemulidae	*Diagramma pictum*	Luppe	Fifira makuri	33.0
Haemulidae	*Plectorhinchus chaetodontoides*	Tubbal boa	Fifira buri	29.9
Haemulidae	*Plectorhinchus chaetodontoides* (juvenille)	Tubbul boa (kecil)	Fifira Buri	29.9
Haemulidae	*Plectorhinchus lessoni*	Luppe (b)	Kenta kabulu	17.8

Haemulidae	*Plectorhinchus oreintalis*	Luppe (a)	Kenta kabulu	35.0
Harpodontidae	*Saurida gracilis*	Jarah gigi (b)	Kenta bisara/***Kenta Bisara Makuri	14.6
Hemiramphidae	*Euleptorhamphus viridis*	Timbaloah tampae (b)	Tandu dui	18.0
Hemiramphidae	*Hemiramphus far*	Pilangan	Taruda nguhu	19.8
Hemiramphidae	*Hemiramphus robustus*	Oras	Taruda mohute	14.4
Hemiramphidae	*Hyporhamphus affinis/archipelagicus*	Tampae	Osiki	15.4
Hemiramphidae	*Hyporhamphus quoyi*	Oras silah	Urapi	15.8
Holocentridae	*Myripristis adusta*	Babakal silah	Mbula mudukeo	15.8
Holocentridae	*Myripristis hexagonatus*	Babakal mera	Kenta Mbula	13.8
Holocentridae	*Myripristis murdjan*	Babakal batu	Mbula	13.8
Holocentridae	*Myripristis pralinia*	Babakal mira (a)	Mbula/***Mbula Mensoi	9.6
Holocentridae	*Myripristis violacea*	Babakal	Mbula/***Mbula Biru	10.9
Holocentridae	*Myripristis vittata*	Babakal mira (b)	Mbula	11.7
Holocentridae	*Neoniphon argenteus*	Kakaroo (hijau)	Kenta Kanari/*Nggurou	11.3
Holocentridae	*Neoniphon openrcularis*	Kakaroo (kaler)	Kenta kanari	15.8
Holocentridae	*Neoniphon sammara*	Kakaroo (putih)	Kenta kanari	14.6
Holocentridae	*Sargocentron caudimaculatum*	Lambe batu (b)	Fesui/***Mongintaho	11.7
Holocentridae	*Sargocentron cornutum*	Kakaroo labe	Kenta kanari	8.5
Holocentridae	*Sargocentron diadema*	Kakaroo (merah)	Kenta kanari/***Kenta Kanari Meha	7.9
Holocentridae	*Sargocentron ittodai*	Lambe batu (a)	Kenta Kanari Meha	9.6
Holocentridae	*Sargocentron microstoma*	Keras buku	Gurou	8.6
Holocentridae	*Sargocentron spiniferum*	Lambe	Fesui (a)	19.8
Istiophoridae	*Istiophorus platypterus*	Layarang	Kenta melayare	117.3
Kyphosidae	*Kyphosus bigibbus*	Ila (batu)	Ilo mohute (a)	31.0
Kyphosidae	*Kyphosus cornelii*	Ila boyo (ekor tanta)	Ilo mohute (c)	29.2
Kyphosidae	*Kyphosus vaigiensis*	Ila batu (ekor biasa)	Ilo mohute (b)	29.2
Labridae	*Anampses geographicus*	Pello (a)	Tanggili olo	14.2
Labridae	*Anampses lennardi*	Pello (b)	Kenta timu	13.0
Labridae	*Anampses meleagrides*	Pello (c)	Kenta timu	10.5
Labridae	*Bodianus mesothorax*	Lampa	Longe	11.7
Labridae	*Cheilenus undulatus*	Langkoe	Menami	83.1
Labridae	*Cheilinus chlorurus*	Lampa batu	Tai pere or Tai repe	19.8

Labridae	*Cheilinus fasciatus*	Lampa terusang (a)	Wakkoru	17.8
Labridae	*Cheilinus trilobatus*	Lampa igabuku (a)	Moturu oloo (a)	19.8
Labridae	*Cheilinus unifasciatus*	Lampa terusang (b)	Moturu oloo (b)	20.1
Labridae	*Cheilio inermis*	Palugandah	Fee-fee	21.7
Labridae	*Choerodon anchorago*	Bukalang	Torokai	17.0
Labridae	*Choerodon cyanodus*	Lalamong (a)	Lamu-lamu	29.2
Labridae	*Choerodon jordani*	Lalamong (c)	Lamu-lamu kakanda	8.4
Labridae	*Choerodon rubescens*	Lalamong (b)	Lamu-lamu wungo	36.4
Labridae	*Coris gaimardi*	Pello mira (a)	Tanggili olo	17.8
Labridae	*Epibulus insidiator*	Lampa pangutah	Kenta medosa	23.2
Labridae	*Halichoeres dussumieri*	Pello biasa	Tanggili One	7.1
Labridae	*Halichoeres hortulanus* (IP: female)	Pello batu	Tanggili olo	5.0
Labridae	*Halichoeres hortulanus* (TP: male)	Pello igabuku	Tanggili	20.0
Labridae	*Halichoeres scapularis*	Pello alo (a)	Tanggili	9.6
Labridae	*Halichoeres solorensis*	Lampa biasa	Tanggili Olo Ijo	8.8
Labridae	*Halichoeres trimaculatus* (IP: female)	Pello tanda loong (female)	Tanggili Tanda Iku/**Tadeli Tanda (Fofine)	12.6
Labridae	*Halichoeres trimaculatus* (TP: male)	Pello tanda loong (male)	Tanggili Tanda Iku/**Tadeli Tanda (Moane)	20.0
Labridae	*Halichoeres zeylonicus*	Pello alo (b)	Tanggili	9.6
Labridae	*Hemigymnus melapterus*	Baseparai	Melamu or Hone-honeke	36.4
Labridae	*Novaculichthys taeniurus*	Pello mongoli (b)	Hongoli	13.8
Labridae	*Oxycheilinus diagrammus*	Lampa igabuku (b)	Ka karenga	17.8
Labridae	*Pseudodax moluccanus*	Pello mira (b)	Tanggili olo	13.8
Labridae	*Stethojulis strigiventer*	Pello (d)	Pulen- pule	7.5
Labridae	*Stethojulis trilineata*	Pello samo	Tanggili olo	7.5
Labridae	*Suezichthy soelae*	Pello (e)	Punto-punto	5.4
Labridae	*Thalassoma lunare*	Pello dora	Tanggili Ijo	11.7
Labridae	*Xyrichtys pavo*	Pello mongoli (a)	Hone-honeke	18.2
Leiognathidae	*Gazza minuta*	Bebete (a)	Loba-loba	10.2
Leiognathidae	*Leiognathus equulus*	Tampelo	Kenta bete (b)	11.2
Leiognathidae	*Leiognathus smithursti*	Bebete (b)	Kenta bete (a)	7.9
Lethrinidae	*Gnathodentex aurolineatus*	Totokke tuba	Randa moruta/**Kenta Tobutu	13.8

Lethrinidae	*Gymnocranius euanus*		Kadafo Ngulu	21.0
Lethrinidae	*Gymnocranius frenatus*	Tatabe	Kadafo Mata Meha	15.8
Lethrinidae	*Lethrinus amboinensis*	Popontu lausa (c)	Kadafo Komoa	29.2
Lethrinidae	*Lethrinus atkinsoni*	Sumpa pote	Kadafo pudu/**Kadafo Mohute/***Betomba Mohute	20.8
Lethrinidae	*Lethrinus erythropterus*	Kutamba bannah	Kadafo onuhi	21.7
Lethrinidae	*Lethrinus genivittatus*	Tatam biro (a)	Kadafo rondo/*Tarifande Kandole/**Kadafo Kandole/***Tarifande	11.7
Lethrinidae	*Lethrinus harak*	Kutamba	Kadafo tanda or Salafsu	21.7
Lethrinidae	*Lethrinus lentjan*	Dara papa alo	Kadafo betomba	26.1
Lethrinidae	*Lethrinus miniatus*	Popontu lausu (a)	Kadafo	30.2
Lethrinidae	*Lethrinus nebulosus*	Andupen (a)	Kikiaa	27.9
Lethrinidae	*Lethrinus nebulosus* (juvenille)	Andupyeng	Lobu Kikiaa	27.9
Lethrinidae	*Lethrinus obsoletus*	Mantirus	Kadafo Mohute/*Tarifande/**Kadafo Makuri	25.5
Lethrinidae	*Lethrinus olivaceus*	Lausu	Saso	32.1
Lethrinidae	*Lethrinus ornatus*	Sumpa mira	Onuhi/**Kadafo Utu/***Betomba Meha	16.6
Lethrinidae	*Lethrinus rubrioperculatus*	Tatam biro (b)	Kadafo one/**Tarifande	21.7
Lethrinidae	*Lethrinus semicinctus*	Popontu lausu (b)	Kadafo rondo (a)	15.8
Lethrinidae	*Lethrinus variegatus*	Popontu	Usu-Usu Kandole/*Kadafo Kandole/**Tidoli/***Kadafo Kandole	9.6
Lethrinidae	*Lethrinus xanthocheilus*	Kutu	Ru'u	29.9
Lethrinidae	*Monotaxis grandoculis*	Bagangan	Tua butu	25.5
Lutjanidae	*Aphareus furca*	Kurus bali	Lompa-lompa	29.2
Lutjanidae	*Aphareus rutilans*	Bero babi igabuku	Kenta kanene	43.5
Lutjanidae	*Aprion virescens*	Guntor	Lompa-lompa	41.8
Lutjanidae	*Etelis carbunculus*	Langkuabo mira	Lompa-lompa	50.0
Lutjanidae	*Etelis radiosus*	Langkuabo	Lompa-lompa	32.8
Lutjanidae	*Lutjanus argentimaculatus*	Inniye	Koni meinte	40.7
Lutjanidae	*Lutjanus biguttatus*	Bitte jateh	Lokal-loka	9.6
Lutjanidae	*Lutjanus bohar*	Ahaang	Kotoha	26.8
Lutjanidae	*Lutjanus carponotatus*	Langsuroh alo	Salla	17.8

Lutjanidae	*Lutjanus decussatus*	Bangaro	Salla/**Salla Tanda	13.8
Lutjanidae	*Lutjanus ehrenbergi*	Baba banku	Kenta Tumolla/***Kenta Kulo	15.8
Lutjanidae	*Lutjanus fulviflamma*	Baba igabuku	Salla/*Salafau/***Salafau	13.3
Lutjanidae	*Lutjanus fulvus*	Sumpehlea	Sala fau/**Salafau Makuri/***SalaFau Makuri	17.8
Lutjanidae	*Lutjanus gibbus*	Daapa	Kenta meha/*Loppongoo	18.4
Lutjanidae	*Lutjanus johnii*	Kumbah buha (b)	Baga (a)	29.2
Lutjanidae	*Lutjanus kasmira*	Sasageh (b)	Salla/*Kuwoni/***Roraga	13.9
Lutjanidae	*Lutjanus lemniscatus*	Ine bangkau	Kotoha	27.3
Lutjanidae	*Lutjanus lutjanus*	Sasageh (c)	Salla	11.5
Lutjanidae	*Lutjanus malabaricus*	Ine tarusang	Koni meinte	37.9
Lutjanidae	*Lutjanus monostigma*	Baba	Roraga/kotoha	24.1
Lutjanidae	*Lutjanus quinquelineatus*	Sasageh (a)	Salla	17.0
Lutjanidae	*Lutjanus rivulatus*	Sangai	Baga (c)	31.9
Lutjanidae	*Lutjanus rufolineatus*	Sasageh (d)	Kuwoni	9.6
Lutjanidae	*Lutjanus russelli*	Kumbah buha (a)	Kenta Tumolla (b)	21.7
Lutjanidae	*Lutjanus vitta*	Langsuroh terusang	Salla	18.9
Lutjanidae	*Macolor macularis*	Sulai asau	Tonalu	25.5
Lutjanidae	*Pristipomoides filamentosus*	Bambangan (a)	Lompa-lompa	34.5
Lutjanidae	*Pristipomoidies auricilla*	Bambangan (c)	Mbula-Mbula	18.5
Lutjanidae	*Pristipomoidies flavipinnis*	Bambangan (b)	Fara-fara	26.4
Lutjanidae	*Pristipomoidies zonatus*	Bambangan (d)	**Kadafo Nguhu	21.6
Lutjanidae	*Symphorichthys spilurus*		Mangkarania	25.5
Lutjanidae	*Symphorus nematophorus*	Mora pisa	Baga (b)	38.1
Malacanthidae	*Malacanthus brevirostris*	Babala	Lokal-loka	14.6
Malacanthidae	*Malacanthus latovittatus*	Paluganda alo	Fee-Fee Olo	19.8
Monacanthidae	*Acreichthys tomentosus*	Epe samo (biasa)	Sogo pei	5.2
Monacanthidae	*Aluterus scriptus*	Eppe silla	Sogo Pei	43.5
Monacanthidae	*Amanses scopas*	Epe loong	Sogo	9.6
Monacanthidae	*Cantherhines pardalis*	Epe	Sogo olo	11.7
Monacanthidae	*Monacanthus chinensis*	Epe samo (alu)	Sogo rondo	17.0
Monacanthidae	*Paramonacanthus choirocephalus*	Eppe samo	Sogo Rondo	4.3

Mugilidae	*Liza subviridis*	Bonte libbo (b)	Fonti Mohute	15.8
Mugilidae	*Liza vaigiensis*	Duppua	Fonti tambora	26.6
Mugilidae	*Mugil cephalus*	Bonte libbo (a)	Fonti	40.7
Mugilidae	*Valamugil buchanani*	Bonte silah	Fonti/**Fonti Komoa/***Fonti Mohute	40.0
Mullidae	*Mulloidichthys flavolineatus*	Banguntu janggutan tuba	Tio lumalo	13.9
Mullidae	*Mulloidichthys vanicolensis*	Banguntu janggutan igabuku	Tio lumalo/*Tingkusa Makuri	15.7
Mullidae	*Parupeneus barberinoides*	Timbungan igabuku (c)	Tio tandai	13.8
Mullidae	*Parupeneus barberinus*	Timbungan tubba (a)	Tio bata/*Tio Tanda/***Tio Tanda	25.5
Mullidae	*Parupeneus bifasciatus*	Timbungan samo	Tio/***Tio Nguhu Meha	15.8
Mullidae	*Parupeneus cyclostomus*	Timbungan igabuku (b)	Tio makuri	21.7
Mullidae	*Parupeneus heptacanthus*	Timbungan igabuku (d)	Tio meha	13.8
Mullidae	*Parupeneus indicus*	Timbungan tubba (b)	Tio Bata/***Tio Makuri Pangku	17.8
Mullidae	*Parupeneus macronema*	Timbungan igabuku (a)	Tio	17.8
Mullidae	*Parupeneus multifasciatus*	Timbungan tubba (c)	Tio liku/*Tio Tombo/**Tio Fatu/***Tio Nguhu	13.8
Mullidae	*Parupeneus pleurostigma*	Timbungan	Tio	15.0
Mullidae	*Upeneus asymmetricus*	Balubba (tanda hitam)	Tingkusa	13.8
Mullidae	*Upeneus moluccensis*	Balubba (garis kuneh)	Tio lumalo/**Tio Fatu	10.9
Mullidae	*Upeneus sundaicus*	Balubba	Tio lumalo	10.5
Mullidae	*Upeneus tragula*	Balubba samo	Tingkusa/*Tingkusa Buri/**Tio Buri	13.8
Mullidae	*Upeneus vittatus*	Balubba alo	Tingkusa	11.0
Muraenidae	*Gymnothorax fimbriatus*	Ondoh sillah	Kompa bunga moliri	32.8
Nemipteridae	*Nemipterus balinensis*	Lankiaba alo	Karisi (b)	8.8
Nemipteridae	*Nemipterus celebicus*	Lankiaba	Karisi (a)	10.5
Nemipteridae	*Nemipterus nematophorus*	Karisi/Langkiaba	Kandetimu	13.4
Nemipteridae	*Pentapodus caninus*	Tintah (a)	Tonto mohute	11.0
Nemipteridae	*Pentapodus trivittatus*	Tintah bonda (a)	Tonto/**Rangintube	11.7
Nemipteridae	*Scolopsis auratus*	Tinta	Randa moruta	10.0
Nemipteridae	*Scolopsis ciliatus*	Tintah bonda (b)	Tonto (b)	9.2
Nemipteridae	*Scolopsis lineatus*	Tintah tuba	Tonto Buri	10.9
Nemipteridae	*Scolopsis margaritifer*	Tintah iga buku	Fai-fai (b)	13.0
Nemipteridae	*Scolopsis monogramma*	Sualala	Fai-fai (a)	14.2

Nemipteridae	*Scolopsis trilineatus*	Tintah (b)	Tonto buri/*Tonto Biasa/**Tonto Sora/***Tonto Mohute	9.6
Ostracidae	*Ostracion cubicus*	Taburruah (b)	Falampopa	19.8
Ostraciidae	*Lactoria cornuta*	Cocoreng	Bubu Bubu	20.1
Ostraciidae	*Ostracion meleagris*	Taburruah (a)	Pu.u - Pu.u	11.7
Ostraciidae	*Rhynchostracion nasus*	Taburruah tarusang	Puu-puu	15.0
Pempheridae	*Pempheris oualensis*	Beseh boe	Ilo/**Karangka Olo	9.6
Platycephalidae	*Cymbacephalus beauforti*	Kumbah buaya (b)		21.7
Platycephalidae	*Onigocia spinosa*	Pepesari	Kenta Kumbou	6.6
Platycephalidae	*Papilloculiceps nematophthalmus*	Kumbah buaya (a)	Kenta kumbou/***Kenta Kumbuo Biru	29.0
Platycephalidae	*Rogadius asper*	Kumbah Buaya (C)	Kenta kumbou/***Kenta Kumbuo Makuri	8.4
Plotosidae	*Euristhmus nudiceps*	Titingan (a)	Oitu	15.0
Plotosidae	*Paraplotosus albilabris*	Sambelah	Oitu	51.8
Plotosidae	*Plutosus lineatus*	Titingan (b)	Oitu	16.0
Pomacentridae	*Abudefduf vaigiensis*	Alalas	Kenta Mombi	9.6
Pomacentridae	*Chrysiptera unimaculata*	Tibo loong (a)	Tokuku	4.3
Pomacentridae	*Dischistodus perspicillatus*	Tibo pote	Bokku-bokku/**Tokuku Meha	7.9
Pomacentridae	*Hemiglyphidodon plagiometopon*	Tibo	Bokku-bokku (a)	7.5
Pomacentridae	*Pomacentrus milleri*	Tibo loong (b)	Tokuku Biru	4.0
Priacanthidae	*Heteropriacanthus cruentatus*	Beseh loong	Bula-bulafa (d)	21.9
Priacanthidae	*Priacanthus hamrur*	Beseh (merah)	Bula-bulafa (b)	15.6
Priacanthidae	*Priacanthus macracanthus*	Beseh (tarusan)	Bula-bulafa (c)	14.0
Priacanthidae	*Priacanthus sagittarius*	Beseh (biasa)	Bula-bulafa (a)	13.4
Pseudochromidae	*Cypho purpurescens*		Koka Molokka	4.0
Scaridae	*Bolbometopon muricatum* (unicolour)	Angke	Tofoula	41.1
Scaridae	*Calotomus spinidens* (unicolour)	Amammar	Punto-punto	7.0
Scaridae	*Cetoscarus bicolor* (TP: male)	Mogoh borra	Fangu kakanda	60.0
Scaridae	*Chlorurus bleekeri* (IP: female)	Mogoh loonge (c)	Lehe biru	21.3
Scaridae	*Chlorurus bleekeri* (TP: male)	Mogoh nyulah (b)	Lehe biru	39.0
Scaridae	*Chlorurus sordidus* (IP: female)	Mogoh loonge (b)	Fangu ijo	17.8
Scaridae	*Chlorurus sordidus* (TP: male)	Mogoh nyulah (i)	Lehe fatu/***Fangu Biru	26.0
Scaridae	*Hipposcarus longiceps*	Ulapai	Fangu mohute	18.6

Scaridae	*Hipposcarus longiceps* (IP: female)	Ulapri nyulah buku	Lehe Mohute	10.0
Scaridae	*Leptoscarus vaigiensis* (IP: female)	Banguntu	Pulen-Pule (Fofine)	14.7
Scaridae	*Leptoscarus vaigiensis* (TP: male)	Mogoh nyulah (c)	Pulen-Pule (Moane)	14.7
Scaridae	*Scarus chameleon* (IP: female)	Mogoh nyulah (e)	Lehe Rata Iku/*Lehe Mohute/***Fangu Mohute(Fofine)	14.2
Scaridae	*Scarus chameleon* (TP: male)	Mogoh nyulah (m)	Fangu Ijo/*Lehe Ijo (Moane)	20.0
Scaridae	*Scarus dimidiatus* (IP: female)	Mogoh pote (b)	Lehe	15.8
Scaridae	*Scarus dimidiatus* (TP: male)	Mogoh (a)	Lehe ijo	22.0
Scaridae	*Scarus flavipectoralis* (unicolour)	Mogoh nyulah (k)	Lehe kakanda	13.8
Scaridae	*Scarus frenatus* (IP: female)	Mogoh mira	Lehe kakanda karenga/***Fangu Ijo	20.5
Scaridae	*Scarus frenatus* (TP: male)	Mogoh nyulah (d)	Lehe fatu (b)	36.0
Scaridae	*Scarus ghobban* (IP: female)	Bataan	Lehe fangu/***Fangu Tambaga (Fofine)	36.4
Scaridae	*Scarus ghobban* (TP: male)	Pandanan	Fangu Ijo (Moane)	62.0
Scaridae	*Scarus globiceps* (IP: female)	Mogoh pote (c)	Nama-nama/*Lehe Beka (Fofine)	12.6
Scaridae	*Scarus globiceps* (TP: male)	Mogoh nyulah (a)	Lehe (Moane)	12.6
Scaridae	*Scarus niger* (unicolour)	Mogoh loonge (d)	Lehe biru	17.8
Scaridae	*Scarus oviceps* (IP: female)	Mogoh (b)	Lehe (Fofine)	13.8
Scaridae	*Scarus oviceps* (TP: male)	Mogoh nyulah (f)	Lehe fatu (Moane)	25.0
Scaridae	*Scarus prasiognathus*	Mogoh sasah	Lehe	29.2
Scaridae	*Scarus psittacus* (IP: female)	Mogoh loonge (a)	Lehe kofungo-lehe firiso/**Lehe Kakanda (Fofine)	11.5
Scaridae	*Scarus psittacus* (TP: male)	Mogoh nyulah (g)	Lehe ijo/***Fangu Biru (Moane)	20.0
Scaridae	*Scarus quoyi* (unicolour)	Mogoh nyulah (l)	Lehe kakanda	10.0
Scaridae	*Scarus rivulatus* (IP: female)	Mogoh pote (d)	Lehe mohute/*Fangu Mohute/***Fangu Mohute	17.8
Scaridae	*Scarus rivulatus* (TP: male)	Mogoh nyuloh (j)	Lehe	17.8
Scaridae	*Scarus rubroviolaceus* (IP: female)	Borra	Lehe	29.2
Scaridae	*Scarus rubroviolaceus* (TP: male)	Mogoh mira	Lehe ijo	48.0
Scaridae	*Scarus schlegeli*	Mogoh nyulah (h)	Lehe ijo	14.4
Scaridae	*Scarus schlegeli* (IP: female)	Mogoh pote (a)	Lehe	14.4
Scaridae	*Scarus viridifucatus* (unicolour)	Mogoh loonge (e)	Lehe biru	14.6
Scombridae	*Auxis rochei*	Turingah boyo or Babalaki	Balaki	21.7

Scombridae	*Euthynnus affinis*	Turingah	Cakala biru	35.5
Scombridae	*Grammatorcynus bicarinatus*	Ande ande allo	Talan-tala	43.5
Scombridae	*Grammatorcynus bilineatus*	Ande ande igabuku	Talan-tala/***Falo-Falo	40.0
Scombridae	*Gymnosarda unicolor*	Bambulo	Mambulo	80.2
Scombridae	*Megalaspis cordyla*	Kulli	Mambulo	27.1
Scombridae	*Rastrelliger kanagurta*	Rurumah	Rumah-Rumah	17.5
Scombridae	*Thunnus albacares*	Rambayan	Balang kuni (b)	74.9
Scombridae	*Thunnus obesus*	Bangkunis	Balang kuni (a)	84.3
Scorpaenidae	*Pterois antennata*	Laruh mera	Sangkularu Meha	9.6
Scorpaenidae	*Pterois volitans*	Laruh loong	Sangkularu	17.0
Scorpaenidae	*Synanceja verrucosa*	Kallipo summe	Kenta fatu	17.8
Serranidae	*Aethaloperca rogaa*	Kiapu popokah	Okke koka	25.5
Serranidae	*Anyperodon leucogrammicus*	Kiapu tallah	Okke mohute	22.4
Serranidae	*Centrogenys vaigiensis*	Kallippo biasa	Tendu Tendu	7.3
Serranidae	*Cephalopholis argus*	Kiapu loong	Okke dalika/**Okke Kakanda/***Okke Biru	23.6
Serranidae	*Cephalopholis aurantia*	Kiapu mira (a)	Okke	25.5
Serranidae	*Cephalopholis cyanostigma*	Kiapu bite mira (b)	Okke	15.8
Serranidae	*Cephalopholis miniata*	Kiapu bite mira (a)	Okke buri meha/*Okke	19.8
Serranidae	*Cephalopholis polleni*	Kiapu (b)	Mangkarnia	19.0
Serranidae	*Cephalopholis sexmaculata*	Kiapu mira (c)	Okke	20.9
Serranidae	*Cephalopholis sonnerati*	Kiapu mira lempes	Okke Meha	24.3
Serranidae	*Cephalopholis spiloparaea*	Kiapu mira polos	Okke	10.5
Serranidae	*Cephalopholis urodeta*	Kiapu panenele	Okke olo	13.0
Serranidae	*Cromileptes altivelis*	Kiapu kamudi/tikus	Okke beka	29.2
Serranidae	*Epinephelus areolatus*	Kiapu kubah	Kenta Okke	16.8
Serranidae	*Epinephelus bontoides*	Kiapu nyarengkeh (c)	Okke biru	13.8
Serranidae	*Epinephelus caeruleeopunctatus*	Kiapu buntar tikolo (b)	Okke tulareke/**Okke Dalika	31.4
Serranidae	*Epinephelus coioides*	Kiapu buntar tikolo	Kenta Okke	36.5
Serranidae	*Epinephelus cyanopodus*	Lumu tarusang	Okke	47.7
Serranidae	*Epinephelus fasciatus*	Kiapu matekuli	Kenta Okke	17.8
Serranidae	*Epinephelus fuscoguttatus*	Kiapu tongal (tiger)	Okke (tiger besar)	35.6
Serranidae	*Epinephelus lanceolatus*	Kiapu mansarunae	Okke ndoke	96.2

Serranidae	*Epinephelus maculatus*	Kiapu nyarengkeh (b)	Okke tembaga/*Okke Buri/***Kurapu	25.6
Serranidae	*Epinephelus magniscuttis*	Kiapu kokoro (a)	Lanti	57.2
Serranidae	*Epinephelus malabaricus*	Kiapu (a)	Okke	84.7
Serranidae	*Epinephelus merra*	Kiapu sibbo	Tularekke	14.2
Serranidae	*Epinephelus miliaris*	Kiapu nyarengkeh (a)	Okke	19.0
Serranidae	*Epinephelus morrhua*	Kiapu kokoro (b)	Kurapu meha	36.4
Serranidae	*Epinephelus ongus*	Kiapu ngaluhu	Okke buri mohute/*Okke Biasa	15.8
Serranidae	*Epinephelus polyphekadion*	Kiapu ngaluhu (tiger)	Okke (tiger keceil)	36.4
Serranidae	*Epinephelus tukula*	Kiapu buntar tikolo (a)	Kenta Okke	73.8
Serranidae	*Gracila albomarginata*	Kiapu bandoka	Okke	17.8
Serranidae	*Grammistes sexlineatus*	Kinsang	Kenta Beka	13.8
Serranidae	*Plectranthias japonicus*	Kiapu mira (d)	Okke olo	7.5
Serranidae	*Plectropomus areolatus*	Sunu mehra	Sunu biru mohute	30.3
Serranidae	*Plectropomus laevis* (grey colour morph)	Sunu bantoel	Okke	48.7
Serranidae	*Plectropomus laevis* (yellow colour morph)	Sunu sunurang	Okke makuri (a)	48.7
Serranidae	*Plectropomus leopardus*	Sunu mira or Sunu alo (A)	Sunu	47.0
Serranidae	*Plectropomus maculatus*	Sunu camba	Sunu mera buri mohute/*Sunu	40.0
Serranidae	*Plectropomus oligocanthus*	Sunu mira or Sunu alo (B)	Sunu	31.0
Serranidae	*Variola albimarginata*	Taringang (b)	Okke meha (C)	25.5
Serranidae	*Variola louti*	Taringang (a)	Sunu	30.4
Siganidae	*Siganus argenteus*	Belowis silah	Monoi/**Monoi Tubila	13.6
Siganidae	*Siganus canaliculatus*	Belowis samo (b)	Kola biru/**Kola Rondo	14.8
Siganidae	*Siganus doliatus*	Kekea (batu)	Borona/*Borona Makuri	11.3
Siganidae	*Siganus fuscescens*	Belowis samo (a)	Kola mohute	17.8
Siganidae	*Siganus guttatus*	Birrah (titik)	Borona (a)	14.3
Siganidae	*Siganus lineatus*	Birrah (kuran)	Borona buri	14.6
Siganidae	*Siganus puellus*	Kekea (igabuku)	Borona makuri	17.0
Siganidae	*Siganus punctatus*	Mangilala	Borona watu/*Borona Biru/**Borona Biru	17.8
Siganidae	*Siganus spinus*	Belowis kangkang	Kola bungi	11.0
Siganidae	*Siganus trispilos*	Kekea (bintik 3)	Borona tanda biru	11.7

Siganidae	*Siganus vulpinus*	Kekea kunyeh	Borona Makuri	11.3
Soleidae	*Dexillichthys muelleri*	Kalampede biasa (a)	Kaleppa	8.8
Soleidae	*Phyllichthys punctatus*	Kalempede biasa (b)	Kaleppa	11.3
Sphyraenidae	*Sphyraena barracuda*	Pangaluang	Alu	65.4
Sphyraenidae	*Sphyraena jello*	Papalo silah	Ndoma	55.4
Sphyraenidae	*Sphyraena obtusata*	Papalo samo	Falo-falo	16.9
Sphyraenidae	*Sphyraena qenie*	Lenko	Sombu woku	63.9
Synodontidae	*Synodus variegatus*	Jarah gigi (a)	Kenta bisara/***Kenta Bisara Biru	17.8
Terapontidae	*Terapon jarbua*	Kokoreh	Kalaero	16.2
Tetraodontidae	*Arothron hispidus*	Gurisang	Lombe	21.7
Tetraodontidae	*Arothron nigropunctatus*	Lumis	Kenta Kombu	15.0
Zanclidae	*Zanclus cornatus*	Tatape rambai	Bukku nuo'o	10.9
Stomatopoda				
Lysiosquilidae	*Lysioquilina maculata*	Balo batu	Ura	

Appendix V: Catch and species abundance per technique

Catch per unit effort, value per unit effort (VPUE), fishing operation details and percentage of catch eaten, sold and gift, per technique in each village, where D = Darawa, L = Lentea, SB = Sama Bahari and S = Sombano.

	Fishing Gear															
	Bubu traps				**Fish Fence**				**Set gillnet parallel to reef**				**Set gillnet perpendicular to reef**			
Village	D	L	SB	S	D	L	SB	S	D	L	SB	S	D	L	SB	S
Sample size	15	2	-	18	3	3	-	3	-	2	1	15	-	-	3	-
CPUE (Bubu: kg/trap/day)	0.55 kg/trap/d	0.26 kg/trap/d	-	0.36 kg/trap/d	32.92 kg/d	4.83 kg/d	-	13.47 kg/d	-	0.03 kg/m/h-soak	0.01 kg/m/h-soak	0.04 kg/m/h-soak	-	-	0.03 kg/m/h-soak	-
Kg/day	3.1	1.1	-	2.2	32.9	4.9	-	13.5	-	10.0	3.5	12.3	-	-	26.7	-
VPUE	1,419 Rp/trap/d	1,012 Rp/trap/d	-	808 Rp/trap/d	69,167 Rp/d	12,500 Rp/d	-	25,833 Rp/d	-	128 Rp/m/h-soak	30 Rp/m/h-soak	100 Rp/m/h-soak	-	-	151 Rp/m/h-soak	-
Rp/day	7,500	3,750	-	4,722	69,167	12,500	-	25,833	-	50,000	15,000	33,133	-	-	124,167	-
Duration travel	1:00h	1:00h	-	1:35h	1:40h	2:00h	-	1:40h	-	1:00h	2:00h	1:32h	-	-	1:40h	-
Duration fishing	-	-	-	-	-	-	-	-	-	2:00h	2:00h	1:20h	-	-	2:20h	-
Day fishing/week	3	3	-	3	3	3	-	3	-	4	3	7	-	-	4	-
Operation/day	-	-	-	-	-	-	-	-	-	1	1	1	-	-	1	-
No. Traps	6	5	-	6	1	1	-	1	-	-	-	-	-	-	-	-
Soak time	48h	48h	-	48h	48h	48h	-	48h	-	4h	2h	3h	-	-	6h	-
Length	-	-	-	-	233	100	-	127	-	135	250	136	-	-	125	-
Inch	-	-	-	-	1.5-2.5	1.5	-	1.5	-	2.5	2.5	2.5	-	-	2	-
% Eaten	34	20	-	52	30	47	-	20	-	15	10	21	-	-	13	-
% Sold	59	80	-	45	57	50	-	77	-	80	90	78	-	-	83	-
% Gift	8	0	-	3	13	3	-	3	-	5	0	1	-	-	4	-

CONTINUED: Catch per unit effort, value per unit effort (VPUE), fishing operation details and percentage of catch eaten, sold and gift, per technique in each village, where D = Darawa, L = Lentea, SB = Sama Bahari and S = Sombano.

	Fishing Gear															
	Gillnet drive-in encircling				**Gillnet drive-in parallel to reef**				**Beach Seine**				**Seine net with scare lines**			
Village	D	L	SB	S	D	L	SB	S	D	L	SB	S	D	L	SB	S
Sample size	8	4	9	-	-	-	5	-	-	-	-	3	-	1	-	-
CPUE	0.10 kg/m/set	0.07 kg/m/set	0.10 kg/m/set	-	-	-	0.20 kg/m/set	-	-	-	-	0.04 kg/m/set	-	0.40 kg/m/set	-	-
Kg/day	7.4	7.9	13.1	-	-	-	20.4	-	-	-	-	34.0	-	80.0	-	-
VPUE	222 Rp/m/set	245 Rp/m/set	172 Rp/m/set	-	-	-	557 Rp/m/set	-	-	-	-	121 Rp/m/set	-	1,500 Rp/m/set	-	-
Rp/day	16,625	28,000	31,389	-	-	-	72,000	-	-	-	-	101,667	-	300,000	-	-
Duration travel	0:56h	1:07h	1:06h	-	-	-	1:46h	-	-	-	-	1:00h	-	1:00h	-	-
Duration fishing	1:52h	2:15h	2:46h	-	-	-	1:48h	-	-	-	-	2:00h	-	2:00h	-	-
Day fishing/week	3	5	6	-	-	-	5	-	-	-	-	7	-	2	-	-
Operation/day	1	1	1-2	-	-	-	1	-	-	-	-	2	-	2	-	-
Length (m)	76	100	140	-	-	-	155	-	-	-	-	420	-	100	-	-
Inch	1.75	2.25	1		-	-	2	-	-	-	-	3	-	2.5	-	-
% Eaten	35	42	27	-	-	-	24	-	-	-	-	10	-	20	-	-
% Sold	46	50	70	-	-	-	68	-	-	-	-	90	-	70	-	-
% Gift	19	8	3	-	-	-	8	-	-	-	-	0	-	10	-	-

CONTINUED: Catch per unit effort, value per unit effort (VPUE), fishing operation details and percentage of catch eaten, sold and gift, per technique in each village, where D = Darawa, L = Lentea, SB = Sama Bahari and S = Sombano.

	Fishing Gear											
	Spear-gun				Hand Line				Hand Trawl			
Village	D	L	SB	S	D	L	SB	S	D	L	SB	S
Sample size	-	-	6	-	2	7	6	-	4	-	8	-
CPUE	-	-	1.19 kg/hr	-	1.46 kg/hr	1.67 kg/hr	1.38 kg/hr	-	1.16 kg/hr	-	1.42 kg/h	-
Kg/day	-	-	3.4 kg/d	-	5.8 kg/d	5.0 kg/d	4.3 kg/d	-	2.5 kg/d	-	4.0 kg/d	-
VPUE	-	-	4,167 Rp/h	-	3,917 Rp/hr	4,167 Rp/hr	6,111 Rp/hr	-	4,583 Rp/h	-	3,302 Rp/h	-
Rp/day	-	-	13,333	-	15,429	12,500	19,667	-	10,000	-	10,000	-
Duration travel	-	-	0:40 h	-	1:42 h	1:00 h	1:10 h	-	0:37 h	-	1:00 h	-
Duration fishing	-	-	2:30 h	-	3:51 h	3:00 h	3:10 h	-	2:15 h	-	2:51 h	-
Day fishing/week	-	-	4	-	7	3.5	4	-	3.5	-	4	-
Operation/day	-	-	1	-	1	1	1	-	1	-	1	-
% Eaten	-	-	72	-	35	26	27	-	63	-	55	-
% Sold	-	-	28	-	35	66	70	-	35	-	45	-
% Gift	-	-	0	-	30	8	3	-	2	-	0	-

Catch composition and percentage of mature fish in catches from bubu traps gillnets set parallel to the reef and gillnets set perpendicular to the reef for all villages, where D = Darawa, L = Lentea, SB = Sama Bahari and S = Sombano. Families with abundance of less than 5% were grouped as other fish.

	Fishing Gear											
	Bubu traps				**Set gillnet parallel to reef**				**Set gillnet perpendicular to reef**			
Village	**D**	**L**	**SB**	**S**	**D**	**L**	**SB**	**S**	**D**	**L**	**SB**	**S**
Caesionidae											30	
Carangidae								6				
Clupeidae											14	
Diodontidae		7										
Holocentridae											38	
Kyphosidae											8	
Labridae	11	11		19								
Lethrinidae	9	43				54	41	26				
Lutjanidae		7					35					
Mullidae	45	7		34		7	18	8				
Nemipteridae	5			14			6	12				
Scaridae	23	7		15								
Scorpoenidae		14										
Serranidae						15						
Siganidae						11		14				
Sphyraenidae								8				
Other fish	7	4		18		13	0	26			10	
% mature	**37**	**73**		**47**		**38**	**76**	**56**			**80**	

Catch composition and percentage of mature fish in catches from hand lines, hand trawls fish fences and Spearguns, for all villages, where D = Darawa, L = Lentea, SB = Sama Bahari and S = Sombano. Families with abundance of less than 5% were grouped as other fish.

	Fishing Gear															
	Spear-gun				**Hand Line**				**Hand Trawl**				**Fish Fence**			
Village	**D**	**L**	**SB**	**S**	**D**	**L**	**SB**	**S**	**D**	**L**	**SB**	**S**	**D**	**L**	**SB**	**S**
Balistidae						7										
Belonidae											29		5			
Gerridae			8								18					
Hemiramphidae																32
Holocentridae													8			
Labridae			47		9	20								5		
Lethrinidae					78	50	98		98		11		11			10
Lutjanidae													5			
Mulgilidae														7		
Mullidae													44			11
Nemipteridae																5
Plotosidae														40		
Scaridae			5											7		28
Serranidae						15					13					
Siganidae			31										6	21		
Other fish			9		13	8	2		2		11		29	20		14
% mature			**89**		**84**	**50**	**94**		**62**		**91**		**78**	**69**		**60**

Catch composition and percentage of mature fish in catches from drive-in encircling gillnets, drive-in gillnets parallel to reef, beach seine nets and seine nets with scare lines for all villages, where D = Darawa, L = Lentea, SB = Sama Bahari and S = Sombano. Families with abundance of less than 5% were grouped as other fish.

	Fishing Gear															
	Gillnet drive-in encircling				**Gillnet drive-in parallel to reef**				**Beach Seine**				**Seine net with scare lines**			
Village	D	L	SB	S	D	L	SB	S	D	L	SB	S	D	L	SB	S
Acanthuridae														58		
Carangidae		5														
Clupeidae			86													
Gerridae		23										46				
Hemiramphidae	13		10				77									
Labridae	5															
Lethrinidae	31	55										30				
Mullidae	18	7														
Nemipteridae	20															
Scaridae	6													33		
Siganidae							14					12				
Other fish	7	10	4									12		9		
% mature	**79**	**57**	**99**				**93**					**73**		**90**		

Appendix VIII: List of registered boats, boat types and owners in each village.

SOMBANO

Owner	Boat Type	Registration
La Nuu	Katintin	K-001-O
Ld. Arnia	Katintin	K-002-O
La Faraku	Bodi TS	K-003-O
La Sumoina	Bodi TS	K-004-O
La Dame	Katintin	K-005-O
La Karimu	Katintin	K-006-O

Lentea

Owner	Boat Type	Registration
La Sudi	Bodi TS	K-001-J
Kellu	Bodi TS	K-002-J
Saudara	Katintin	K-003-J
Patahudin	Bodi TS	K-004-J
Safarudin	Katintin	K-005-J
Marni	Katintin	K-006-J
La Ali J	Katintin	K-007-J
Nurdin	Katintin	K-008-J
Munsir a	Bodi TS	K-009-J
Munsir b	Bodi TS	K-010-J
Munsir c	Bodi TS	K-011-J
La Nika	Katintin	K-012-J
Muhsin	Katintin	K-013-J
Maanimu	Katintin	K-014-J
Ld. Balafa	Katintin	K-015-J
Sardin	Katintin	K-016-J
Ld. Idris	Katintin	K-017-J
La Ibu	Katintin	K-018-J
Agus	Katintin	K-019-J
Nanna	Bodi TS	K-020-J
La Dini	Katintin	K-021-J
Wa Malamu	Katintin	K-022-J
Kandiri	Katintin	K-023-J
Hasa	Katintin	K-024-J
Jambutu	Katintin	K-025-J
Hamsah	Katintin	K-026-J
La Badi	Katintin	K-027-J
Hendo	Katintin	K-028-J
Maaruf	Katintin	K-029-J
Tajudin	Katintin	K-030-J
Amirudin	Katintin	K-031-J

Sama Bahari

Owner	Boat Type	Registration
Suhaele	**Bodi TS**	**K-001-P**
Rustam	**Bodi TS**	**K-002-P**
Jabira	**Bodi TS**	**K-003-P**
Lambia	**Bodi TS**	**K-004-P**
Juader	**Bodi TS**	**K-005-P**
Gang	**Bodi TS**	**K-006-P**
Sanudding	**Bodi TS**	**K-007-P**
Rajuning	**Bodi TS**	**K-008-P**
Kadirun	**Bodi TS**	**K-009-P**
Buddu	**Bodi TS**	**K-010-P**
Udi/Koce	**Bodi TS**	**K-011-P**
Aliso	**Bodi TS**	**K-012-P**
Latar	**Katintin**	**K-013-P**
Tana	**Bodi TS**	**K-014-P**
Jarupi	**Bodi TS**	**K-015-P**
Tebung	**Bodi TS**	**K-016-P**
Ponggo	**Bodi TS**	**K-017-P**
Herman	**Bodi TS**	**K-018-P**
Sanudding	**Bodi TS**	**K-019-P**
Laingu	**Bodi TS**	**K-020-P**
Sadar	**Bodi TS**	**K-021-P**
Ownerng	**Bodi TS**	**K-022-P**
La Nogi/Mareng	**Bodi TS**	**K-023-P**
Jono	**Bodi TS**	**K-024-P**
Ruasing	**Bodi TS**	**K-025-P**
Ajudar	**Bodi TS**	**K-026-P**
Duda/Ruasing	**Bodi TS**	**K-027-P**
Mi/Borda	**Bodi TS**	**K-028-P**
Juabar	**Bodi TS**	**K-029-P**
La Dasi	**Bodi TS**	**K-030-P**
Tutu	**Bodi TS**	**K-031-P**
Suhandi	**Bodi TS**	**K-032-P**
La Bari	**Bodi TS**	**K-033-P**
Tahe	**Bodi TS**	**K-034-P**
Laburahima	**Bodi TS**	**K-035-P**

Sama Bahari

Owner	Boat Type	Registration
Manjus	**Bodi TS**	**K-036-P**

Jupardi	**Bodi TS**	**K-037-P**
Kriss	**Bodi TS**	**K-038-P**
La Uda	**Bodi TS**	**K-039-P**
Mader	**Bodi TS**	**K-040-P**
La Dama	**Bodi TS**	**K-041-P**
La Eto	**Kapal Motor**	**K-042-P**
La Milu	**Bodi TS**	**K-043-P**
Haruping	**Bodi TS**	**K-044-P**
Laburahima	**Bodi TS**	**K-045-P**
Gante	**Bodi TS**	**K-046-P**
Rudi	**Bodi TS**	**K-047-P**
Gopang	**Katintin**	**K-048-P**
Kaladi	**Bodi TS**	**K-049-P**
Asik	**Kapal Motor**	**K-050-P**
Gai	**Kapal Motor**	**K-051-P**
Gai	**Bodi TS**	**K-052-P**
Hader	**Bodi TS**	**K-053-P**
Tawwin	**Bodi TS**	**K-054-P**
Toto, K	**Bodi TS**	**K-055-P**
Tanah	**Bodi TS**	**K-056-P**
Asik	**Bodi TS**	**K-057-P**
Garro	**Bodi TS**	**K-058-P**
Maharudin	**Bodi TS**	**K-059-P**
La Moane	**Bodi TS**	**K-060-P**
Muntah	**Bodi TS**	**K-061-P**
Pepe	**Bodi TS**	**K-062-P**
Junaidin	**Bodi TS**	**K-063-P**
Junaidin	**Katintin**	**K-064-P**
Tandudo	**Bodi TS**	**K-065-P**
Kuddi	**Bodi TS**	**K-066-P**
Jubira	**Bodi TS**	**K-067-P**
Redi	**Bodi TS**	**K-068-P**
La Nai	**Bodi TS**	**K-070-P**

Sama Bahari

Owner	**Boat Type**	**Registration**
Bidang	**Bodi TS**	**K-071-P**
Maronta	**Katintin**	**K-072-P**
Ld. Aru	**Katintin**	**K-073-P**
La Eto	**Bodi TS**	**K-074-P**

Haluming	**Bodi TS**	**K-075-P**
Mala	**Bodi TS**	**K-076-P**
Sako	**Bodi TS**	**K-077-P**
Juaseng	**Bodi TS**	**K-078-P**
Haing	**Bodi TS**	**K-079-P**
La Goa	**Bodi TS**	**K-080-P**
Toto, K	**Bodi TS**	**K-089-P**
Harisudin	**Bodi TS**	**K-090-P**

Darawa

Owner	Boat Type	Registration
La Adinuru	**Katintin**	**K-001-M**
La Julu	**Katintin**	**K-002-M**
La Ida. T	**Katintin**	**K-003-M**
La Bondo	**Katintin**	**K-004-M**
La Tuba	**Katintin**	**K-005-M**
La Humu	**Katintin**	**K-006-M**
La Utu	**Katintin**	**K-007-M**
La Murdia	**Katintin**	**K-008-M**
La Dio	**Katintin**	**K-009-M**
La Abidin	**Katintin**	**K-010-M**
La Rasidu	**Katintin**	**K-011-M**
La Nganto	**Katintin**	**K-012-M**
Wa Siola	**Katintin**	**K-013-M**
Wa Safiana	**Katintin**	**K-014-M**
La Saridin	**Katintin**	**K-015-M**
La Umu	**Katintin**	**K-016-M**
La Aidi	**Katintin**	**K-017-M**
La Muhamadi	**Katintin**	**K-018-M**
La Aliodi	**Katintin**	**K-019-M**
La Kaddimu	**Katintin**	**K-020-M**
La Supri	**Katintin**	**K-021-M**
La Pingi	**Katintin**	**K-022-M**

Darawa

Owner	Boat Type	Registration
La Oni	**Katintin**	**K-023-M**
La Jumani	**Katintin**	**K-024-M**
Fa Undi	**Katintin**	**K-025-M**
La Dahlan	**Katintin**	**K-026-M**
La Anisi	**Katintin**	**K-027-M**
La Moa	**Katintin**	**K-028-M**
La Funa	**Katintin**	**K-029-M**
Aliodi	**Katintin**	**K-030-M**
La Ande	**Katintin**	**K-031-M**
La Kodu	**Katintin**	**K-032-M**

La Riao	**Katintin**	**K-033-M**
La Nahima	**Katintin**	**K-034-M**
La Rahman	**Katintin**	**K-035-M**
La Suhardin. U	**Katintin**	**K-036-M**
La Maami	**Katintin**	**K-037-M**
La Ida. K	**Katintin**	**K-038-M**
La Suhardin. A	**Katintin**	**K-039-M**
La Basnia	**Katintin**	**K-040-M**
La Bae	**Katintin**	**K-041-M**
La Dee	**Katintin**	**K-042-M**
Wa Jija	**Katintin**	**K-043-M**
La Jamuadi	**Katintin**	**K-044-M**
La Tatu	**Katintin**	**K-045-M**
La Jahida	**Katintin**	**K-046-M**
La Fazir	**Katintin**	**K-047-M**
La Amuru	**Katintin**	**K-048-M**
La Musrifin	**Katintin**	**K-049-M**
La Dudu	**Katintin**	**K-050-M**
La Too	**Katintin**	**K-051-M**
La Jarami	**Katintin**	**K-052-M**
Hadara – Bahmidin	**Katintin**	**K-053-M**
La Bombae	**Katintin**	**K-054-M**
La Dalefa	**Katintin**	**K-055-M**
La Bisi	**Katintin**	**K-056-M**
La Maggo	**Katintin**	**K-057-M**
La Doi	**Katintin**	**K-058-M**
La Tembo	**Katintin**	**K-059-M**
La Trisno	**Katintin**	**K-060-M**
La Adinanto	**Katintin**	**K-061-M**
La Sukarman	**Katintin**	**K-062-M**
La Manari	**Katintin**	**K-063-M**
La Arifudin	**Katintin**	**K-064-M**
La Jafara	**Katintin**	**K-065-M**

Darawa

Owner	**Boat Type**	**Registration**
La Gode	**Katintin**	**K-066-M**
La Samiudin	**Katintin**	**K-067-M**
La Ida. K	**Katintin**	**K-068-M**
La Hajima	**Katintin**	**K-069-M**
La Naafa	**Katintin**	**K-070-M**
La Ane. P - La Hida	**Katintin**	**K-071-M**
La Jaya	**Bodi TS**	**K-072-M**
La Kane	**Katintin**	**K-073-M**
La Dabaea	**Katintin**	**K-074-M**
La Fazir	**Katintin**	**K-075-M**

Appendix IX: **Population and marine resource users of Kaledupa 2003**

Population of Kaledupa and number of households from local government census (June 2003) and total numbers of marine resource users, in each administrative village around Kaledupa from a rapid census by Opwall in 2003. Bajo villages are in italics. * Number of fishers who performed fishing regularly, **number of fishers who said that fishing was important as a source of income or food, number of seaweed growers who did not perform fishing***.

Administrative Area (sub-village)	Pop.	House holds	Fishers*	Fishing only**	Fish fence owners	Bubu traps owners	Seaweed growers	Seaweed growers ***	Marine resource users
Ambeua (Furake)	20	5	5	0	0	3	14	9	14
Ambeua (village)	1104	292	50	46	0	11	4	0	50
Balasuna	1246	323	61	56	0	0	47	42	103
Buranga	1359	320	23	16	1	3	68	61	84
Darawa	500	176	98	0	1	49	98	0	98
Horuo (*Mantigola*)	1120	310	140	138	0	0	12	10	150
Horuo (Umala)	298	83	21	21	0	8	0	0	21
Kaswari (Peropa & Taou)	957	247	53	52	30	7	1	0	53
Lagiwae	934	258	14	13	0	5	14	13	27
Langge	1016	236	65	20	11	12	150	105	170
Laulua	910	257	16	16	11	2	0	0	16
Lentea	615	285	7	0	0	2	91	84	91
Ollo	1332	321	18	15	0	6	43	40	58
Pajam	763	214	6	0	2	4	0	0	6
Sama Bahari	1102	251	185	132	0	1	64	14	199
Sandi	1144	279	36	21	7	8	70	55	91
Sombano	595	145	22	6	2	9	133	117	139
Tampara (Latiha)	208	47	4	4	3	1	0	0	4
Tampara (villages inland)	623	94	7	0	1	2	4	0	7
Tanomeha (*Lahoa*)	58	34	18	10	0	2	19	11	29
Tanomeha (village)	773	422	34	19	9	6	150	135	169
Total	16677	4599	883	585	78	141	982	696	1579
Percentage of Pop.	NA	NA	5.29%	3.51%	0.47%	0.85%	5.89%	4.17%	9.47%

Appendix X: Material for focus group discussions

X.I Octopus fishers

Octopus provides a major source of income for communities around Kaledupa. In Sampela, the fishery is worth an estimated Rp 52 million per month and provides the main source of income for many households.

Recent increase in the price of octopus, availability of ice and an improvement in the trade route has led to an expansion of the fishery with more middlemen and more fishermen. An increased number of local octopus fishers is putting pressure on the limited number of fishing grounds like Langirra and Bungen Solo, which can only produce a limited number of octopus. In addition, there has been an increase in external fishermen from Kendari, Sinjai and Bau Bau coming to the waters around Kaledupa to fish for octopus.

Evidence for stock decline

Interviews with middlemen and fishermen from Darawa Lentea, Sama Bahari and Sombano said that

1) The number of octopus caught has decreased from previous years due to an increase in number of fishermen and destruction of coral habitat which octopus need to live in.
2) The size of octopus is decreasing
3) Fishermen have to spend more time on the reef to catch the same number of octopus.

Octopus Biology

Female octopus can spawn only once in their lifetime after which they die. Spawning occurs throughout the year, with 2 peaks periods one in Sept and the other unknown. Females must reach an age of 10-13 months old or approximately 1kg before they are mature and can lay eggs. When females are ready to lay eggs, they barricade themselves into their den and mix stored sperm with their eggs. They attach the eggs to the roof of their den with what looks like strings of eggs. On average the female lays 240,000 eggs on strings 4-10cm long with on average 600-1200 eggs per string. The female spends the next 30 days or so cleaning, aerating and preventing predation of the eggs until they hatch. From spawning onwards the female doesn't eat and uses all her energy to care for the eggs. When the eggs hatch the female dies a few days later. So to ensure that young octopus are produced for future years, it is essential that the females can survive long enough to lay eggs and protect them until they hatch

Males become sexually mature at an early stage - they only need to be 200-300g to mate successfully with females, whereas females need to be at least 1kg before they can produce eggs. Furthermore, males can mate many times with different females. The exact size of maturation for males and females depends on the amount of food available to the octopus.

When eggs hatch the larvae spend 30 days floating in the sea before settling on the seabed. While floating in the sea the larvae are submitted to sea currents which may carry the larvae tens of kilometres before settling. The larvae hatching in reefs further up current during that season can settle in reefs down current. The life span of both male and female octopus from settlement is 12-15 months.

The short life span can be both advantageous and disadvantageous to the availability of octopus to fishers and fisheries management. The quick growth rate, efficient food-growth conversion and large production of eggs is ideal for a marine resource to be exploited. Because females lay many eggs, with a reasonable survival rate, the whole of the stock can be replaced quickly provided enough females avoid capture and are able to protect their eggs until hatching. However, the short life of octopus makes them highly susceptible to intensive fishing because small octopus rapidly grow to a catchable sizes and entire octopus stock can be fished out over periods as short as 1 year suddenly disappearing without the warning. Research indicates females may be more prone to capture during brooding periods because they do not move from their den. This is confirmed by octopus fisheries studies where very high levels of exploitation produce a sudden collapse.

Octopus Fishing Techniques

Metal rod (Pontu)
Pronged stick
2 curved sticks (Hepuria)
Speargun
Lure (Boneka)

A number of fishing techniques used to target the octopuses in different ways. Some are caught while staying inside their burrows (especially with the "Stick" method), others while foraging on the reef (spear and speargun) and the remaining octopuses are caught using a lure (boneka).

When fishermen use techniques that extract octopus from their dens, they are more likely to target females with eggs as when females brood they completely barricade their dens with rubble and coral fragments making the den more obvious to fishers. The use or techniques like spears or pronged sticks is more likely to kill or damage the female so that both she and the eggs die. Furthermore it is impossible to tell the size or condition of the octopus before they are killed. Other more traditional techniques like hepuria extract the octopus live so that undersized or females caring for eggs may be returned without harm.

The lure technique targets octopus that are active on the reef either searching for food or males looking to mate with females. As males become sexually mature at an early age (2-3ons) the lure is more likely to target male octopus and decrease the likelihood of catching females with eggs. The boneka technique also allows the octopus to be viewed before capture, which means that small sizes (that are immature and have a low economic value) could be rejected. However many fishermen believe it is harder to catch octopus with a lure and is physically demanding, especially for older fishermen as it requires leaning over the edge of a canoe for an extended period of time.

X.II Net fishers

Gillnets are very selective of the size of fish they catch, as the fish must be the right size to fit tightly in the holes. If the fish are too small fish they pass through the net holes and if the fish are too big they just bounce off the net. So a gill net will catch fish which are almost all the same size. As the size of the mesh increases, the size of the fish caught also increases! Gill nets catch the most fish if a large mesh size is used when the net hangs tight or a small mesh is used hanging loose.

Because gillnets can target exact sizes of fish, encouraging fishers to use the correct size of mesh for targeting adult fish of specific species will ensure that fish have a chance to spawn before they are caught. This also ensures that fishers get the biggest catches (and money) possible, as all the small fish they would have caught using a small mesh can now be caught at a larger size using a big mesh making the whole catch weigh more.

Problems in Sama Bahari

- Increasing the size of mesh for Ngarua and Ngampa will protect Sumpa pote, Kutamba, and Mantirus.
- Increasing the size of mesh used for Ngalabu by a little will protect Bansa as they are caught at 10cm and must be at least 14cm to reproduce

Ngarua (Tonabu di Rambisi/Gillnet Drive-in, parallel to reef) 2.5”

Species	Bajo	Kaledupa	% Mature	Mean Size	Size Mature
Caranx melampygus	Simba	Langoang	0	20.0	38.3
Cheilio inermis	Fee-fee	Palugandah	0	15.3	21.7
Lethrinus atkinsoni	Kadafo pudu	Sumpa pote	0	17.0	20.8
Lethrinus harak	KADAFO TANDA/SALAFAU	Kutamba	0	19.0	21.7
Lethrinus obsoletus	Kadafo Mohute	Mantirus	0	23.0	25.5
Lethrinus olivaceus	Saso	Lausu	0	20.0	32.1
Scarus rubroviolaceus (IP: female)	Lehe	Borra	0	23.0	29.2
Valamugil buchanani	FONTI	Bonte silah	0	22.7	40.0

Ngalabu (Banto /Gillnet Drive-in encircling) 1-1.5”

Cheilio inermis	Fee-fee	Palugandah	0.00	20.0	21.7
Gerres oyena	Ommuu	Bansa	0.00	10.0	13.8
Sphyraena barracuda	Alu	Pangaluang	0.00	36.5	65.4

Ngampa (Nabu/Tonabu/Gillnet set parallel to reef)

Lethrinus harak	KADAFO TANDA or SALAFAU	Kutamba	0.00	19.0	21.7

Lethrinus obsoletus	Kadafo Mohute	Mantirus	0.33	22.0	25.5

Ngampa mate (Nilabu/Labu/Gillnet set perpendicular to reef)

Cephalopholis argus	Okke dalika	Kiapu loong	0.00	20.0	23.6
Epinephelus tukula	Okke	Kiapu buntar tikolo (a)	0.00	54.0	73.8

Problems in Darawa

Banto (Gillnet Drive-in encircling/Ngalabu) 1.5”

	Bajo	Kaledupa	% Mature	Mean Size	Size Mature
Caranx sexfasciatus	Simba	Anggatang	0.00	22.5	47.0
Cheilinus chlorurus	Tai pere or Tai repe	Lampa batu	0.00	12.8	19.8
Halichoeres trimaculatus (TP: male)	Tanggili Tanda Iku	Pello tanda loong (male)	0.00	15.0	20.0
Lethrinus lentjan	Kadafo betomba	Dara papa alo	0.00	16.3	26.1
Lethrinus obsoletus	Kadafo Mohute	Mantirus	0.00	14.8	25.5
Parupeneus barberinus	Tio bata	Timbungan tubba (a)	0.00	16.1	25.5
Scarus ghobban (IP: female)	Lehe fangu	Bataan	0.00	15.0	36.4
Sphyraena jello	Ndoma	Papalo silah	0.00	33.8	55.4

Problems in Lentea

Banto (Gillnet Drive-in encircling/Ngalabu) 2.5”

Carangoides chrysophrys	Simba Simba	Dayah nyubba tudah toba	0.00	19.8	25.5
Carangoides malabaricus	Koa – Koa	Tudah tobah (b)	0.00	19.0	25.5
Lethrinus amboinensis	Kadafo Komoa	Popontu lausa (c)	0.00	20.0	29.2
Lethrinus harak	KADAFO TANDA or SALAFAU	Kutamba	0.00	18.0	21.7
Rhizoprionodon acutus	Kenta kodipo	Kareo libbo	0.00	42.0	65.6
Synodus variegatus	Kenta bisara (a)	Jarah gigi (a)	0.00	12.0	17.8

Nabu/Tonabu (Gillnet set parallel to reef/Ngampa)

Species	Bajo	Kaledupa	% Mature	Mean Size	Size Mature
Lethrinus amboinensis	Kadafo Komoa	Popontu lausa (c)	0.00	18.1	29.2

Valamugil buchanani	FONTI	Bonte silah	0.00	27.7	40.0
Siganus canaliculatus	Kola biru	Belowis samo (b)	0.33	13.2	14.8

Labu/Nilabu (Gillnet set perpendicular to reef / Ngampa mate)

Siganus fuscescens	Kola mohute	Belowis samo (a)	0.17	14.3	17.8

Problems in Sombano

Banto (Gillnet Drive-in encircling / Ngalabu) 2.5”

Carangoides malabaricus	Koa - Koa	Tudah tobah (b)	0.00	15.4	25.5
Caranx ignobilis	Simba moo	Meah pote	0.00	16.1	71.2
Kyphosus bigibbus	Ilo mohute (a)	Ila (batu)	0.00	19.0	31.0
Kyphosus vaigiensis	Ilo mohute (b)	Ila batu (ekor biasa)	0.00	19.8	29.2
Lethrinus obsoletus	Kadafo Mohute	Mantirus	0.00	18.0	25.5
Naso annulatus	Onga Onga	Kumai kubah	0.00	20.2	40.0
Odonus niger	Pogo olo ijo	Pogo nyuloh	0.00	20.0	21.7
Paraplotosus albilabris	Oitu	Sambelah	0.00	26.3	51.8
Sphyraena barracuda	Alu	Pangaluang	0.00	38.7	65.4
Valamugil buchanani	FONTI	Bonte silah	0.00	25.0	40.0
Lethrinus harak	KADAFO TANDA or SALAFAU	Kutamba	0.12	18.2	21.7

Labu/Nilabu (Gillnet set perpendicular to reef/Ngampa mate)

Lethrinus harak	KADAFO TANDA or SALAFAU	Kutamba	0.00	16.5	21.7
Lethrinus obsoletus	Kadafo Mohute	Mantirus	0.00	17.2	25.5
Mugil cephalus	Fonti	Bonte libbo (a)	0.00	24.0	40.7
Valamugil buchanani	FONTI	Bonte silah	0.00	20.8	40.0

General Questions for Fishers

1. Fishers have had to increase net length to increase their catch. If everyone keeps increasing the length there will be no fish left to catch: should fishers agree on a net length that should not be exceeded?

2. Do fishers believe the smaller the mesh size the more fish they will catch?

3. Fishers blame a reduction in net fishing catch over the last 30 years on bomb and cyanide use and now fishers also blame the use of more nets and more

seros. What are fishers going to do to stop this problem becoming worse if each year there are more nets and longer nets and more seros?

4. Some fishers say that fish like Kola have not decreased but now they have to travel further away or fish in deeper waters: how far away and how deep do fishers have to fish before they think there is a problem?

5. Fishers say there are not enough good fishing areas now. Why are there less good fishing areas now? (agar and sero?)

6. If fishers feel that something is unfair how are they going to organise themselves to express their feelings? Do fishers feel there are serious problems? What about next year?

X.III Bubu Fishers

Problem 1: **Bubu size selectivity**

Sombano: Polo Biasa

47% of all fish caught in **Sombano** using **Polo biasa** are mature and the following fish are most threatened by bubus:

Species	Kaledupa	% Mature	Mean Size	Size Mature
Aluterus scriptus	Sogo Pei	0.00	15.7	43.5
Cheilinus trilobatus	Tai pere or Tai repe	0.00	14.3	19.8
Chlorurus sordidus (IP: female)	Fangu ijo	0.00	14.4	17.8
Epinephelus caeruleeopunctatus	Okke tulareke	0.00	24.5	31.4
Epinephelus maculatus	Okke tembaga	0.00	11.5	25.6
Halichoeres trimaculatus (TP: male)	Tanggili Tanda Iku	0.00	15.0	20
Lethrinus harak	Kadafo Tanda or Salafau	0.00	16.0	21.7
Lethrinus nebulosus	Kikiaa	0.00	16.0	27.9
Lethrinus obsoletus	Kadafo Mohute	0.00	16.7	25.5
Lethrinus rubrioperculatus	Kadafo one	0.00	16.4	21.7
Naso thynnoides	Tui-tui iba	0.00	12.0	17.8
Paraplotosus albilabris	Oitu	0.00	29.5	51.8
Parupeneus barberinus	Tio bata	0.00	15.6	25.5
Scarus frenatus (IP: female)	Lehe kakanda karenga	0.00	15.8	20.5
Scarus ghobban (IP: female)	Lehe fangu	0.00	20.3	36.4
Scarus ghobban (TP: male)	Fangu tambaga	0.00	20.6	62

Lentea: Polo Biasa

45% of all fish caught in **Lentea** using **Polo Biasa** are mature but only 2 catches were sampled so look at estimates for Somabno and Darawa. The following fish are most threatened by bubus in Lentea:

Species	Kaledupa	% Mature	Mean Size	Size Mature
Lethrinus amboinensis	Kadafo Komoa	0.0	19.6	29.2
Choerodon anchorago	Torokai	0.0	17.0	20.0
Diodon liturosus	BORUTU	0.0	20.0	29.2

Darawa: Polo biasa

55% of all fish caught in **Darawa** using **Polo biasa** are mature and the following fish are most threatened:

Species	Kaledupa	% Mature	Mean Size	Size Mature
Carangoides othogrammus	Simba Simba	0.00	20.0	29.5
Cheilinus chlorurus	Tai pere/Tai repe	0.00	15.5	19.8
Cheilinus trilobatus	Tai pere/Tai repe	0.00	18.5	19.8
Epinephelus caeruleeopunctatus	Okke tulareke	0.00	18.0	31.4
Epinephelus maculatus	Okke tembaga	0.00	19.0	25.6
Halichoeres trimaculatus (TP: male)	Tanggili Tanda Iku	0.00	16.0	20.0
Lethrinus lentjan	Kadafo betomba	0.00	12.4	26.1
Lethrinus obsoletus	Kadafo Mohute	0.00	15.9	25.5
Lethrinus olivaceus	Saso	0.00	21.0	32.1
Naso tuberosus	Dakke	0.00	13.5	25.5
Plectorhinchus chaetodontoides	Fifira buri	0.00	12.0	29.9
Scarus ghobban (IP: female)	Lehe fangu	0.00	19.0	29.9
Scarus ghobban (TP: male)	Fangu tambaga	0.00	17.8	36.4
Siganus fuscescens	Kola mohute	0.00	14.0	62.0
Parupeneus barberinus	Tio bata	0.01	16.9	17.8
Cheilio inermis	Fee-fee	0.33	16.2	25.5

Darawa: Polo Karinda

36% of all fish caught in **Darawa** using **Polo Karinda** are mature and the following fish are most threatened:

Species	Kaledupa	% Mature	Mean Size	Size Mature
Aluterus scriptus	Sogo Pei	0.00	19.0	43.5
Cheilinus chlorurus	Tai pere or Tai repe	0.00	12.5	19.8
Lethrinus lentjan	Kadafo betomba	0.00	21.5	26.1
Lethrinus nebulosus	Kikiaa	0.00	15.0	27.9
Lethrinus obsoletus	Kadafo Mohute	0.00	14.0	25.5
Parupeneus barberinus	Tio bata	0.00	16.9	25.5
Scarus ghobban (IP: female)	Lehe fangu	0.00	16.1	36.4
Scarus ghobban (TP: male)	Fangu tambaga	0.00	21.2	62.0

Most threatened are **Parrot fish** and **Goat fish**

Size selectivity of sexually immature individuals is occurring and that the majority of species caught were a fraction of their maximum size and were sexually immature. Removal of large numbers of immature fish could result in population decline through a direct reduction because there are not enough adults to reproduce. Siganidae, Scaridae, Mullidae, Lethrinidae, Lutjanidae, Labridae and Acanthuridae were the most species families, comprising over 65% of the total number of species (98). Parrotfish, goatfish and wrasse were the most abundant fish families in the overall catch and in separate catches from different habitats.
Tio = Mullidae
Kola and Borona = Siganidae
Fangu and Lehe = Scaridae
Kadavo = Lethrinidae

This also has ecological ramifications, whereby the population reduction of herbivores such as parrotfish, surgeonfish and damselfish could result in alteration of community structure. Algal proliferation as a consequence of reduced grazing has important effects upon coral survival and alteration of succession of both coral and macroalgal species.

Parrotfish (Lehe)
Parrot fish are herbivores and are caught around coral where they graze algae from dead coral using teeth that are fused into powerful beak. During the feeding process, the parrot fish eats a lot of dead coral and produces grains of sand. One large parrotfish can produce 2 tons of sand per year. So Hoga's nice white beaches are made of parrotfish poo!

When parrot fish grow they first become females which are usually drab, brown or grey and eventually grow in size until they change sex to become males which are mainly largest, brightest (many are green) and most aggressive and least numerous.

Catching all Parrot fish before they reach a large size is a problem as some females must reach a large size before they can sex-change to being males, which could have serious implications for reproduction.

Most parrotfish live in harems with a single dominant male and 2-7 females which they exclusively mate with. Strict size related pecking order that governs social rank within harems. This is why the largest female in a harem will transform into a male after the disappearance of the harem's previous male. Over 2-3 weeks ovaries transform to testes and males become a bright new colour.

Parrot fish spawn into the deep sea just off the reef- a pair (male and female) or a group of females and one male, will rush out from the coral, into the open sea and release eggs and sperm simultaneously. Eggs hatch in about 24hrs but the very small fish remain floating in the sea for several weeks before they settle on a reef.

At dusk, parrotfish find crevices and ledges to sleep in. Many of the species exude a strange cocoon like mucus envelope, which they remain inside during the night. They do this to mask their smell to prevent being eaten by predators such as moray eels.

Wrasse (Tangili)

First fish to go sleep at night and last to wake up in the morning. Small species of wrasse sometimes sleep buried in the sand or wedge themselves into holes or crevices. They are like parrotfish in the way they change sex, spawn pelagically but don't form harems. Male protect and patrol boundaries of home territories of 3-6 feeding herds of females and attempts to exclusively mate with those females. He also chases away other males that try to mate with the females, which happens throughout the day.

Solution

An increase in mesh size could reduce the capture of smaller fish and increase catch per day over both short and long term periods. **But Polo Karinda appears to catch more immature fish so this may not be a problem – this needs to be discussed with fishers**.

Increasing entrance size and trap size will increase catch weight as larger entrance size will catch more fish of a larger size. This may be a better solution than increasing mesh size as in polo karinda – discuss with fishers.

Questions for fishers

Are there many fish they do not eat or sell?
Have they tried different mesh or entrance sizes? Discuss design of traps

Problem 2: **Low Catch values**

Fishers in Lentea and Sombano are catching less fish and fishers have to travel further than fishers from Darawa – this suggests Lentea and Sombano habitat is less productive and/or has a higher density of traps. However, even the catches in Darawa are half of those seen in other places in the world. **Karinda catches more that Polo Biasa but Polo Karinda catches as many undersized fish as Polo Biasa!**

	Kg/trap/day	Rp/trap/day	Av. Traps no.	Av. Catch (kg) all traps/2 day	Time Travel
Darawa	0.5	Rp 1400	5.5	6.2	1:00 hr
Lentea	0.2560	5.0000	5.0	2.05	1:00 hr
Sombano	0.4	Rp 800	6.4	4.5	1:30 hr
Karinda Darawa	0.6	Rp 1900	3.7	4.4	1:20 hr

Lentea Polo fishers depend on fishing for an income. Sombano is more dependent on fish for food than to sell

	eat	sell	gift
Darawa	34	59	7
Lentea	20	80	0
Sombano	48	48	4

CPUE in some areas is low due and is mainly due to bomb fishing.

Solutions
Part of the problem will be the removal of higher catch levels by removing too many immature fish to increase fish around to catch each year. Also catching small fish gives smaller catch weight than letting the small fish get bigger and then catching the big fish.

Species	Nama Kaledupa	% Mature	Mean Size	Size Mature
Carangoides malabaricus	Koa - Koa	0.00	13.0	25.5
Lethrinus nebulosus	Kikiaa	0.00	15.7	27.9
Lethrinus obsoletus	Kadafo Mohute	0.00	18.5	25.5
Paraplotosus albilabris	Oitu	0.00	28.2	51.8
Parupeneus barberinus	Tio bata	0.00	14.4	25.5
Pristipomoides filamentosus	Lompa-lompa	0.00	28.0	34.5
Scarus chameleon (TP: male)	Fangu Ijo	0.00	12.8	20.0
Grammatorcynus bilineatus	Talan-tala	0.10	35.4	40.0
Lethrinus harak	Kadafo Tanda/Salafau	0.24	16.5	21.7

Habitat destruction is most likely to be the main reason for low catches as a damaged habitat will give less fish. Heavy bomb damage is obvious and can only be stopped by involving the Jagawanna. Coral is also damaged by Abalone fishers, poling along the reef crest and by taking live coral to put round bubus. This needs to be discussed.

The low catches could also be due to the number of traps used in an area. This needs to be discussed.   Density-experiments next year

Questions for fishers
Do fishers always put traps in exactly the same place?
How close together are bubus?
Do fishers use of live or dead coral and why? Is there an alternative?

X.IV Fish Fences Fishers

Results from surveys
Problem 1: Selection of immature fish and non-eaten species

61% of catch is mature and species are caught that are not eaten or sold. The following fish are most threatened by seros:

The most commonly caught species of economic importance in interviews were Kola (Siganus canaliculatus), Kadafo (Lethrinus harak) and Usu-usu (Lethrinus rubrioperculatus/ variegatus). Urapi (Hyporhamphus affinis) is the species that is considered by the majority of the fishermen to be the most important during the calm season between mid-August and early November known locally as "Ekano sangia". During this season certain species of garfish are known to migrate past Kaledupa in large shoals in order to spawn nearby (females were often caught with eggs oozing from them). During this time Urapi caught are 240-280mm and are not immature

Experiments in Peropa

The investigation found that altering mesh size reduced the numbers of individuals caught from 4 economically important pelagic shoalers (half beaks and sardines).
It was hoped that by increasing mesh size above 25mm would decrease reduce the number of fish caught that were not eaten or sold and that the number of immature species of Emperor fish (genus Lethrinus) and Rabbit fish (genus Siganus) caught by this technique could be reduced. Statistical analysis of the data showed that increasing the mesh size from 25mm to 50mm had no effect on the size at which these species were caught with the exception of Lethrinus rubrioperculatus and testing a larger size of mesh than 50mm may be needed.

Solution
Most of the fishermen interviewed use a 25mm mesh net in the futu. Where the mesh sizes of the other sections are concerned there is some variation between different fences but most fences use a combination of 31.25cm and 37.5cm mesh. It is also quite common to find 50cm net used for the panaju section as it is generally a long section and larger mesh is less expensive.

A minimum mesh size. Interviews with fishermen indicate that many of them could be persuaded to support this if it was official regulation and showed clear benefits to them personally. Unfortunately many of them also insist that the small shoaling fish are too valuable to forfeit and since the data in this report suggests that even increasing mesh size to 37.5mm results in a noticeable decrease in these species it seems unlikely that many fishermen would be willing to use the larger mesh if they see a decline in their revenue. This could be solved by using different mesh sizes at different times of the year.

Problem 2 Catch in Sombano is low

		Inch	Length	% eaten	% Sold	% Gift	kg/day	RpPUE
Sombano	reefcrest	1.5	80	20	77	3	13.5	25833
Darawa	seagrass	1.5	300	30	57	13	32.9	69167
Lentea	seagrass	1.5	100	47	50	3	4.8	12500

For much of the year, most fishermen estimated that catch weights were approximately 5-20kg of fish every day. The calm season is a prosperous time of year for the fishermen because of the vast numbers of Urapi and most claimed to catch between 20-50kg of fish each day. Some claimed to have caught as much as 100kg in a single day.

Discuss Habitat decline and effects of catching immature fish

Increasing numbers
Numbers of seros has been rapidly increasing over the last few years, in 2002, 2003 and 2004 there were 37, 70 and 100 fish fences respectively. The highest concentration focussed along the South West coast of the region of Kaswari. Almost all other fences around the island were located along the Eastern side of the island stretching from the village of Laulua in the North to the closely neighbouring island

of Lentea to the South but these were more widely spaced than those found in Kaswari. If left unmanaged, the numbers of fishermen using this technique could continue to increase to the point where the fish stocks can no longer support it.

Solutions

One possible measure could be to implement a licensing scheme. Licenses could be provided to anyone currently fishing with the technique and used to prevent new fishermen from erecting fences around Kaledupa without the express permission of the local authorities. Beyond this it may be possible for existing fence fishermen to “buy out” fence licenses from each other to reduce the numbers of traps. In areas such as Kaswari the density of the fences is already recognised to impacting each fences ability to catch fish. Information from interviews has shown that some fishermen understand the benefits that fewer fences would bring to them.

Problems with Trap Design

Some fishermen use two futu sections since having only one may lead to overcrowding and predation within the catch. Also at certain times of the year catches may become so large that overflowing occurs back out of the futu. Both of these problems ultimately lead to a loss of revenue.

Appendix XI: Recommended Fisheries Legislation

Gear and operation modifications

Gillnets 1.5” for coastal pelagics and 3-4” for reef fish, with maximum net length 200m.

Seine nets 3-4” and maximum net length 200m

Fish fences 3-4” mesh, with 1.5” laid inside during *Hyporhamphus affinis* season, minimum distance between fish fences 500m.

Bubu traps modification required however experiments needed to suitable determine trap design.

Licensing of Fishing Gear and Middlemen

Fish fences licenses for all fish fence owners

Tangle nets and Trawls all require licensing

Bubu Traps local village agreements to the number or density of traps placed in each area

Middlemen Trading of marine products on Kaledupa should be limited to licensed individuals from Kaledupa, who would be required to keep sale records and abide by size restrictions of any species.

Technical restrictions

Technical restrictions such as minimum size limits will require coordination between the Fisheries Department and National Park Rangers to monitor and licence traders and perform spot checks of trading vessels entering and leaving the park.

Ban on Lobster fishing around Kaledupa for 5 years.

Initial size limits octopus 500g, with gradual increase to 1kg (minimum size of maturation for females, males 200-300g)

Size limits for sea cucumbers

Closed season for at least 1 grouper aggregation site per island

Size restrictions for capture and trade of live fish with release of undersized fish.

Banned Fishing Techniques

Ban on Crowbars at sea

Compressors

Marine protected areas

MPAs are highly effective in the maintenance of sustainable fisheries around them but only when used in conjunction with fisheries management in non protected areas. The benefits of MPAs need to be explained to communities to ensure maximum compliance and sites discussed with the Kaledupa community.