FAO Fisheries Circular No. 962 FIDI/C962
ISSN 0429-9329

THE USE OF STUDENTS IN SURVEYING SUBSISTENCE FISHERIES - A PACIFIC ISLAND CASE STUDY

Food
and
Agriculture
Organization
of
the
United
Nations

THE USE OF STUDENTS IN SURVEYING SUBSISTENCE FISHERIES - A PACIFIC ISLAND CASE STUDY

by

Gilles Hosch
Marine Resources Information Officer
FAO Sub-Regional Office for the Pacific Islands
Apia; Samoa

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 2000

The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

This work is dedicated to the memory of Gary Schwalger. Gary passed away unexpectedly at much too young an age in Apia early in May 2000. He was a great example to many young people in Samoa by way of his selfless and positive spirit, and for his love of nature and his fellow human beings.

PREPARATION OF THIS DOCUMENT

This is the report of a research project which was carried out by the FAO Subregional Office for the Pacific Islands (SAPA) in Samoa. The report outlines the results obtained from a field study testing the validity of subsistence fisheries data collected by secondary school students. The study was jointly financed by the FAOR fund (field work), the SAPA office (general operating expenses) and the Government of Luxembourg (APO contract - GCPA/INT/005/LUX).

The report comprises study rationale, methodologies used, results obtained and discussion. The appendices contain questionnaires and materials used, a paper by the same author on implications of setting up a student census programme, reference tables on Samoan names of organisms, length-weight conversion factors and other relevant materials used and generated during this study.

The author of the report is Mr Gilles Hosch, Marine Resources Information Officer, FAO Subregional Office for the Pacific Islands in Samoa.

Distribution includes:

FAO
SAPA Members
CROP Agencies

Hosch, G.
The use of students in surveying subsistence fisheries. A Pacific island case study.
FAO Fisheries Circular. No. 962. Rome, FAO. 2000. 104p.

ABSTRACT

This study tests the quality of subsistence fishery data returned by students in a field trial of a student census. 112 fourteen to eighteen year old students from one rural school on Upolu's East Coast, Samoa, participated in the study. The students were all drawn from the second and third but last classes of the Samoan secondary education system (years 11and 12).

Students were given a logbook containing one questionnaire on household specifics (socio-economic data), and seven daily log sheets, into which household seafood consumption, and fishing trip and catch specifics were recorded. Students recorded information for one week in the last full calendar week of August 1999. A household survey and a creel census were carried out in parallel, to serve as validating surveys, against which the data collected by the students were compared.

It was found that there was weak overlap between socio-economic data collected by the students and data collected by the validating surveys, with students reporting generally inflated values across the range of items sampled. It appears that this was not due to poor performance of students recording the information, but is likely to be due to the fact that the selected age group in this study does not embody a representative cross-section of the rural community (specifically in terms of household economics). Only 29 % of the logbook sections recording daily fishing activity (catch and trip information) were answered satisfactorily. This was in part attributed to the complexity of the daily log sheets and the length of the exercise. The pool of logbooks which had been completed satisfactorily however, yielded good results which closely matched indicators rendered by the validating surveys.

From the analysis of observed results it emerges that a carefully designed student census can generate a wealth of low-cost and appropriate data concerning exploitation dynamics of subsistence fisheries, while raising elemental awareness for the resources within the younger generation.

CONTENTS

Page

Figures & Tables ix

Glossary xi

1. Introduction 1

2. The Student Census 2

3. Study Objective 4

4. Study Design 5

4.1. General Layout 5

4.2. Study Area 6

4.3. The Participating School 7

4.4. Teaching Materials Provided 7

4.5. The Questionnaires 8

4.6. The Field Work 9

4.7. Data Handling, Data Quality Markers and Scopa of Analysis 10

5. Results 12

5.1. Validating Data 12

5.2. Student Pool, Logbook Returns & Performance 13

5.3. Detected Problem Areas 15

5.4. Socio-Economic Data 16

5.5. Capture Data 19

Fishing Effort 19
Fishing Grounds 20
Fishing Methods 21
Catch 22
Catch per Unit Effort 27
Perspective from the Back of the Envelope 30

5.6. Data Quality Filters 30

6. Discussion 33

7. Conclusions 36

8. Acknowledgements 38

Page

Appendix **39**

Annex 1. Historical Summary of Subsistence Fishery Surveys in Samoa **40**

Annex 2. Paper: The Involvement of Students in the Collection of Artisanal Fishery Data - a New Way Forward **41**

Annex 3. Teaching Aids **49**

Annex 4. Student Exercise Book **64**

Annex 5. Household Survey Questionnaire **73**

Annex 6. Creel Census Questionnaire **75**

Annex 7. Student Census Logbook **77**

Annex 8. Species List: Samoan Names **87**

Annex 9. Family/Order List: Length-Weight Conversion Factors **90**

Annex 10. Student Census Database Input Forms **92**

Annex 11. Web Resources on Operating Student Census Schemes **95**

Annex 12. A Teacher's Assessment on the Benefits of Involving Students **97**

Annex 13. The Torres Strait Islands Data Collection Scheme **98**

Annex 14. References & Bibliography **100**

FIGURES AND TABLES

		Page
Figure 1	Map: Location within the Pacific	**6**
Figure 2a	Age distribution overall and into schooling year	**14**
Figure 2b	Number of valid logbooks per class and mean score achieved in valid logbooks	**14**
Figure 3	Cumulative histogram of student scores	**14**
Figure 4	Return of SC answers to a particular question over the week	**14**
Figure 5	Percentage of households owning at least one of the reported gear items	**18**
Figure 6	Break up of all reported gear items from the Household Survey (in %)	**19**
Figure 7	Break up of all reported gear items from the Student Census (in %)	**19**
Figure 8	Distribution of most reported organisms from the Creel Census catch (in %)	**23**
Figure 9	Distribution of most reported organisms from the Student Census catch (in %)	**23**
Figure 10	Progress of biodiversity in the catch (based on first 65 recorded catches)	**23**
Figure 11	Mean length distribution for Acanthuridae	**25**
Figure 12	Mean length distribution for Scaridae	**25**
Figure 13	Mean length distribution for Lethrinidae	**25**
Figure 14	Mean length distribution for Holocentridae	**25**
Figure 15	Mean length distribution for Siganidae	**26**
Figure 16	Mean length distribution for Labridae	**26**
Figure 17	Mean length distribution for Serranidae	**26**
Figure 18	CC one-person catch rates (day/twilight-spear-lagoon)	**28**
Figure 19	SC one-person catch rates (day/twilight-spear-lagoon)	**28**
Figure 20	Distribution for Serranid length in different data sets	**32**

Table 1	Binary data quality markers attached to grouped and single entries within the Student Census database	**12**
Table 2	Household interviews conducted per village, percent village representation in survey pool, and household numbers per village according to the 1997 Household Income and Expenditure Survey	**13**
Table 3	Logbook returns per village and percent representation in the data pool	**13**
Table 4	Student performance in recording data into both parts of the logbook	**15**
Table 5	General household statistics	**16**
Table 6	Catch fate and fishing purpose statistics	**16**
Table 7a	Canned seafood and bought/received fresh/frozen purchase statistics	**17**
Table 7b	Canned seafood consumption statistics	**17**
Table 8	Fresh seafood consumption statistics	**17**
Table 9	Fishing gear inventory	**18**

Page

Table 10a	Effort indicators for the fishing community of Aleipata. Reported figures refer to fishing households only	**20**
Table 10b	Trip duration	**20**
Table 11a	Fishing effort spent in traditional village waters	**21**
Table 11b	Break-up of effort into ecosystemic fishing areas	**21**
Table 12	Fishing methods used in the Aleipata community	**22**
Table 13	Species diversity and composition in the catch	**24**
Table 14	Weight comparison for a hypothetical catch of 700 fish distributed into the 7 most commonly occurring fish families, based on Creel Census and Student Census size distribution data	**29**
Table 15	CPUE figures for one-man underwater spearing by day/twilight in the lagoon per hour and per standardised trip	**28**
Table 16	Comparing total catch between surveys	**30**
Table 17	Score, age and distribution into years 11 & 12 for students whose logbooks respond to stringent filtering criteria	**31**
Table 18	Summary of indicator quality and reasons for observed discrepancies	**35**

GLOSSARY

av	arithmetic average (or mean)
CC	Creel Census: fisher person's interviews conducted as part of this project
entry	actual information (data point), recorded into a field
field	address in a database, under which a specific element of information can be stored and saved
fpq	frontpage questionnaire (*see* "logbook")
HhS	Household Survey: household interviews conducted as part of this project
hh	household
hhs	households
hr	hour
logbook	denotes the A4 size booklet students were given to record fishery related activities of their household into. The logbook is sub-divided into a so called "frontpage questionnaire" which primarily recorded socio-economic data, and seven daily log sheets into which seafood consumption, fishing trip and catch details were recorded. (*see* Annex 7)
n	valid logbooks; sample size
n_2	sample size within valid logbooks, if different from number of valid logbooks
query	filtering routine applied to data in a database, isolating and grouping data which combine along, and correspond to user-defined criteria
record	string of entries in a database, which share one or more common identifiers (*e.g.* Tony's reported catch for Monday consists of 7 single records, each record stating species name, mean length and number caught, giving rise to 21 single entries. The common identifiers for these 21 entries are Tony's name and the day of Monday. The 21 entries constitute Tony's *catch record* for Monday)
SC	Student Census: student fishery survey conducted as part of this project
s.e.	standard error
wk	week

1. INTRODUCTION

The lagoons and reefs of most tropical island countries are a major source of protein for the coastal rural populations. On Upolu for instance, over three quarters of the villages are engaged in fishing with an average of between 2 and 4 fishing trips per week, and half of the rural households are reliant on reef fisheries as their main source of protein (Zann *et al.*, 1991). For this reason, the continued well being of the coastal living resources is of great importance to these communities.

Under the growing pressures of population growth, coastal developments and improved and sometimes deleterious fishing techniques, these resources have come under threat. Accounts of local species extinctions across the Pacific are testimony to this trend. It is for this reason, that much attention has been drawn to issues of coastal resources management over the past two decades, and in particular to issues of management and sustainability of coastal fisheries resources.

There is a general consensus in the literature that management systems which can effectively mitigate the compromising factors are needed. A tendency to decentralise fisheries management is emerging across the Pacific Islands, by which the power of regulating and managing fisheries resources is devolved to the communities who depend on them. One extension of this process is the need for awareness campaigning and popular education about the resources at stake. In a setting of compromised resources and altered resource dynamics, transfer of knowledge about ecological processes engendered by human interactions with the natural environment becomes a necessity.

The chronic lack of subsistence fisheries data has also been identified as a pressing issue by many authors. Data, and in particular time series of data are an important source of information to detect emerging trends in resource exploitation and resource performance. If available, problems can be detected early on, management decisions can be based on numerical evidence, and the effectiveness of regulations can be gauged against data collected on a regular basis.

In the Pacific Islands in particular, though, subsistence fisheries are often found to compete with commercial fisheries for attention from national authorities. Fisheries Divisions are often under-staffed and otherwise short of resources, and find it difficult to allocate the necessary time and effort to the monitoring of the subsistence fishery sector. One direct consequence is that the grasp on exploitation rates, consumption, and the state of the resources is generally very weak. To illustrate this point, Annex 1 lists the surveying efforts carried out in Samoa to date as an example.

A number of select countries in the Pacific have had subsistence fishery surveys financed by overseas development agencies. These classic-type surveys (based on household interviews and creel census) usually give very detailed accounts of the fishery, but are not repeated on a time scale useful enough to start monitoring trends in resource dynamics. The required expertise and cost these surveys command is typically prohibitive for the countries to carry them out by their own means. Also, and most importantly, the level of complexity of many such surveys lies beyond the grasp of many professionals with basic fisheries training, putting an unfortunate question mark behind the usefulness of the reports.

Considerations of vertical against horizontal sampling for data are of importance too, since both these virtual axes carry a cost tag which is of critical importance when it comes to the feasibility of fishery surveys. The complexity of tropical coastal ecosystems, most notably mangrove, lagoon and coral reef systems, seems to naturally underline the need for complex sampling programs, in order to feed elaborate tropical fishery models. The sophistication of some surveys seems to aim at achieving in-depth scientific snap-shot appraisals of resource status, rather than establishing time series of solid indicators, able to detect problems of much simpler nature in the interaction between the fisher communities and the resources monitored.

While the importance of scientific research into these systems cannot be over-emphasised, it is essential to keep surveying and research clearly separated. Resource scarcity to conduct surveys is and will remain a limiting factor for years to come in most Pacific island countries. It should therefore be borne in mind what the ultimate objectives of surveys are, who is going to make use of the generated reports, and who the beneficiaries will be.

2. THE STUDENT CENSUS

In 1989, one original and integrated approach has been suggested to address the issues of both a lack of subsistence fisheries data and awareness campaigning for the safeguard of the resources. Under the FAO TCP/SAM/8852 fisheries project, the idea was brought forth (and trialed) to work hand in hand with rural schools. A robust module of coastal fisheries and ecology could be integrated into the science curriculum of the most senior classes, and learning would be achieved by reading *and* doing. That is to say that the theoretical aspects would be taught in class, and that practical work would follow suit by involving students in the collection of fisheries related information in their households. The collected information, in its simpler forms, accumulating over time for a given school, would serve as local reference material to found the teaching upon, and make it tangible.

The data collected by the students in logbook form would eventually be returned to the fisheries authority in charge, who could input the data into a database to calculate various indicators for the fishery.

That is the idea of a student census in a nutshell. A small number of attempts to have students collecting fisheries type data as part of surveys can be found in the literature (e.g. King, 1995 [page 259]). The potential to cut survey costs and securing natural resource data by “using” students has been understood many years ago. Yet, earlier surveys using a student census hint at the fact that pooling accurate and qualitatively sound data has proven to be very difficult. Unfortunately, a concomitant of achieving poor data quality has been poor documenting of the attempts, prohibiting an analysis of the reasons which led to failure. Every new attempt would thus have to start from scratch as there are no experiences reported to learn from, and build upon. As a matter of fact, reporting of failure is not yet part of a culture of progress in development work, although it is the key to advancement in complex cross-sectoral fields such as this one.

Experiences in the Pacific Islands, involving students in the collection of natural resource data lie within, and also outside of the fisheries sector. These experiences come notably from the Torres Strait Islands and Vanuatu.

In the Torres Strait Islands, younger school kids are involved in a data collection scheme which records catches of turtles and dugongs, and has kids produce artwork and essays around the theme of marine animals and their protection. The accents of this programme rest both on monitoring of, and raising awareness for the resources (G. Williams; Manager; Aquatic Environment Program; personal communication; *see* Annex 13).

In Vanuatu, students in rural communities were involved in a data collection scheme, looking at wood types and uses made in their households. This programme was operated by the Department of Forestry, and the prime interest lay in the data generated. Unfortunately, there is no written account of the results achieved by this programme, and the programme has ceased to operate (A. Mathias; former Director of Vanuatu Forestry Division, FAO-SAPA Forestry Officer; personal communication).

Probably the best established programme of the kind is the SPaRCE project (Schools for the Pacific Rainfall Climate Experiment), involving nearly 200 schools around the Pacific, stretching from PNG to Hawaii, up to Guam and down to New Zealand. This is a cooperative field project invloving elementary schools, middle schools, colleges and teachers from various Pacific island and atoll nations. Within the project, students have the opportunity to enhance their education by invlovement in a hands-on, scientifically valid research programme, in which science of meteorology is presented in connection with its application to technology and the society. The project allows the participants to set up the equipment and do measurements on water, rainfall, temperature, humdity, pressure, and wind speed and direction. These results are analysed daily by the students/participants and sent by mail or email to the University of Oklahoma in the USA for regional data quality control and assessment as a regional forecast. The data are also used to support climate modelling scenarios of the Pacific Region (Postawko & Morrissey, 1999).

Further experiences from the Pacific Rim include two more well-funded programmes in Australia and the United States. In Australia, the “Waterwatch” programme is collecting nationwide riverine water quality data. Schools who wish to participate in the programme are invited to do so, and the setup is demand based. Schools are supplied with water test kits from State Authorities managing the programme, and the students carry out sampling along strict protocol guidelines which ensure data quality. Data are pooled by the schools and fed back to the programme authorities. The same holds true for the United States, and their “Riverwatch Network” programme. Web resources pointing to these latter two programmes are appended in Annex 11.

In the setting up of a student fisheries census framework, it is important to bear in mind that there are two players. The participating schools and the students on one hand, and the fishery authority on the other hand. Both pursue similar objectives, but have quite different interests vested in the survey work. These interests have got to be clearly perceived, and mutually respected in order to lay the foundations for sustainable cooperation and success between the two partners. The school is primarily interested in teaching the students about the natural resources upon which their community depends, and which it is important to protect. This is achieved in part through creating awareness and understanding at a young age. Schools should also be interested in providing their students with a useful, hands-on learning experience, where students actively monitor their respective household activities related to fishing, understand the value of, and participate in information gathering. In actual fact, the more isolated and resource deficient a rural school will be, the more likely it is that teachers will be eager to expose their students to interesting and committed work, boosting community identity and the self-esteem of the school.

The interest of the fishery authority is primarily focused on securing data, but the goal of raising awareness and fostering understanding of the fishery with the young generation *must* be upkept. Doing so will ensure that the interests of the participating schools will be well looked after, and that communication between the schools and the fishery authority will work smoothly. It is for instance important that the school gets an agreed feedback from each census in form of indicators computed from the raw data, which are useful for teaching purposes. Failing to do so will leave schools frustrated with the impression of merely being “used” as cheap labor, and future cooperation and success is undermined.

The nature of the framework within which schools and fishery authorities implement a student census will vary from place to place. Many factors, such as schooling facilities, age of students, logistics, cultural aspects, type of fishery and resources in general will each bear an impact on which levels of cooperation can be achieved between the two parties, and how successful the work can be. The paper attached in Annex 2 discusses theoretical aspects of this process in more depth.

3. STUDY OBJECTIVE

At the second meeting of South West Pacific Ministers for Agriculture in June 1997, held in Apia, Samoa, *“the representative from Western Samoa elaborated on the difficulty in obtaining fish statistics from the subsistence/artisanal sector. He recommended for consideration the method trialed in his country involving school children to collect fishery data from this sector.”* The trial referred to took place during the joint FAO TCP/SAM/8852 fisheries project. Student derived statistics were used to generate sustainable yields for a number of villages. Yet, overall student data quality was questioned in a later IDSS/AusAID report (Zann, 1996), stating: *“it was found that there was generally a close relationship in estimates of catch and effort between creel census and household surveys, but school diaries were less reliable. The latter were therefore not employed in 1995-96 surveys, and were used only when no other information was available.”* No other information of this past experience involving students could be traced.

The study endeavours to follow up on the above recommendation. It reports on the results obtained during a field trial of a subsistence fisheries student census, carried out to that effect in Samoa in August 1999. The objectives of the study are as follows;

1. to test the quality of student data, by comparing them to validating data collected over the same period of time in the same area, using household and creel interviews;
2. to evaluate student performance and detect possible problem areas which need careful attention when designing a student census;
3. to explore ways of data handling which will maximise the quality of data used to compute indicators from;
4. to catalogue data types into groups of weak and strong correlation, and to try to explain any observed discrepancies.

NOTE: There was no intention to survey the small-scale fishery of the study area *per se*. Although fishery figures were generated for this coastline, the intention was not to cover all capture and socio-economic aspects of the fishery. The aim was to evaluate the quality of a range of data types collected by students.

4. STUDY DESIGN

4.1. General Layout

Aleipata, the coastal district of east Upolu, Samoa, was chosen as the study area. A dozen coastal villages are located in this area. There is one secondary school which is attended by the children of these villages. The school in Aleipata was selected because of the relative geographic isolation of the community, and the relatively homogeneous make-up of its coastline and coastal ecosystems. Both factors concur to make Aleipata an ideally contained and simple study unit.

The school was approached by FAO, and the head of school (a science teacher) was enthusiastic about participating in the study, and implementing the work in her school.

The school was provided with teaching support materials prepared by the project for the teachers, and educational materials for the students. Logbooks prepared by the project were distributed to the students.

Teaching about the fishery, this project and the carrying out of the student data recording were left entirely at the discretion of the school. A “non-invasive” and minimalistic approach was taken in order to guarantee the data gathered were not coming from a process which required costly external training inputs.

Students recorded fishing activity in their households over the course of one entire week (Monday - Sunday) at the end of August 1999. During the same period (Monday - Friday), a team of seven extension officers from the Samoan Fisheries Division sampled validating data by running a household survey and a creel census. The data collected in the validating household and creel surveys were mirrors of the data collected by the students.

All collected data were then input into a database and evaluated.

4.2. Study area

Samoa consists of two dormant volcanic islands, Savai'i and Upolu, and a few smaller adjacent islands, with a total land area of 2,935 square kilometers. Barrier reefs enclosing narrow lagoons encircle much of the coastline except for the north coast of Upolu, the main island, where there is an extensive shelf area which extends up to 22 kilometers offshore. Figure 1 shows a map of Samoa and its location within the Pacific Ocean.

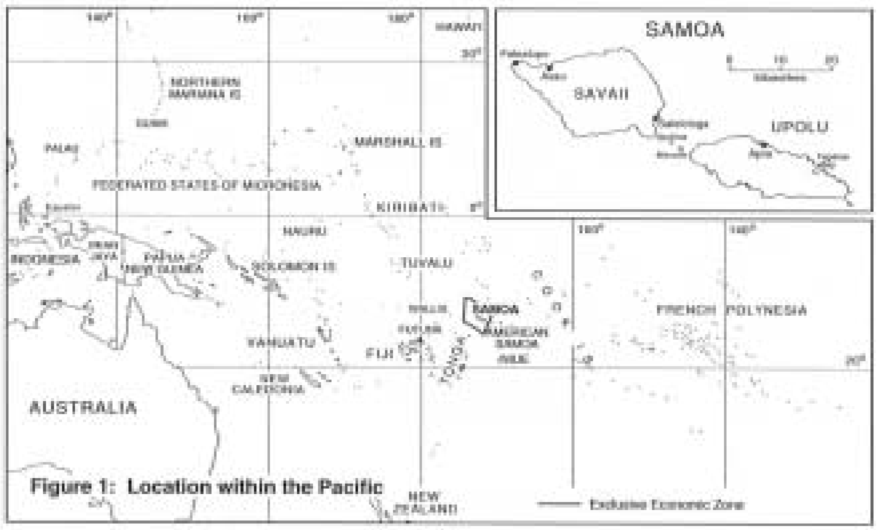


Figure 1: Location within the Pacific

The study area is located on the East Coast of Upolu, and lies within the Aleipata district. There are 12 villages distributed along the coast, from Lalomanu in the south to Tiavea in the north. Aleipata has a narrow coastal plain backed by volcanic slopes. There are 4 volcanic crater islands offshore, Nu'utele, Nu'ulua, Fanuatapu, and Namu'a. The shoreline consists of low lava cliffs around Lalomanu, and coarse sandy beaches to the north. There were no more than 2 ha of mangroves reported by Zann in 1991.

The inner lagoon is mainly of fine sand, dominated by seagrasses, with a mixed coral assemblage around Lalomanu. The outer lagoon and back reef is dominated by a *Porites* community, with patches of coarse sand and rubble. The reef crest consists of a pavement of coralline algae and larger coral blocks and boulders. The reef slope consists of a broad, gently sloping spur and groove terrace, towards a sand/coral bottom at around 25 m. On the slope, coral cover and diversity is low to moderate. The shore length of the Aleipata coast is 10.5 kilometers, whith a total reef area of 980 ha and a reef edge length of 17.2 kilometers (Andrews & Holthus, 1989).

Spread along the coast are 558 households counting an estimated total population of 4509 people (based on 1997 Government figures). This gives rise to 429.4 people per kilometer of coastline.

4.3. The participating school

In Samoa, the schooling system is sub-divided into primary, secondary and tertiary education. Primary school starts at the age of five, and counting for 7 years. At year 8, students enter the first year of secondary education, which is commonly referred to as “form 1”. Secondary education covers 6 years, the last year being year 13, or form 6.

Secondary schools are divided into Junior Secondary Schools and Senior Secondary Schools. Senior secondary schools generally teach year 12 and year 13 students only. Junior secondary schools teach up to year 11, and sometimes up to year 12, depending on the school and the district.

The participating Aleipata Junior Secondary School is located in Mutiatele and draws students from the entire Aleipata district. The school is a typical rural school with somewhat limited resources. In this particular school, students are taught up to year 12 inclusive. There were three year 11 classes and one year 12 class with a combined number of 112 students in Aleipata Junior Secondary School at the time the study was carried out. It was decided to work with these 4 most senior classes. The age bracket of students in these classes was 14 to 18, with most students aged from 15 to 17.

It was agreed that science teachers would introduce the project to their classes, and make use of provided materials to provide students with a briefing on reef ecolgy and subsistence fisheries, appropriate to the level of understanding of the students. Then students would be taught on how to record information from their households, using the logbook.

4.4. Teaching materials provided

A comprehensive set of project-specific materials was provided to the school. This set included teaching aids, educational material and exercise material.

for the teachers

An A4 size booklet was prepared by the project which contained a concise description of the project rationale, an overview summary on reef ecology and human interactions (*see* Annex 3), and the solutions book to the exercises that were part of the materials handed out to the students.

The aim was to make sure that all participating teachers understood exactly what the work was trying to achieve, and to help teachers refresh their knowledge on reef ecology by providing them with information in a compact form.

for the students

There were three items of educational materials provided to support the learning experience of the students. Materials provided were as follows;

- ✓ A booklet called "Understanding Fisheries in the South Pacific" was distributed to every student participating in the project. This booklet was published by the Forum Fisheries Agency in 1991 and targets young Pacific Islanders in higher secondary education. In very simple language, the 42 page publication explains how tropical fisheries work, describing the marine environments, fisheries resources, fishing methods and management options.
- ✓ A video entitled "Who cares about the fish? Community based fisheries management project" released in 1997 by the Samoan Fisheries Division, and supported by AusAID, was provided to the school as audio-visual material to underpin the teaching. The video documents the process initiated in Samoa to devolve lagoon fisheries management to the communities exploiting the resources, describing problems in the fishery and management options available to coastal communities.
- ✓ An exercise book prepared by the project was distributed to every student. It contained exercises specific to data recording into the log book. This was to ensure a good understanding of the expected tasks before the students would take their log books home and start recording the actual information (*see* Annex 4).

4.5. The questionnaires

Three distinct questionnaires form the backbone to this study. The Household Survey questionnaire, the Creel Census questionnaire, and the Student Census questionnaire (also referred to as *logbook*). All three questionnaires are appended in Annexes 5, 6 and 7. Household Survey and Creel Census questionnaires are the validating questionnaires, while the Student Census is the experimental questionnaire.

The questionnaires did not intend to comprehensively cover all the ground covered by a traditional survey. The aim was to record the various types of data gathered in a regular survey, to evaluate student performance in recording them and to detect eventual performance disparities between differing types of data.

The questionnaires were designed for simplicity. Simplicity was prioritised in order to guarantee proper student understanding and to lay the foundations for optimal student performance. Because of quality optimisation of returned data, there is much benefit in thoughtful design for simple, self-explanatory questionnaires.

Household Survey (HhS) Annex 5

The Household Survey gathered information of mainly socio-economic nature. Areas covered by the questionnaire included household information (number of members, income earners, etc.), seafood consumption, fishing gear inventory, fishing methods, fishing grounds targeting and fishing activity. No data on catch were recorded as part of this questionnaire, and recall data were avoided as far as possible.

Creel Census (CC) Annex 6

The Creel Census was laid out to record data on fishing trip and catch specifics, including gear used, waters fished, time fished, and catch. Catch data recorded were

Samoan vernacular species names, numbers caught, and minimum, maximum and mean length per species.

Student Census (SC) Annex 7

The Student Census was sub-divided into two distinct questionnaires; the "frontpage questionnaire" where students recorded socio-economic information about their household, and seven single daily log sheets, into which seafood consumption and trip and catch information was logged.

The A4 size student logbook contained a set of rules at the front, which laid out how the log book was to be used and how the various questions were to be answered. This was to enable students to consult these pages whenever they would feel unsure about answering some of the questions. This section also contained drawings of vertebrate and invertebrate marine life, pointing out the axes along which measurements were to be taken. A ruler was printed onto the back cover of each log book to ensure all students were equipped to take measurements at home. A blank (no day specified) log sheet was inserted at the back of the book, in order to enable a student to re-write a messed up page.

The rules and the "frontpage questionnaire" were written in Samoan language, while the daily log sheets were in English. Samoan language was used to ensure best understanding. The use of English for the daily log sheets arose through the fact that Samoan professionals involved in the translation of the questionnaires observed that the English language was less confusing to interprete the questions asked, than potential translations into the Samoan language. The level of English used in the daily log sheets is basic, and the English taught in year 11 and 12 classes would generally be up to these standards.

4.6. The field work

The principal of the school was approached by FAO in early June 1999 in order to present the project outline, and to enquire about the school's potential interest in getting involved in the study.

The principal was enthusastic about the project, and eager to have her school participating in a pilot study focusing on community invlovement in resource monitoring/management/protection. It is important to point out that no cash compensations or other forms of payments were given, nor promised to the school. There was a clear understanding that the cooperation was on a purely voluntary basis, and that the sole benefits to the school would be the learning opportunity provided.

The dates of the sampling window were agreed upon and all materials as outlined in 4.4. were provided to the school by late July 1999, leaving the school with approximately four weeks to prepare the students. The school decided not to call upon outside help (FAO / Fisheries Division) to lecture to classes about the process.

The project hired the services of seven extension officers from the Fisheries Division for one entire work week. The author and seven extension staff were based out of Mutiatele for the week of 23rd to 27th August 1999. All household interviews and fishermen interviews were conducted in Samoan by the extension staff.

Household interviews were carried out from 9 o'clock in the morning until 5 o'clock in the afternoon, with an hour for lunch around noon. The twelve villages were sampled entirely, and in no particular order or sequence. The team organised the sampling runs on a village to village basis. The aim was to sample as many households as possible in the Aleipata district. An adult person available in a household was approached and politely invited to answer the survey questions. The reason for the interview was invariably stated. The average duration of an interview was about 15 minutes.

Every extension officer had a measuring device and Creel Census questionnaires as part of his/her materials. Creel interviews were carried out at random, on shore, by the roadside, or in a home, whenever the occasion presented itself to interview a returning fisher person. There were also a number of creel interviews carried out at night. These were actively sought occasions, and represent the smaller part of all interviews carried out. A bias was introduced through the way the creel interviews came about. Because the interviews were all landbased, and conducted primarily on the shoreline, more inshore fishing events such as gleaning or rod and line fishing from shore were sampled. These particular types of fishing are hence represented with disproportionately high incidence in the pool of censused fishing events. For this reason, the pool of creel census data does not constitute a representative and random cross section of the general fishing activity in Aleipata.

While the Student Census covers all seven days of the last August week, the Household Survey and the Creel Census only cover the five working days. Cultural implications and work practices made sampling on both Saturday and Sunday impractical.

The extension officers of the Fisheries Division are known to the Aleipata community, as they are working with many of these villages within the framework of the Samoan village fisheries project. The latter is an AusAID funded project implemented by the Fisheries Division. Although extension officers stated the reason for their presence when conducting an interview, there remained a sense of confusion among the community as to why the extension officers were "patrolling" the district, conducting household surveys, and questioning fisher people about their catch and fishing trips. It became clear that many people suspected that the extension officers were checking on the implementation of village fisheries by-laws and adherence to rules. It was felt later that radio and press anouncements about the upcoming work would have contributed to avoid this situation, and guarantee more unbiased returns from these validating surveys.

4.7. Data handling, data quality markers & scope of analysis

The data collected from the three surveys were all fed into a purpose built database, using MS Access 97 software. Records were queried using the database, while basic statistical analysis of selected data and graphic representation was performed using MS Excel 97 software.

No data quality routines were applied to data collected as part of the validating surveys. In general, data collected by the extension staff were of good to excellent quality.

Logbooks and exercise books were returned to the project in early September 1999. Exercise books had not been marked by the teachers. They were marked by the project, and the scores achieved in the exercise books were fed into the Student Census database as additional entries to individual logbooks. In this way, every student was formally linked to a potential performance indicator.

All collected student data were input into the database, and non-sampled binary data quality markers were added for given sets of data collected by each student. These markers were used to define particular sets of data as valid or invalid (*e.g.* the catch record of a given day). This was necessary in order to segregate clearly erroneous data and/or poorly answered questionnaires from well answered questionnaires and realistic data. Erroneous data pertained mostly to deficiently reported fishing trips and catch records, mostly with reported species sizes clearly below the size at which they would start to show up in the catch. For instance, reporting 1 centimetre long groupers induced a data quality marker for the entire catch record of that day, saying "false".

The data quality markers are essential to the Student Census database, since they enable filtering for accurate data within the entire data assemblage. Only filtered data are used for analysis and deduction of indicators. The quality markers and filtering must be clearly distinguished from deceitful data manipulation, as the aim is not to make results fit preconceived ideas. The sole aim is to trim data quality by eliminating evident error at the source. Markers were used in different combinations to filter and extract different types of data from within the database. Student Census database input forms, showing quality marker tick boxes are reproduced in Annex 10 for reference.

In addition to inserting non-sampled data quality markers into the database, a number of sampled data are also potential candidates to use for filtering purposes. These are notably student age, class, and most importantly the score achieved in the student exercise book. The usefulness of such sampled filters will vary between data types for a given database. Applying these filters rests primarily on good observation and common sense. Their usefulness is discussed in more detail in section 5.6.

Table 1 lists the data quality markers attached to the various student census database elements.

Element	Marker	Criterion for “yes” (true)
Grouped entries		
Frontpage questionnaire	satisfactory?	most questions answered
Daily log sheets	satisfactory?	most questions answered and data reasonable
Entire log book	discard?	many questions unanswered and data clearly erroneous
Daily catch record	valid?	data reasonable
Daily trip record	valid?	data correctly recorded and reasonable
Single entries		
Frontpage questionnaire		
Buy/receive fish regularly	answered?	question answered
Daily log sheet		
Fresh fish eaten today	answered?	question answered
Tined seafood eaten today	answered?	question answered
Tin information	answered?	question answered
Fish received or bought	answered?	question answered
How much	answered?	question answered
Fishing today	answered?	question answered

Table 1: List of binary data quality markers attached to grouped and single data entries within the student census database

The scope of the formal analysis of returned data is to evaluate what types of data were recorded sufficiently well to serve for analysis. And for those types of data which were recorded well enough, to look at the ranges the numerical values fall into and how they compare to the ranges recorded in the validating surveys. This work sets out to compare orders of magnitudes and overall fit, rather than performing hardcore multi-factor analysis of variance on batches of data from different sources.

The question that is to be answered is whether students can collect meaningful fisheries data which are representative to a certain degree of what is happening in the field. There is no scope in aspiring to produce statistical equivalents between surveys. Many sources of bias in all three surveys induce enough error as to make statistical overlaps highly unlikely. While the Household Survey and the Creel Census are the validating surveys for the purposes of this study, it is evident that both of them can only provide an approximation to the “true” picture of the fishery, due in part to some of the biases afore mentioned.

5. RESULTS

5.1. Validating data

There were 511 interviews conducted as part of the Household Survey, and 65 fishing trips were recorded as part of the Creel Census. It is estimated that the Household Survey covered some 93% of the households in Aleipata, based on the figures of the Household Income and Expenditure Survey of 1997. The 65 fishing trips recorded over the span of a week represent only a tiny and unknown portion of all the fishing trips taking place over the course of a week in Aleipata.

Table 2 provides an overview of Household Survey returns per village, and percent representation of villages in the pool of collected data.

Village	No. interviews conducted	Percent representation	1997 household numbers
Tiavea	72	14.1	70
Amaile	34	6.7	29
Samusu	78	15.3	91
Utufaalalafa	14	2.7	15
Saleaumua	50	9.8	61
Mutiatele	43	8.4	36
Lotopue	23	4.5	23
Malaela	13	2.5	23
Satitoa	51	10.0	69
Ulutogia	17	3.3	19
Vailoa	37	7.3	36
Lalomanu	78	15.3	86

Table 2: Household interviews conducted per village, percent village representation in survey pool, and household numbers per village according to the 1997 Household Income and Expenditure Survey

5.2. Student pool, logbook returns & performance

112 students were to participate in the study (75 students in three year 11 classes and 37 students in one single year 12 class). Net logbook returns to the project were 49 from year 11 students, and 34 from year 12 students (including exercise books), which is a total of 83 logbooks. This represents an initial return of 74% on the total number of students involved.

The 83 students who returned their logbooks came from 11 of the 12 villages covered by the household survey. The break-up of students into villages is shown in table 3. Included in the table is the number of logbooks which were discarded (*see* section 4.7.) per village, and percent representation of the village in the pool.

Village	Logbooks returned	No. discarded	Valid logbooks	Percent representation
Tiavea	8	1	7	13.3
Amaile	4	-	4	5.3
Samusu	5	1	4	5.3
Utufaalalafa	-	-	-	-
Saleaumua	16	-	16	21.3
Mutiatele	6	1	5	6.7
Lotopue	8	-	8	10.7
Malaela	6	3	3	4.0
Satitoa	11	2	9	12.0
Ulutogia	2	-	2	2.7
Vailoa	4	-	4	5.3
Lalomanu	10	-	10	13.3

Table 3: Logbook returns per village and percent representation in the data pool

Eight logbooks were given a “discard” quality marker, which effectively removed them from the pool, reducing the logbooks available for analysis to 75 in number, and the net return of useable logbooks to 67%. Even though 75 logbooks is a relatively small number to be representative of 12 villages, it is to be noted that there is a relatively close resemblance in percent village representation between household and student surveys (*see* tables 2 & 3). The Student Census coverS an estimated 13.4% of the households in Aleipata.

Figure 2a: Age distrbution overall and into schooling year

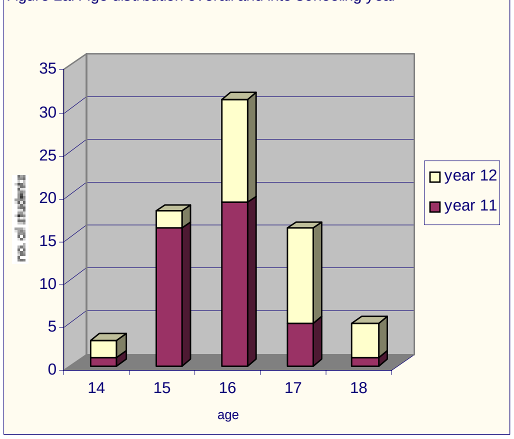


Figure 2b: No. valid logbooks per class & mean score achieved in valid logbooks

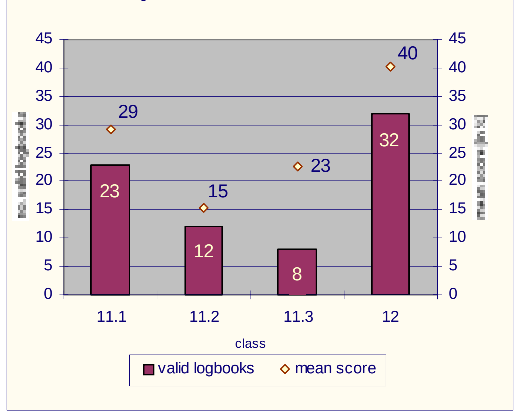


Figure 3: Cumulative histogram of student scores

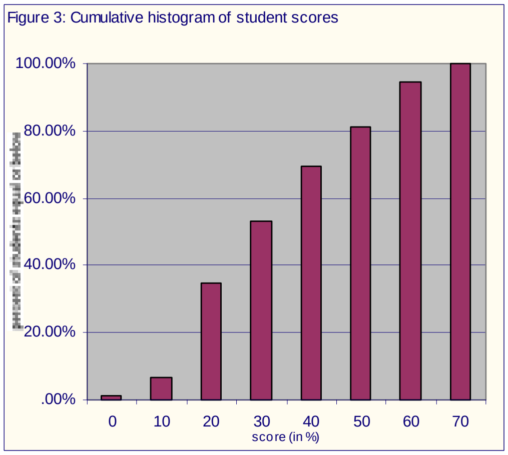
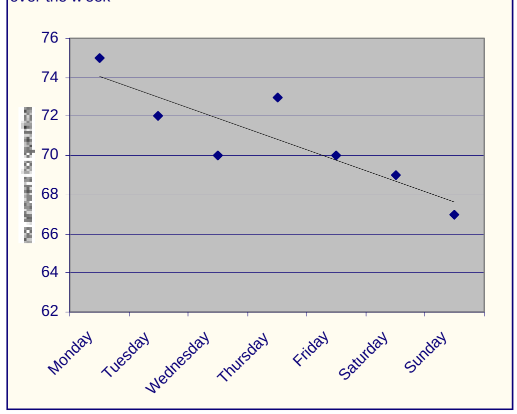


Figure 4: Return of SC answers to a particular question over the week



The students who participated in the study were all between 14 and 18 years of age, with the mode at 16 years old. Figure 2a represents overall age distribution of participating students, as well as age distribution into schooling years. Mean scores for exercise books per class, as well as number of valid logbooks returned per class are represented in figure 2b. It is to be noted that there are remarkable differences in scores between classes, and that the year 12 students achieved the highest mean class score with 40% (almost tripling the lowest mean score of 15% for year 11 class 11.2). The figures suggest that age differences and preparation of the students by the teachers could bear certain impacts on student performance.

Figure 3 represents cumulative student score frequencies. It shows that some 80% of the students scored less than 50% in the exercise book. Most of the allocated marks in the exercise book went towards training exercises imitating logbook entries. This hints at the fact that, although care was taken to produce a simple logbook, the level of complexity of the logbook might still have been too high for the average student to fully understand.

The data quality markers applied to the first and second part of the logbook, namely the frontpage questionnaire and the daily log sheet section, can be used to measure overall student performance, and percentages are shown in table 4. These ratings provide a fair idea as to which part of the census was the most difficult for the students to answer. Computed percentages are based on all returned logbooks, including discarded ones.

	satisfactory	non-satisfactory
Frontpage questionnaire	77%	23%
Daily log sheets	29%	71%

Table 4: Student performance in recording data into both parts of the logbook

Recording of general household information and similar straight forward items of information went well with over three quarters of the students. The reverse situation holds true for the daily task of recording consumption information, fishing activity and catch details, which was achieved satisfactorily by less than one third of the students that returned their logbooks.

5.3. Detected problem areas

Problems were primarily detected with recording of information into the daily log sheets.

Since seafood consumption data were recorded on a daily basis in a rather monotonous form, it appears that quite a number of students fell out of interest with answering these questions, or only granted them scant attention, ever decreasing as the week went on. Figure 4. represents this decreasing trend for the question on whether self-caught fresh seafood was eaten by the household on the day. The same question was generally poorly understood. This does not necessarily come as a surprise, as there might be little difference to a youngster as to whether the fish eaten for dinner was caught by the father or the cousin next door. Contradictions between answers to questions on self-caught seafood consumption, catch record and remarks were many. However, appraisals written by students into the “remarks” section at the bottom of the daily log sheet helped to understand what actually happened on the day. Therefore the “remarks” section in the daily log sheets, which was inserted to help students say things they did not manage to record as part of the provided tick boxes and number fields has proved a very useful element.

It also appeared that students were under the impression that the recording of catch and fishing trip information was the main focus of the census, and that the consumption information was not all that important. Some students only ticked a box when it was to say “yes”, and presumably left fields blank for a “no” or a “zero”.

The layout in which a questionnaire comes always introduces some form of bias. This was clearly the case with both catch and fishing trip tables, the two main tables of the daily log sheets. The catch table asking for name, number and mean length of species caught has 10 lines to record the information into. The 11th line asks for number of other species and their total number, in case the 10 provided lines are not sufficient. Many students with erroneous catch records invariably filled all ten lines, probably thinking that if there were ten lines, then ten would have to be filled out, irrespective of what the catch actually did look like on that day.

The same was found for an important number of trip records, where all three lines would be used up for every day the household fished. Moreover, the trip table proved too complex for many of the students, who failed to correctly understand what information was sought and how it was to be recorded.

The fact that the rules at the front of the logbook explained how these tables were to be used suggests that many students did not consult the rules. This is one more reason to advocate that questionnaires should be self-explanatory, in order to guarantee good returns.

5.4. Socio-economic data

In this section, the socio-economic data (*i.e.* data not directly related to capture) recorded by the Student Census is compared to the data collected by the Household Survey. For every indicator, filters applied to extract the data from the Student Census database are stated. Figures reported are means and standard errors, sample size (n), and the percentage (%) of useable logs or questionnaires for analysis (based on 83 logbooks / 511 HhS questionnaires collected), wherever appropriate and applicable.

Table 5 regroups information on household size, on the number of household members earning a formal cash wage (income earner), on the main household income source, and on whether a household engages in any sort of fishing activity.

	no. household members				**no. income earners per hh**				**main income (% of sample)**			
	av	s.e.	n	%*	av	s.e.	n	%	fishing	farming	both	neither
HhS	8.08	0.17	510	99.8	0.71	0.04	508	99.4	11	37.3	24.3	27.4
SC	9.16	0.51	64	77.1	1.68	0.16	63	75.9	18.3	50	26.7	5
filters	logbook discarded = false; fpq satisfactory = true; blank entries skipped											

Table 5: General household statistics (*percentage of useable logs or questionnaires for analysis [based on 83 logbooks / 511 HhS questionnaires collected])

note: consult glossary for acronyms used in table headings

Table 6 regroups information on catch usage/fate and on the economic purpose of the fishing carried out by households (subsistence/ mixed/ commercial). “Subsistence” denotes fishing where no catch is traded for cash, while “commercial” denotes fishing where no catch is used by the fishing household for food.

	catch fate			**fishing purpose**		
	consumed in hh	given away	sold off	subsistence	mixed (artisanal)	commercial
HhS	66	8.3	25.7	33.2	66.5	0.3
SC	52.1	19.6	28.3	10.9	89.1	0
filters	logbook discarded = false; fpq satisfactory = true; hh fishes = true; blank entries skipped; sum of recorded percentages = 100; n=46 (76.7%)					

Table 6: Catch fate and fishing purpose statistics

Tables 7a and 7b regroup information on seafood purchase and consumption. The daily log sheet question for tin size was weakly phrased and induced mostly unworkable returns. For this reason, canned seafood was taken as 425g mackerel tins. This is reasonable, as this tin represents by far the most commonly bought in the area. 96.6 percent of the tins reported in the Household Survey were of this type. This is due to its competitive value (± USD0.17/100g). A better way to phrase the question could have been to actually have labels of the tins available in Aleipata represented in the questionnaire and ask students to tick these every time a tin of that type was consumed.

For all questions answered with a “yes”, stating that tins had been consumed on the day, only 47.6 percent of the same students reported the number of tins that had been consumed. Therefore, the average consumption in questions answered with “yes” was extrapolated to all positive replies, for every given day of the survey. This entails a very large error, and the Student Census figures for canned seafood consumption given in table 7b are to be considered as nothing more than trend indicative. Consumption per person was inferred using average Student Census household size (*see* table 5).

	hhs buying canned seafood (%)	**hhs buying or receiving fresh/frozen seafood regularly (%)**
HhS	79.8	57.8
SC	80.6	50.8
filters	logbook discarded = false; canned seafood eaten answered = true (for every day of the week); n=36 (43.4%)	logbook discarded = false; fpq satisfactory = true; blank entries skipped; n=63 (75.9%)

Table 7a: Canned seafood and bought/received fresh/frozen purchase statistics

	Consumption/hh/wk (tins)				**Consumption/pers/wk (g)**		
	av	s.e.	n	%	av	n	%
HhS	2.86	0.13	510	99.8	150.32	510	99.8
SC	8.79	n/a	36	42.4	408.06	36	42.4
filters	logbook discarded = false; canned seafood eaten answered = true (for every day of the week)						

Table 7b: Canned seafood consumption statistics

There is close agreement between the Student Census and the Household Survey as to the percentage of households reported to buy and consume canned seafood. The same holds true for the percentage of households which regularly receive or buy fresh or frozen seafood products (table 7a). But, the weekly household consumption of tins (table 7b) computed from the Student Census more than triples the figure obtained from the Household Survey.

Figures on fresh seafood consumption are found in table 8. In the Household Survey, fresh seafood consumption was recalled from the previous day, and it was not specifically referred to as *self-caught* fresh seafood. In the Student Census it was recorded as self-caught fresh seafood for the same day (*i.e.* mismatch in questionnaire designs). Household Survey figures thus contain received and purchased fresh produce, hence figures are not directly comparable. Because of this bias, it should be expected that reported average consumption in the Household Survey is higher. Also, daily Household Survey figures report consumption in one particular area of Aleipata (due to the nature of the sampling programme), while Student Census figures cover all of Aleipata every day. Since the Household Survey ran for 5 days, there are only 4 days to compare data collected from both sources. The average percentage of households consuming fresh seafood was calculated for Monday through Thursday (4 days).

	HhS - fresh seafood consumed (in %)	**SC - self-caught fresh seafood consumed (in %)**
4 day av	60.6	43.3
s.e.	7.86	4.76
filters	logbook discarded = false; question answered = true; 69<n<76 (*see* fig.4)	

Table 8: Fresh seafood consumption statistics

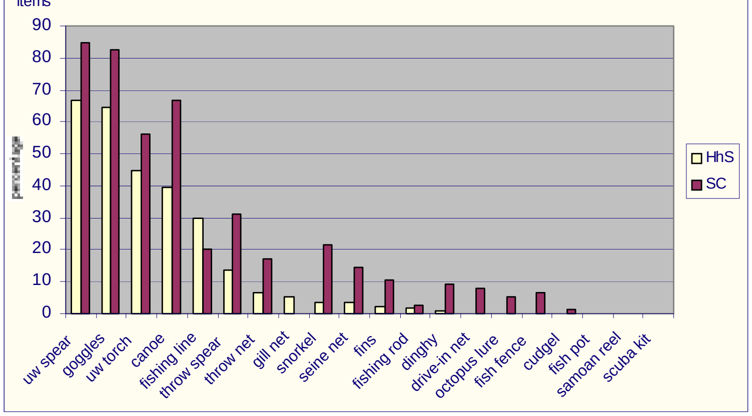
Table 9 groups results of the household fishing gear analysis. All items were pooled, and numbers were expressed both in terms of percent households owning at least one unit of a particular item, and as a percentage share of an item with respect to the whole pool of fishing gear censused.

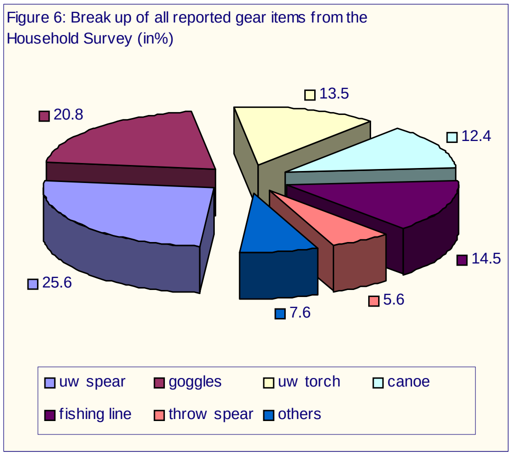
	Household Survey		**Student Census**	
item	% units*	% owning hhs	% units*	% owning hhs
u/w spear	25.59	66.7	19.65	84.7
goggles	20.82	64.4	21.12	82.7
u/w torch	13.53	44.6	12.03	56.0
canoe	12.38	39.7	16.84	66.7
fishing line	14.47	29.9	4.01	20.0
throw spear	5.59	13.5	6.28	31.3
throw net	1.92	6.7	3.48	17.3
gill net	1.53	5.1	-	-
snorkel	1.37	3.7	4.81	21.3
seine net	0.93	3.3	2.94	14.7
fins	0.66	2.3	2.14	10.7
fishing rod	0.66	2.0	0.53	2.7
dinghi	0.33	1.0	1.87	9.3
drive-in net	-	-	1.60	8.0
octopus lure	-	-	1.07	5.3
fish fence	0.05	0.2	1.34	6.7
cudgel	-	-	0.27	1.3
fish pot	0.05	0.2	-	-
samoan reel	0.05	0.2	-	-
scuba kit	0.05	0.2	-	-
filters	logbook discarded = false; n=75 (90.4%)			

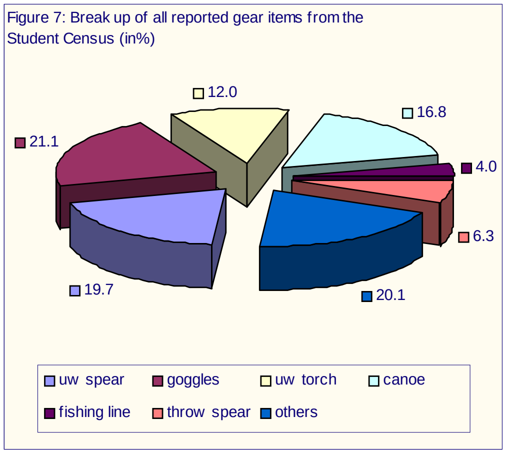
Table 9: Fishing gear inventory (* percentage representation of specific gear type in the entire pool of fishing gear recorded by the survey)

Figures 5, 6 and 7 graph out the numbers listed in table 9. Figure 5 compares the percentage of households owning specific gear items, as recorded by both surveys. The general thrust of these numbers indicates that the student census reports more households owning certain gear items than the household survey, in general between plus 5 to plus 20 percent of the households sampled. The pie charts (fig. 6 & 7) plot the relative gear asset make up of the whole community in percentage of units of fishing gear censused. It is to be noted that once these numbers are expressed in relative terms, both sampling methods achieve relatively close agreement. For ease of consultation, only the 6 most commonly owned items are represented in figures 6 and 7, all other items falling under “others”.

Figure 5: Percentage of households owning at least one of the reported fishing gear items







Note to figures 6 & 7: the first pie in each chart is located at the bottom left hand, then pies follow clockwise. The first legend item sits in the top left corner, then follow across to the right and then down to the bottom left, and across again. (all pie charts in this report are organised this way)

It is to be noted from figures 6 & 7 that the four most common items reported in both surveys are the same (while in slightly differing order), and make up for 72.3 (HhS) and 69.7 (SC) percent of all recorded items respectively. Three of these items represent modern introductions of efficient fishing gears into the fishery. These are the under water spear (or *Hawaiian Sling*), the goggles and the under water torch. There is a general close agreement to be noted in the make-up of all gear reported, with the Student Census reporting a slightly more varied array of gears in the low percentage ranges. A major noteworthy trend discrepancy between the reported fishing gear pools is the higher proportion of fishing lines ownership recorded by the Household Survey.

5.5. Capture data

In this section, student data more directly related to fishing activity will be compared to data collected by both the Household Survey and the Creel Census. For every indicator it will be stated which filters were applied to extract the data from the Student Census database. Figures reported are means and standard errors, ranks, sample size (n), and the percentage (%) of useable logs or questionnaires for analysis (based on 83 logbooks / 511 HhS questionnaires / 72 CC questionnaires collected), wherever appropriate and applicable.

Fishing Effort

Table 10a groups information on fishing effort. Fishing effort can be expressed as number or percentage of fishing households in the community, and the level of fishing activity reported within these households. These figures can later be expressed in terms of numbers of fisher people per unit of coast line or reef area, or as total number of fishing trips per week, *etc.* The Household Survey asked for the number of fisher people in the household and recorded the number of trips each of those fishers would do over a week. The number of trips/household/week was inferred from those previous two for every given interview, from which the average tabulated below was then computed. In the Student Census, fishers/household and trips/household/week were recorded. Here, the number of trips/fisher/week was inferred from the other two obtained averages.

	fishers/hh				**trips/hh/wk**				**trips/fisher/wk**				**households fishing**
	av	s.e.	n	%	av	s.e.	n	%	av	s.e.	n	%	in %
HhS	1.37	0.04	342	100	4.39	0.19	342	100	3.11	0.08	342	100	67.6
SC	1.96	0.19	71	85.5	4.29	0.59	17	20.5	2.19	n/a	n/a	n/a	80.0
filters	logbook discarded = false; blanks skipped				logbook discarded = false; trip info answered & valid = true (for every day of the week)				Inferred from preceding two indicators				logbook discarded = false; n=75 (90.4%)

Table 10a: Effort indicators for the fishing community of Aleipata. Reported figures refer to fishing households only

While students report a higher average of fishers/household, the number of fishing trips/household/week is in close agreement between the two surveys. It is to be noted that only 17 logbooks qualified to establish this indicator, as only those logbooks with fishing trips satisfactorily reported for every single day of the census week could be used to calculate it. This represents only 20.5% of all returned logbooks, and a mere 15.2% of students initially involved in the census. This goes to underline two things; a) the return of valid logbooks can be quite low, and b) duly filtered data still lead to comparable results.

Table 10b summarises the results obtained for the analysis of trip duration, one of the very important indicators in establishing fishing effort. Student Census and Creel Census values are compared.

	trip duration			
	av	s.e.	n_2	%
CC	2.88	0.16	61	93.8
SC	2.77	0.16	73	-
filters	logbook discarded = false; trip info answered & valid = true (for every day of the week); n=17 (20.5%); trip duration question answered = true			

Table 10b: Trip duration

From tables 10a and 10b it is seen that there is very close agreement between the obtained values for number of trips/household/week and trip duration. In combination with the percentage-value for households fishing (table 10a), these indicators form the most important source of information to estimate net fishing effort in the community. Combining these three nominal figures from both sources, SC on one hand and HhS & CC on the other, it is possible to establish a value for hours spent fishing/household/week (encompassing all households). The Student Census returns a value of 9.5 hours, and the HhS - CC survey aggregate gives a value of 8.5 hours.

Fishing Grounds

Information on fishing inside and outside traditional village fishing grounds, and on how much ecosystemic areas (lagoon, reef, outer slope, *etc.*) are fished is grouped into tables 11a and 11b. For both indicators the questions were laid out differently between surveys, and therefore the results come in different forms. Concerning village fishing grounds, the Household Survey counts households fishing exclusively in village waters, and for those who do not, it establishes how much time is spent outside, giving rise to an estimate of total effort spent fishing in village waters. Both figures are reported in table 11a. The Creel Census and Student Census only records trips as having, or not having been spent exclusively in village waters. Therefore, these latter two indicators are less sensitive. It was intentionally kept that way for the sake of simplicity.

	HhS	CC	SC
hhs exclusively fishing village waters (in%)	70.52	-	-
total fishing effort in village waters (in%)	88.17	-	-
trips exclusively fishing village waters (in%)	-	(72.31)	83.82
filters	logbook discarded = false; trip info answered & valid = true (for every day of the week); n=17 (20.5%); village waters question answered = true; no trips valid for analysis within valid logbooks: n_2=68		

Table 11a: Fishing effort spent in traditional village waters

Concerning ecosystemic areas fished, the Household Survey asked interviewees to rank areas primarily fished by the household (ranks 1-3 permitted; all others ranked as 4), allocating a 1 to the most commonly fished area, and so forth. The Creel Survey asked fishers to rank fishing grounds fished during the trip. The analysis of the Student Census counted the number of times an area was reported in the filtered trips, and then established a target percentage value for every given area. This set-up allows for comparison by simply ranking areas in sequence of importance.

	HhS	CC	SC
area	**rank**	**rank**	**% target**
lagoon	1.48	(1.83)	60.27
reef	2.69	(3.46)	20.55
outer slope	3.23	(3.78)	15.07
near shore	3.67	(3.23)	4.11
mangrove	3.97	(3.95)	0
HhS & SC sequence CC sequence	lagoon > reef > outer slope > near shore > mangrove (lagoon > near shore > reef > outer slope > mangrove)		
filters	logbook discarded = false; trip info answered & valid = true (for every day of the week); n=17 (20.5%); area question answered = true; no trips valid for analysis within valid logbooks: n_2=72		

Table 11b: Break-up of effort into ecosystemic fishing areas

Obtained Household Survey and Student Census indicators tabulated in tables 11a and 11b are in close agreement. The effort spent in village waters is reported as between 80 to 90% in both surveys, and the sequence of targeted ecosystemic areas is the same in both. Creel Census figures (in brackets) are to be regarded as trend indicative only, since the Creel Census is not a representative cross section of the fishing activity in the area. The fact that *near shore* features as the second most important area fished in the results obtained from the Creel Census data (versus fourth in line in both HhS and SC) hints at the bias induced by the sampling method of the creel interviews.

Fishing Methods

In the Student Census, the main fishing method used was recorded for each trip. This was mirrored in the Household Survey by asking interviewees to rank the most commonly used fishing techniques in the household. The ranks were applied exactly in the same way as they were for the ecosystemic areas fished (1-3 allowed, all others ranked as 4). As in the previous case, this gives rise to a comparison which has the information ranked in one survey, and expressed in percent representation in the other. In the Creel Census, fishers stated the main fishing method used on their trip. Methods reported in table 12 summarise a range of gears/methods used. For *spearing*, underwater spears, throw spears and undefined spears were pooled. *Line fishing* pools hand lines, trolling lines, fishing rods and bottom lines. *Net fishing* is pooling gill nets, seine nets, throw nets and undefined nets. *Trap fishing* includes fish fences, fish pots and crab/lobster pots.

	HhS	**CC**	**SC**
method	**rank**	**% usage**	**% usage**
spearing	2.53	(73.85)	61.11
line fishing	3.51	(12.31)	20.83
gleaning	3.73	(6.15)	5.56
net fishing	3.79	(3.08)	12.50
trap fishing	3.96	(4.62)	0
CC sequence HhS sequence SC sequence	(spearing > line fishing > gleaning > trap fishing > net fishing) spearing > line fishing > gleaning > net fishing > trap fishing spearing > line fishing > net fishing > gleaning		
filters	logbook discarded = false; trip info answered & valid = true (for every day of the week); n=17 (20.5%); area question answered = true; no trips valid for analysis within 17 logbooks: n_2=72		

Table 12: Fishing methods used in the Aleipata community

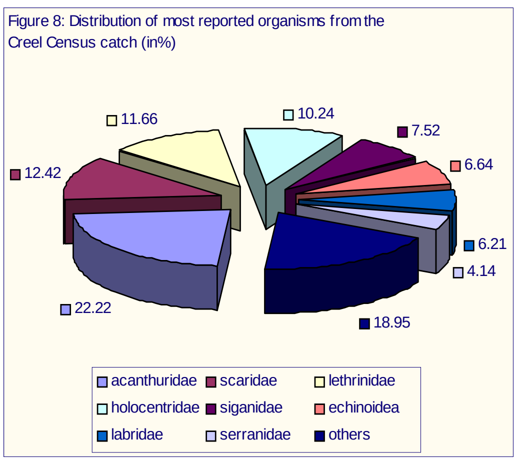
All 3 surveys point to spearing and line fishing as the main fishing techniques used in the community. There is a difference between gleaning and net fishing as third and fourth methods between Household Survey and Student Census, which rank them in opposite order. No trap fishing was reported within the valid student data. The Creel Census data (in brackets) suffer from the bias afore mentioned, and are only to be regarded as trend indicative.

Catch

The analysis of catch data focuses on species distribution and diversity in the catch, and on mean length of reported species. Since there are hundreds of different species caught in tropical reef fisheries, vernacular names and identification of fish in particular, at the species and genus levels pose a real problem. Although the Samoan language has got a name for the most commonly occurring species in the catch, and sometimes even more names for the same species at different stages in its life cycle, it does not have a specific vernacular name for every single species occurring in the fishery. Also, to complicate matters, vernacular names change between villages and districts. The language naturally groups fish into families or orders by giving them names which equally apply to a particular species and their group (*e.g. fuga*: parrotfish), and assigns specific fish within that group more specific names (*e.g. fuga-alova*: blue-barred orange parrotfish).

Students and extension officers from the Ministry of Fisheries alike would have been hard-pressed to know or be able to identify all the different species in the catches they recorded. For this reason, the analysis centred on the family level, even though a part of the recorded information allowed for identification down to the species level.

Figures 8 and 9 represent the distribution of the eight most commonly reported families of organisms in the catch. These eight families are the same between surveys, although differing in their respective share of contribution to the overall catch. 7 families belong to the bony fishes, and one belongs to the invertebrate kingdom, namely the echinoids. Sea urchins are a seasonal item in the Samoan subsistence fishery, and are starting to be fished around that time of the year. In both cases, these 8 families make up for roughly 80% of the catch.



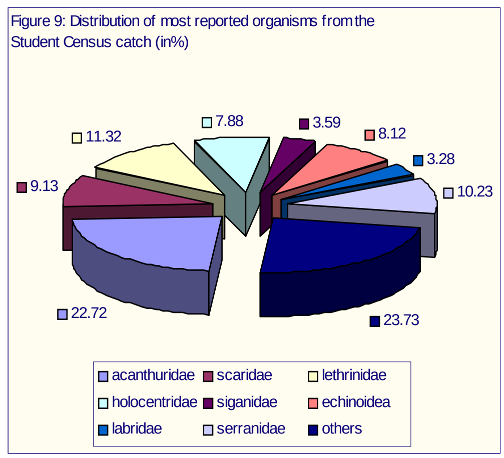


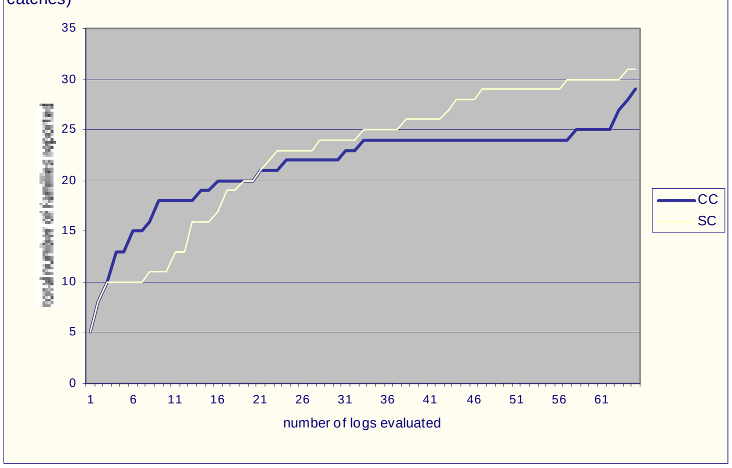
Table 13 details catch diversity by listing all families reported from both Creel Census and Student Census. Care has to be taken in comparing the number of families reported, as the Student Census list originates from a sample of 72 trips, while the Creel Census is based on a total of only 65 trips. Diversity in reported catches increases asymptotically, and the generated figure is dependent on the number of catch records it is based upon.

Figure 10 shows the progression of family diversity in the catch as a function of the 65 catch records in the Creel Census and the first 65 filtered catch records in the Student Census. Again, the Creel Census data suffer from the fact that they originate from a biased sample, and the CC curve is to be regarded as trend indicative only.

	CC	SC
family	**percentage in catch**	**percentage in catch**
acanthuridae	22.22	22.72
scaridae	12.42	9.13
lethrinidae	11.66	11.32
holocentridae	10.24	7.88
siganidae	7.52	3.59
echinoidea	6.64	8.12
labridae	6.21	3.28
serranidae	4.14	10.23
trochidae	3.49	2.26
lutjanidae	3.16	0.47
mullidae	2.40	3.20
chaetodontidae	1.96	2.42
aluteridae	1.53	1.87
muraenidae	1.09	0.39
carangidae	0.98	3.28
octopoda	0.87	1.33
holothuroidea	0.54	2.19
fistulariidae	0.44	0.08
kyphosidae	0.44	0.16
theraponidae	0.44	0.70
diodontidae	0.33	0.31
portunidae	0.33	0.16
priacanthidae	0.11	0.86
tridacnidae	0.11	0.86
pleuronectidae	0.22	-
scombridae	0.22	-
cassidae	0.11	-
lampridae	0.11	-
palinuridae	0.11	-
mugilidae	-	1.48
turbinidae	-	0.62
anaspidea	-	0.23
belonidae	-	0.23
canthigasteridae	-	0.16
gerreidae	-	0.16
hemirhamphidae	-	0.16
total no. families	**29**	**31**

Table 13: Species diversity and composition in the catch

Figure 10: Progression of diversity in the catch (based on first 65 recorded catches)



In the daily catch record, the Student Census asked for name, number and “middle” length of caught organisms. The term “middle” length was used in order to avoid the more technical terms “mean” or “average”. The length measurements reported are thus means and modes for the species in the recorded catches. While the bias in the Creel Census sampling process has got a certain bearing on species distribution in, and composition of the catch recorded, it does not affect the size distribution for given species nearly as much. Size distribution is arguably less dependent from the sampling process *per se*. Still, the bias persists in certain cases, a good example being the 43% contribution of 12 cm long soldier fish (*see* fig. 14), which were recorded during a single night creel survey in one particular on-shore location, where half a dozen youngsters were line fishing on a school of juveniles.

Figures 11 to 17 show the spread of reported average length measurements for the seven most important fish families in the catch for Creel Census and Student Census data. In general it can be said that there is a good overlap over the range of reported mean lengths across these families.

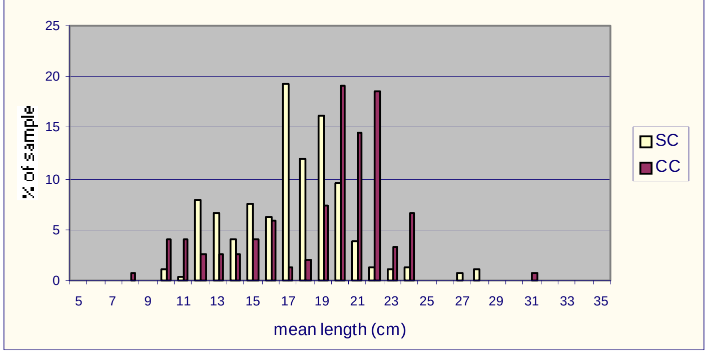
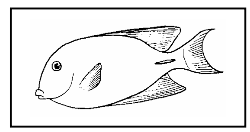


Figure 11: Mean length distribution for Acanthuridae



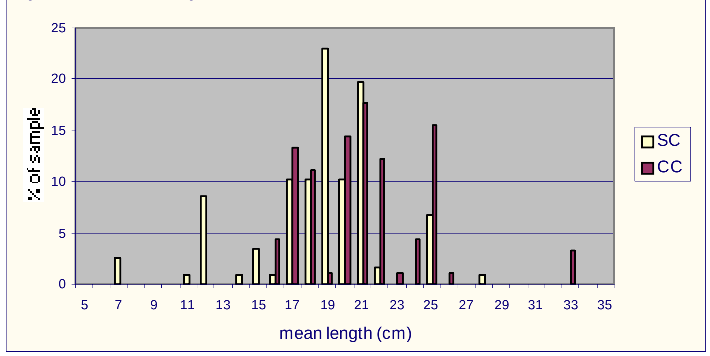
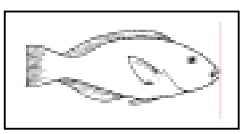


Figure 12: Mean length distribution for Scaridae



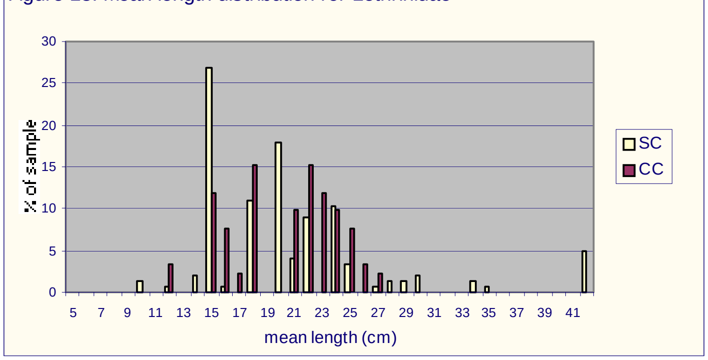
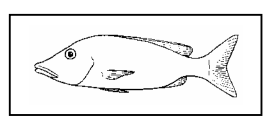


Figure 13: Mean length distribution for Lethrinidae



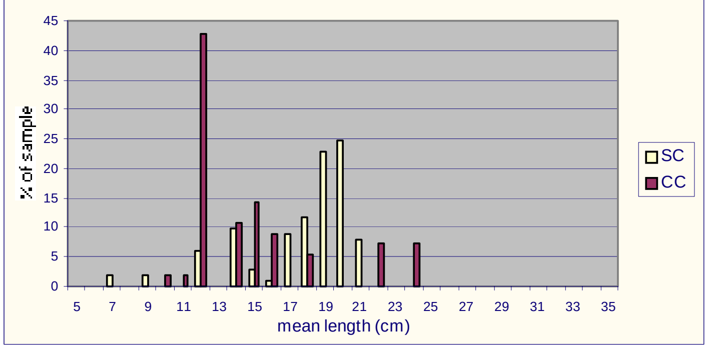
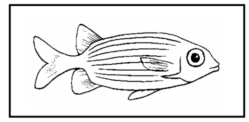
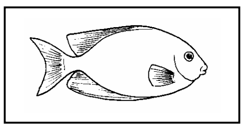


Figure 14: Mean length distribution for Holocentridae





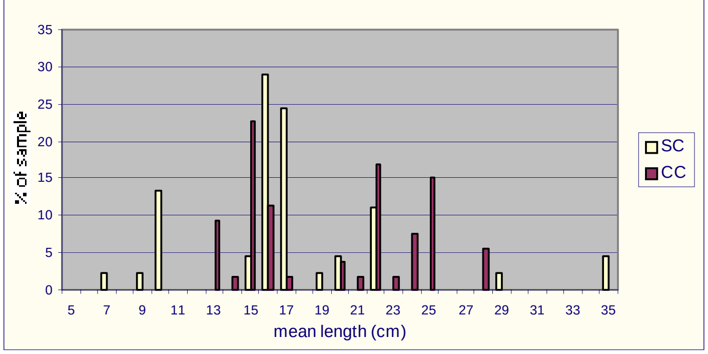


Figure 15: Mean length distribution for Siganidae

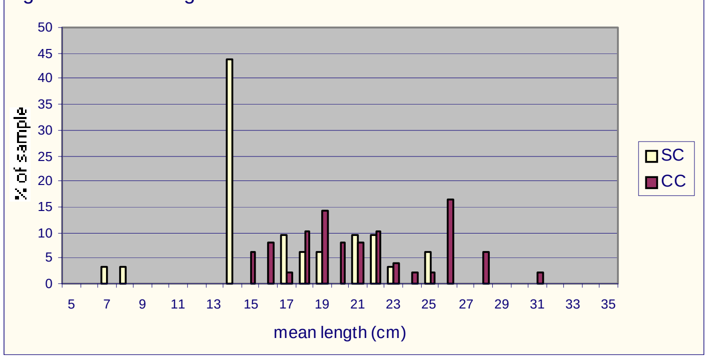
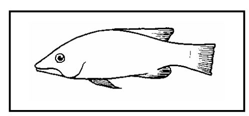
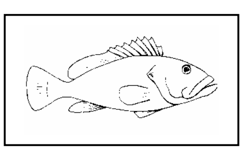


Figure 16: Mean length distribution for Labridae





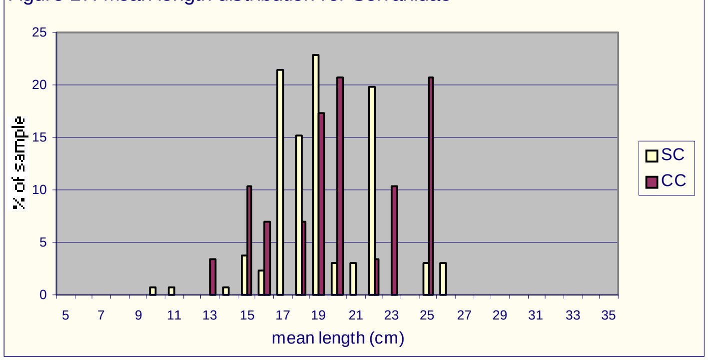


Figure 17: Mean length distribution for Serranidae

Since the data from the catch records come in semi-aggregated form as average lengths, from which an overall average for the family is then calculated, it is not possible to attach meaningful standard errors to these averages. It must also be borne in mind, that most of these families are made up of quite an array of different genuses and species, especially in well-established and diverse families like the surgeonfish and the parrotfish (*Acanthuridae* and *Scaridae*). Therefore, it is expected that some minor or major deviations between surveys should occur, without this necessarily meaning that either process of collecting the data is seriously flawed.

To compare the size ranges obtained for the seven families in a meaningful way, all length data were converted into weight data, respecting the observed distribution of average sizes within each family. Respecting observed size distributions during length-weight conversion is important because weight is a power-function of length. Not doing so would inevitably lead to underestimating weight. Table 14 lists the seven families analysed. For a hypothetical sample of 100 fish per family, it assigns a proportional weight value for every reported average length within a family. *e.g.* if a family had 20% of reported fish with an average length of 21 centimetres, the table returns a value for the weight of 20 fish of that size in grams. It then sums up the weight of the 100 fish of each family, and cross sums the weights of the seven families into kilograms. The returned value represents the weight of a hypothetical catch made up of 700 fish distributed evenly between these seven families, which account for roughly 80% of species in surveyed catches.

The length-weight conversion factors used to obtain weights are listed at the bottom of table 14. These factors were adapted from a table that the Fisheries Division in Samoa regularly uses as part of its own work. These are general conversion factors, which take into account the body shape of the family, and convert length measurements into weight, irrespective of the precise species make-up of the family. Any introduced error is lost on comparison.

It is to be noted that the two generated figures of 106 and 118 kilograms are in relatively close agreement, and that the Student Census size distribution data lead to a more conservative estimate of catch weight per number of species caught (falling 10% short of the Creel Census estimate). This is quite a remarkable result, as students were expected to report slightly exaggerated species sizes, which would of course have lead to higher catch weights on comparison.

<u>Catch per Unit Effort</u>

The last indicator to be analysed and compared is catch per unit effort (CPUE). The collected data which lent themselves best for this analysis came from fishing trips where underwater spears were used, and which occurred during daytime or twilight in the lagoon. Enough trips matching these criteria existed between both Creel Census and Student Census surveys. Narrowing down on a specific gear item, a particular time of the day and a particular ecosystemic area minimises error.

The filter applied to the Student Census database asked for trips befitting these 3 criteria (underwater spear; day-twilight; lagoon), and the trip and catch records had to be valid for the particular day (not for the seven days). The fact that catch and trip recorded needed to be only valid for the day, and not the whole week, gave rise to a slightly larger pool of trips to draw data from. 23 trips befitting these criteria were extracted from the Student Census, and 38 trips from the Creel Census.

The catch from trips in both surveys was converted into weight, using length-weight conversion factors listed in Annex 9. Catch (in g) was then plotted against hours spent fishing, as shown in figures 18 and 19. A regression line with a forced intercept through zero was fitted to the data points.

Figure 18: CC one-person catch rates (day/twilight-spear-lagoon)

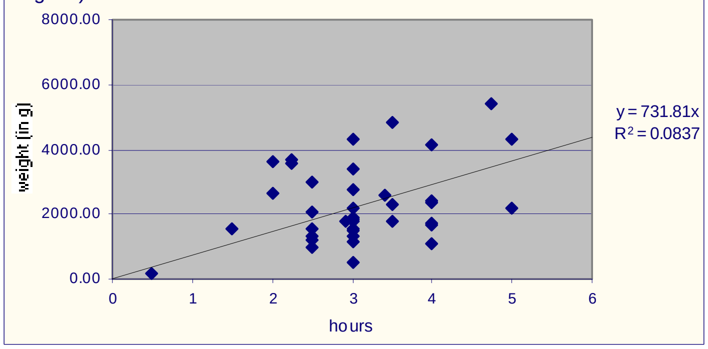
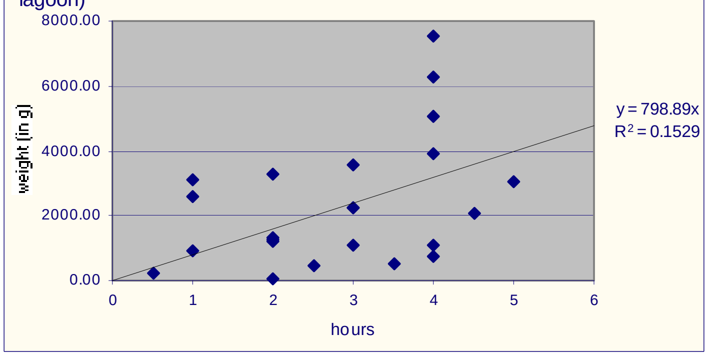


Figure 19: SC one-person catch rates (day/twilight-spear-lagoon)



R square values for both regressions are very low. This is due to the fact that fishing trips are short (engendering little spread across the x-axis), and that there is an important scatter in catch rates between individual fishermen. Scatter is a typical feature of catch data, and basically reflects the nature of good and not-so-good fishing trips. Low R square values are a concomitant of this. Table 15 summarises the main figures from the regression analysis.

	CPUE – one-man / underwater spear / lagoon / day-twilight (in g)					**Catch per trip (in kg)**		
	n	y	R^2	lower 95 c.i. for y	upper 95 c.i. for y	n	av	s.e.
CC	38	731.81	0.0837	612.58	851.03	38	2.32	0.20
SC	23	798.89	0.1529	546.99	1050.79	23	2.35	0.41
filters	Trip valid + catch valid = true; gear = u/w spear; area = lagoon; time of fishing = day or twilight							

Table 15: CPUE figures for one-man underwater spearing by day/twilight in the lagoon per hour and per standardised trip

length (cm)	Acanthuridae		Holocentridae		Labridae		Lethrinidae		Scaridae		Serranidae		Siganidae	
	SC	CC	SC	CC	SC	CC	SC	CC	SC	CC	SC	CC	SC	CC
7	0	0	31	0	20	0	0	0	40	0	0	0	14	0
8	0	6	0	0	28	0	0	0	0	0	0	0	0	0
9	0	0	58	0	0	0	0	0	0	0	0	0	28	0
10	17	67	0	69	0	0	53	0	0	0	12	0	226	0
11	8	88	0	88	0	0	0	0	42	0	15	0	0	0
12	222	74	365	2632	0	0	42	200	525	0	0	0	0	0
13	229	93	0	0	0	0	0	0	0	0	0	117	0	331
14	178	114	901	975	1889	0	188	0	78	0	33	0	0	81
15	396	208	322	1551	0	320	2919	1298	371	0	203	550	233	1185
16	387	373	127	1143	0	511	88	974	109	569	149	448	1809	709
17	1427	98	1331	0	695	151	0	325	1532	1992	1675	0	1812	140
18	1046	173	2054	926	543	887	1907	2630	1773	1920	1429	646	0	0
19	1632	736	4518	0	632	1444	0	0	4579	220	2536	1909	225	0
20	1122	2239	5598	0	0	952	4055	0	2320	3267	397	2687	518	440
21	505	1946	2029	0	1252	1090	1060	2506	5035	4554	461	0	0	252
22	209	2819	0	2060	1425	1551	2586	4389	493	3525	3466	602	1689	2581
23	177	570	0	0	538	702	0	3863	0	359	0	2074	0	325
24	266	1283	0	2572	0	395	3725	3523	0	1601	0	0	0	1462
25	0	0	0	0	1356	443	1378	3041	2733	6217	793	5376	0	3276
26	0	0	0	0	0	3952	0	1440	0	491	896	0	0	0
27	185	0	0	0	0	0	335	1057	0	0	0	0	0	0
28	307	0	0	0	0	1822	736	0	456	0	0	0	0	1684
29	0	0	0	0	0	0	805	0	0	0	0	0	729	0
30	0	0	0	0	0	0	1317	0	0	0	0	0	0	0
31	0	262	0	0	0	806	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	2705	0	0	0	0
34	0	0	0	0	0	0	1208	0	0	0	0	0	0	0
35	0	0	0	0	0	0	650	0	0	0	0	0	2462	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	7250	0	0	0	0	0	0	0
weight (g)	8312	11148	17334	12016	8378	15027	30306	25246	20086	27420	12066	14409	9744	12466
Total SC weight		**106 kg**												
Total CC weight		**118 kg**												
$W=qL^b$	oval&thin		oval&stout		oval&thin		oval&stout		oval&stout		tapering&stout		oval&thin	
q	4.55E-05		3.04E-03		4.55E-05		3.04E-03		3.04E-03		9.19E-06		4.55E-05	
b	2.7851		2.5517		2.7851		2.5517		2.5517		3.1074		2.7851	

Table 14: Weight comparison for a hypothetical catch of 700 fish distributed into the 7 most commonly occurring fish families, based on Creel Census and Student Census size distribution data

Regardless of the scatter in the data, the slopes (y) of both regression lines are in close agreement. The Creel Census data give rise to a catch rate of 731.81 g/hr, and the Student Census a rate of 798.89 g/hr. The 95% confidence interval for the CC slope lies within the 95% confidence interval of the SC slope. When calculating catch/trip (based on these same data), it is found that catches of 2.32 kg/trip (CC) and 2.35kg/trip (SC) respectively, overlap as well. The difference in magnitude of standard errors is primarily due to the smaller sample size of available Student Census data.

Perspective from the back of the Envelope

In order to put all the above results into perspective, it is useful to take a step back, and estimate the total catch of the Aleipata subsistence fishery by using the indicators rendered from both the Student Census and the validating surveys. These estimates are also compared to the figures produced by an earlier survey carried out by FAO in 1990/1991 (FAO/UNDP SAM/89/002). This latter survey precedes the surveys carried out as part of this study by eight years in time. Table 16 regroups all the key indicators used to calculate the total estimated yearly catch of the community. 3 figures in the SAM/89/002 column below are reported in triple format. The first figure stands for southern Aleipata, the figure in round brackets for northern Aleipata, and the square brackets contain the arithmetic mean of both. Aleipata was broken up into two separate units in that survey.

	HhS / CC ('99)	**SC ('99)**	**SAM/89/002 ('90-'91)**
hrs/trip	2.88	2.77	3.3 (6) [4.65]
trips/fishing hh/wk	4.39	4.29	-
% fishing hhs	67.6	80	73 (82) [77.5]
hrs/hh/wk (all hhs)	8.55	9.51	-
hrs/hh/yr	413	459	-
catch/hr (in kg)	0.73	0.80	1.1 (0.75) [0.925]
total no. trips/yr	89,421	103,413	50,564
total hrs/yr	230,454	256,122	235,711
total catch/yr (in mT)	**168.65**	**204.62**	**218.00**
relative to the SC	82.4 %	100 %	106.1 %

Table 16: Comparing total catch between surveys

To be noted is the fact that all three estimates for total yearly catch fall into the same order of magnitude, and into a relatively close range. There is a wider gap between the validating surveys and the Student Census, than there is between the Student Census and the SAM/89/002 survey result. It emerges that the the discrepancy between Creel Census and validating surveys can be attributed almost exclusively to the low percentage of fishing households reported in the Household Survey, which at 67.6% represents 84.5% of the figure reported in the Student Census. That figure (84.5%) coincides closely with the 82.4% in table 16, representing the relative magnitude of the total validating survey catch estimate, as compared to the Student Census estimate.

Following the same line of thought, it is also worth pointing out that the reported average percentage of fishing households in southern and northern Aleipata [77.5%] in '90-'91 is in much closer agreement with the Student Census figure of 80%. It can hence be assumed that a certain amount of the discrepancy of overall catch estimates between Student Census and validating surveys is due to the bias mentioned in section 4.6., causing a number of households to feel suspicious about the purpose of the interviews, and making them feel uneasy about declaring themselves as fishing households.

The overall fit of results for the capture data, especially for indicators such as trips/fishing hh/wk and catch/hr, is very close. All of the capture indicators fall into the same order of magnitude, and into similar or overlapping ranges.

5.6. Data quality filters

The data quality markers inserted into the Student Census database are one of the key elements of this study. Failures of student censuses to produce reliable data in the past led to believe researchers that filters for qualitatively superior data in the collected data assemblage were necessary in order to segregate the good from the bad data. The efficiency of these markers, and how they are applied for filtering purposes is thus crucial to guarantee the quality of obtained results.

In the design of this study, only one quality filter was obtained directly from the students. That is the mark students were given for their returned exercise books. The underlying assumption behind this marker being, that the student's understanding of the exercises would be somehow related or correlated to her/his performance in data recording.

During the design phase of the database, and input of the first returned logbook data, it was realised that many more quality markers could be, and needed to be inserted into the database, if sense was to be made of the returns. The reason was that students could return high quality data in some parts of the logbook, and quite poor data in other parts. Relying on only one marker not directly related to the logbook (*i.e.* the mark for the exercise book) would have meant that a lot of potentially good data would be discarded, or a lot of poor data be taken onboard in the analysis for specific indicators. For this reason, all the markers listed in table 1 were built into the database. They later proved to be of such great value as filtering agents, that the original marker designed into the data collection process was not used a single time to filter and extract data for analysis. It is suggested that specific data quality markers always be attached to data during the input process, if practicable. The constraint is clearly one of human resources, since the person keying in the data needs to have a certain degree of training and understanding about fisheries in general, and the surveyed fishery in particular. This last point must be given due consideration when evaluating the feasibility of a student census programme.

One way to assess the exercise book performance marker is to look at its behaviour between the filtered and unfiltered data sets from the trip and catch data analysis. In that particular analysis, for a trip to fall into the pool of valid data, all trips for the week recorded by one student had to be valid. This gave rise to a pool of only 17 logbooks, containing a total of 73 valid trips. These 17 logbooks can readily be regarded as containing the best quality data returned by the Student Census, since logbooks were chosen on the basis of trips having been recorded properly and consistently throughout the entire week. Table 17 reproduces key indicators from the analysis of the exercise book scores. Also reproduced in the table are age data and student distribution into classes, which could also serve as potential (sampled) markers for performance. Values in brackets were obtained from the pool of the original 83 logbooks returned.

	Score	Age	Year 11	Year 12
av	40 (29)	15.75 (16.06)	-	-
median	41 (27)	16 (16)	-	-
min	6 (0)	14 (14)	-	-
max	57 (67)	18 (19)	-	-
percentage	-	-	58.8 (59)	41.2 (41)

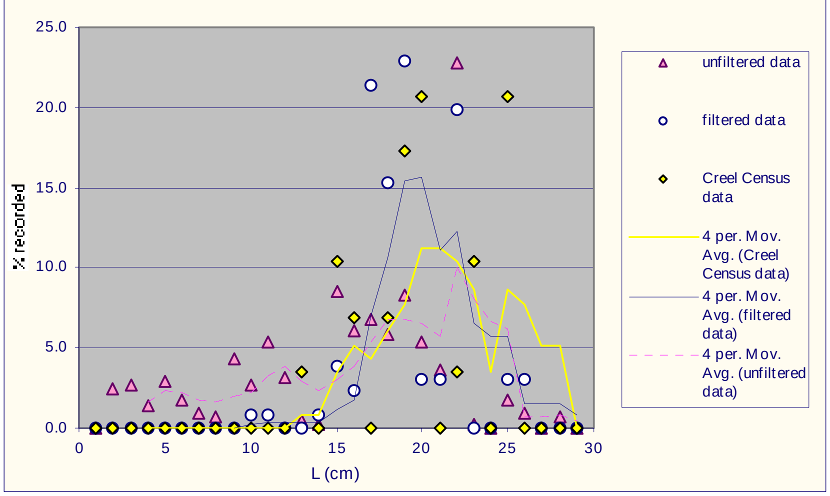
Table 17: Score, age and distribution into years 11 & 12 for students whose logbooks respond to stringent filtering criteria.

It is to be noted from the figures in table 17, that the pool of all students and the restricted pool of 17 top performers return very similar values for age and distribution between year 11 and 12. It can therefore be said, that both these criteria are not reliable natural markers for the purposes of achieving data quality. Student sex, a politically more sensitive indicator, is not tabulated, but was nonetheless looked at. Its distribution between the two pools was not affected either.

Yet, it can be seen that the average exercise book score between both filtered and unfiltered pools is responding sensitively. The median score (41%) attached to the better quality data is 52% higher, than the median score (27%) attached to the whole data set. Still though, the student with the highest score (67%) does not have her/his logbook as part of the filtered pool, while a student with a score of a mere 6% does. This goes to underline that a performance score as a marker is insensitive to some degree, and would therefore induce a larger error in data filtered by its standards. Moreover, for lack of criteria it would be very difficult to set a rational entry level mark, at which logbooks would be accepted into the pool of data serving for analysis. This being said, in situations where data handling capacity is very low, it still seems reasonable to use a score marker and trim error for better results in simple data collection exercises. In the 1989 FAO survey afore mentioned for instance, teachers were asked to suggest “unreliable” returns by putting tick marks on logbooks they would rate as such. That was the only formal quality marker used in that survey.

In order to illustrate to which extent filters trim data sets “into shape”, all length data for Serranids collected by the Student Census were plotted against the data from the filtered set (filter: trip=valid [for every day of the week]) in figure 20. Three series of data are plotted for comparison; unfiltered data, filtered data and Creel Census data.

Figure 20: Distribution for Serranid length in different data sets



It can be seen in figure 20, how lower reported lengths (clearly erroneous below 10 cm) drop out in the filtered data. In doing so, the filtered data's moving average line, which renders the average contribution to the whole catch at a certain size range, takes on an outline adhering closer to the moving average line of the Creel Census data. This can be regarded as tangible evidence for the fact that judicious integration of quality markers into the database is a robust *a priori* tool to achieve a higher degree of data quality.

6. DISCUSSION

Discrepancies and bias

The data collected by the students fell into two broad categories, namely socio-economic data, and data related directly to capture. The analysis of student performance in recording reliable data showed that there was a clear divide between the quality of data recorded as part of the "frontpage questionnaire" and the daily log sheets (*see* table 4). It was established that the "frontpage questionnaire", which recorded information of socio-economic nature had been answered satisfactorily to quite a high degree (77%).

Paradoxically though, the results obtained from the socio-economic data do not match the validating surveys nearly as closely, as do the results obtained from the capture data. Indicators such as household size, number of income earners, fishing gear items owned, canned seafood consumption, *etc.* are all reported with significantly higher means by the Student Census. This is a puzzling result, since a number of elements point out that filtered student data are sound, and would be expected to closely reflect the true picture in the field. This is suggested amongst others by the quality of the results obtained from the student capture data.

One plausible explanation for the discrepancy in results between Student Census and validating surveys in the socio-economic data assemblage could be that the students participating in the survey are not a representative cross-section of the sampled community. There are no hard data available for rural Samoa to support this suggestion. Fact is that youth in Samoa does start to drop out of school at an early age, taking up productive tasks within family life, such as working on the plantation or fishing. 1996 figures for Tonga and Fiji suggest that roughly 30% of youth has dropped out of school at age 16 (UNDP, 1999), which is the mean age of students in the present study. In light of this, one could suspect that the student pool recording the data actually represents a more advantaged economic stratum of the community, which can afford to keep its children in school at a more advanced age. This would certainly help to explain why student households report more income earners, own more fishing gear and seem to eat a lot more canned seafood. It would also explain, for instance, why the students report proportionally less fishing lines. Lines are amongst the cheapest fishing gears available, and are hence found in higher proportions within the entire community.

It also helps to explain why there is a discrepancy with the socio-economic data, and not with the capture data. Capture data are much more independent of the economic stratum from which fishers report catches. A wealthy fisher will not catch more fish in an hour's time, than a poor fisher, purely on the basis of being better off (given they use the same gear). In actual fact, it was shown that the discrepancy arisen between both Student Census and validating surveys with respect to the estimated total catch (*see* table 16) could be assigned almost entirely to the difference in the reported percentages of fishing households in the community, which is a socio-economic indicator.

The hypothesised bias of students not necessarily representing the community in socio-economic terms is an important consideration, and has to be borne in mind when interpreting the results of studies relying on data collected by students. More work into this problem would be useful in order to clarify the linkages.

Using Student Census data

It is important also, to bear in mind what use is going to be made of the data flowing from a student census. In general, a student census is useful as a tool to collect data in situations where means to conduct full-fledged surveys on a regular basis are not given. The student census cannot collect data of such depth and complexity, as it is generally achieved in large-scale resource-demanding fishery surveys. It is in fact limited to collecting relatively straightforward information. The discard rates of questionnaires engendered through some of the filters applied to extract data for analysis demonstrated that the return of useable data is inversely proportional to the complexity of data sought.

Student census data are best thought of as local resource, and resource exploitation information, which is useful to monitor the local context. Student census data should not be primarily conceived of as fishery information useful for comparison to other data, collected through other means in other locations. Student census data are useful to generate time series of robust indicators (*e.g.* catch/hr; gear ownership, *etc.*) which can be used in time to establish trends, and to obtain an understanding of how the resource and the resource users are evolving in a particular geographical area. Sources of error inherent to the data collection process (*e.g.* students not being representative of the whole community) become immaterial, as their influence is lost on comparison with data of the same origin. Generated time series establish rates of change. A constant source of error does not affect these rates. Error negatively impacts data sets, when nominal values are targeted, and nominal values are compared to other such values from other studies, in which data did not suffer from the same sources of error.

From this point of view, a student census programme can provide communities and higher authorities alike with a robust tool to enable more transparent and better fisheries management. It provides a platform to secure a sound degree of data coverage, and to raise awareness and understanding about the resources within the young generation.

Raising awareness and the benefits to students

Very little has been said about the immediate beneficiaries of a student census programme, *i.e.* the students, and one of its main outputs, *i.e.* raising awareness about the importance and the protection of the resources monitored. The reason to this is because the evaluation of the student census in achieving this goal lies beyond the remits of this study. It goes almost without saying though, that there have to be positive educational benefits flowing from the involvement of students in resource monitoring.

Statements of people involved in resource monitoring work involving students back this. Maybe the words of an American teacher involved with his students in the U.S. national RiverWatch programme are most appropriate to provide an idea of how much can be achieved through getting students involved.

Bill Meyers writes about his students: “I find that the students enjoy the program more because they know that quality is important. They take a lot of pride in their work. (…) They learned a lot and became very protective of "their" creek.”

The data collected are of scientific quality and importance: “The Division of Wildlife uses the data to monitor the condition of streams and rivers throughout the state. Occasionally they will go to court to argue that, for instance, more mining should not be allowed in an area and they will use student collected data to prove their point.”

The e-mail received from Bill Meyers, describing the work of his students is appended in full in Annex 12 for consultation. Also see Annex 11 for a list of selected internet resources, including links to the American RiverWatch programme.

Summary on indicator quality

Table 18 summarises the different indicators that the study looked at, and what conclusions were reached with respect to their “truthfulness” or quality. They are split into two broad categories, namely socio-economic and capture. Grades given are *excellent*, *fair*, and *poor*. Indicators are rated *excellent* where there is a virtual overlap in values obtained between Student Census and validating surveys. Indicators are rated *fair* where the values obtained are close and *poor* where there is a clear discrepancy between both Student Census and validating surveys. In the last column of table 18 (explanatory notes), possible reasons for discrepancies in indicators rated *poor* are given.

<table>
<tr><th colspan="2">Socio-Economic</th><th>table</th><th>rating</th><th>explanatory notes</th></tr>
<tr><td colspan="2">no. hh members</td><td rowspan="3">5</td><td>fair</td><td rowspan="3">discrepancies probably incurred by the fact that students are not a representative economic cross-section of the community</td></tr>
<tr><td colspan="2">no. income earners</td><td>poor</td></tr>
<tr><td colspan="2">main income</td><td>poor</td></tr>
<tr><td colspan="2">catch fate</td><td rowspan="2">6</td><td>fair</td><td></td></tr>
<tr><td colspan="2">economic fishing purpose</td><td>poor</td><td>same reason as above</td></tr>
<tr><td colspan="2">% hhs buying tins</td><td rowspan="2">7a</td><td>excellent</td><td></td></tr>
<tr><td colspan="2">% hhs buying/receiving seafood</td><td>fair</td><td></td></tr>
<tr><td colspan="2">tin consumption/wk (/hh & /pers.)</td><td>7b</td><td>poor</td><td>same reason as above</td></tr>
<tr><td colspan="2">daily fresh seafood consumption</td><td>8</td><td>n/a</td><td>questionnaire design flawed – result cannot be rated</td></tr>
<tr><td rowspan="2">fishing gear assets</td><td>% owning hhs</td><td rowspan="2">9</td><td>poor</td><td rowspan="2">student hhs own more gear on average (same reason as above), but overall gear make-up is similar</td></tr>
<tr><td>% overall units</td><td>fair</td></tr>
<tr><th colspan="2">Capture</th><th></th><th></th><th></th></tr>
<tr><td colspan="2">fishers/ fishing hh</td><td rowspan="4">10a</td><td>fair</td><td rowspan="2"></td></tr>
<tr><td colspan="2">trips/fisher/wk</td><td>fair</td></tr>
<tr><td colspan="2">trips/fishing hh/wk</td><td>excellent</td><td></td></tr>
<tr><td colspan="2">% hhs fishing</td><td>poor</td><td>bias in HhS likely to be the cause of the discrepancy</td></tr>
<tr><td colspan="2">trip duration</td><td>10b</td><td>excellent</td><td></td></tr>
<tr><td colspan="2">effort targeting village waters</td><td>11a</td><td>excellent</td><td></td></tr>
<tr><td colspan="2">fishing grounds targeted</td><td>11b</td><td>excellent</td><td></td></tr>
<tr><td colspan="2">fishing methods used</td><td>12</td><td>fair</td><td></td></tr>
<tr><td colspan="2">catch diversity and composition</td><td>13</td><td>fair</td><td>biased CC likely cause of main divergences (which remain small)</td></tr>
<tr><td colspan="2">species sizes</td><td>14</td><td>excellent</td><td></td></tr>
<tr><td colspan="2">CPUE</td><td rowspan="2">15</td><td>excellent</td><td></td></tr>
<tr><td colspan="2">catch/trip</td><td>excellent</td><td></td></tr>
</table>

Table 18: Summary of indicator quality and reasons for observed discrepancies

The emerging picture is that the Student Census managed to gather representative data for the capture side of the fishery, while the socio-economic data flowing from the Student Census are less representative for the community under scrutiny.

It should be stated, that these findings stand in sharp contrast to the original expectations. Given earlier failure reports of student involvement in the collection of fishery data, it was expected that students would probably return more or less reliable socio-economic data, but that the capture data would suffer from brutish exaggerations. Exaggerations could come in terms of number of fishing trips, fishing trip length, numbers of fish caught, species caught, not mentioning the sizes of those species, which could all combine and multiply one another, and make the exercise fail. The findings summarised in table 18 indicate the opposite; student data can be filtered and valid capture data were extracted to obtain accurate catch indicators which reflect the situation on the ground. But, students seem to draw from a community pool that is not representative of the entire community, and hence their involvement gave rise to socio-economic data which are less representative.

7. CONCLUSIONS

1. The picture emerging from the analysis of the above results suggests that a well-designed student census programme can achieve a lot in terms of securing meaningful access to subsistence fisheries data.

2. Questionnaires must be kept simple, and so the intricacy of expected outputs. Increasing questionnaire complexity is inversely proportional to the return of satisfactory answers; *i.e.* the more complex the questionnaires, the smaller the number of satisfactory returns.

3. Data quality markers should be in-built into the data entry forms of the database, and linked to specific items of information on a questionnaire to questionnaire basis. This enables customised data filtration, which maximises the quality and return of data used to calculate specific indicators.

4. The age of students participating in a programme is crucial to determine whether the data will be representative of the community as a whole. This can be gauged from schooling rate statistics. It appears to have an impact on the accuracy of socio-economic data students gather.

5. The student census avails itself particularly fit for the securing of catch data cover for specific geographic areas.

6. The student census can be used as a practical educational tool to raise awareness for, and teach about resources, which are of importance to the communities students are part of, and need protection.

7. The student census can be aimed at raising awareness about, and monitoring of other natural resources, sea- or landbased. Other current and past activities support this suggestion.

8. Within the broader development context, the student census should enable national or local authorities to gain independence from overseas development aid for the securing of subsistence fishery information, due to the relatively modest costs that a streamlined student census programme should incur.

8. ACKNOWLEDGMENTS

The entire project, from initial formulation to printing of this report, ran for over two years. Over this time, many people were consulted, and added to the success of this work coming to fruition. First of all, I wish to thank the Government of Luxembourg for sponsoring my contract with FAO.

There are two people I wish to especially thank for their support throughout this work. My boss, Dr Vili A Fuavao, FAOR, for his trust and guidance, and Dr Mike King, Team Leader of the AusAID funded Samoan Village Fisheries Project, for his pointing me into this direction, and providing me with the necessary coaching. I am also much indebted to Mr Kelvin Passfield, Fisheries Adviser to the Samoan Village Fisheries Project, with whom I spent many hours discussing aspects and implications of the work, some of whose ideas have flown directly into this report, and who donated a lot of time to help out with the field work.

Many thanks go to Ms Mili Matila, headmaster of the Aleipata Junior Secondary School, and her team of science teachers. Her enthusiasm to participate in the survey was a heartening experience, and without her team, this work would not have come to be. In the same thrust, I wish to thank all the students who participated in the survey, and who selflessly donated their precious spare time to participate in this study. Mr Peter Varghese from the Curriculum Development Unit of the Department of Education is thankfully mentioned for his involvement in the initial phases, providing background information about the schooling system, and arranging for the formal endorsement of the project by the Department of Education.

I wish to thank Mr Autalavou Taua from the Fisheries Division, and his team of extension officers who have completed an excellent job in the field with the household and creel surveys. I am also indebted to my former colleague Mr Lui Bell, Aquaculture Adviser to the Samoan Village Fisheries Project, for his involvement as a translator, and source of critical expertise during the design of the questionnaires. Many thanks also to Ms Suesan Saucerman, Fisheries Biologist of the Department of Marine and Wildlife Resources in American Samoa for her support and inputs.

Further thanks go to Dr Ian Cartwright, Deputy Director, and Ms Nancy Kwalea, librarian, at FFA in the Solomon Islands, who supported the project with study materials, and to Ms Seema Deo, SPREP Environmental Education Officer, who provided information and various materials on Samoa. I also wish to thank Ms Matile Tafua-Rivers, UNDP UN Volunteer, who provided hard to come by statistical information about the Samoan education sector.

Last but not least, I wish to thank all the other many people, not directly mentioned, who in one way or another contributed to the success of this work.

Appendix

Annex 1 Historical Summary of Subsistence Fishery Surveys in Samoa

Annex 2 The Involvement of Students in the Collection of Artisanal Fishery Data - a New Way Forward

Annex 3 Teaching Aids

Annex 4 Student Exercise Book

Annex 5 Household Survey Questionnaire

Annex 6 Creel Census Questionnaire

Annex 7 Student Census Logbook

Annex 8 Species List: Samoan Names

Annex 9 Family/Order List: Length-Weight Conversion Factors

Annex 10 Student Census Database Input Forms

Annex 11 Web Resources on Operating Student Census Schemes

Annex 12 A Teacher's Assessment on the Benefits of Involving his Students

Annex 13 The Torres Strait Islands Data Collection Scheme

Annex 14 References & Bibliography

Annex 1 Historical Summary of Subsistence Fishery Surveys in Samoa

- 1978 interview survey — Dept of Statistics
  - 48 villages (subd. into 4 areas on Upolu & 2 areas on Savai'i)
  - sampling 1 week each quarter for 1 year
  - dismissed by the Dept of Fisheries as 'completely unreliable'

- 1983 'snapshot' survey — Leon P. Zann & Dept of Fisheries
  - 40 urban and rural villages (random sampling from Dec.'83 to Feb.'84)
  - estimates on catch composition, fish consumption, CPUE...
  - time frame too short to allow for generalisations to be made

- 1986 Apia fish market surveys — Dept of Fisheries
  - statistical information on inshore fish landings at the market commences
  - ongoing

- 1989 Agriculture census — Dept of Statistics
  - produces nation-wide figures on fishing effort and fish usage

- 1990 Inshore Resources Assessment — FAO/SAM/8852 & Dept of Fisheries
  - coastal resources inventory produced for Upolu
  - little data were collected from Savai'i and were not included in the report
  - household survey: 20 urban & 38 rural villages sampled twice (Dec.'90 & May'91)
  - creel census: 8 villages for 2-4 week periods in 1991
  - Luatuanu'u: 16-month survey to assess seasonality in detail
  - estimates on catch composition, fish consumption, CPUE, state of the resource...
  - the household survey questionnaire had 2 versions, of which 1 was a diary which was completed by high school students (200 diaries on both Upolu & Savai'i)

- 1995 Inshore Resources Assessment — IDSS/AusAID & Dept of Fisheries
  - coastal resources inventory produced for Savai'i
  - estimates on catch composition, fish consumption, CPUE, state of the resource...
  - the student diary was not used anymore. Zann notes that the student diary data returned in the 1990 survey had turned out "less reliable"

- 1999 Artisanal Fisheries Student Census — FAO
  - formal research study evaluating the potentials and merits of involving secondary school students in the collection of subsistence fisheries data

Annex 2 The Involvement of Students in the Collection of Artisanal Fishery Data - a New Way Forward

paper tabled at the;

MRAG Workshop on Aspects of Coastal Resource Management
Suva, Fiji, 30th June to 2nd July, 1999
as Discussion Paper

First Heads of Fisheries Meeting (HOF1) at SPC Headquarters
Noumea, New Caledonia, 9th to 13th August, 1999
as Information Paper 22

by

Gilles Hosch
Marine Resources Information Officer
FAO Sub-Regional Office for the Pacific Islands
Apia; Samoa

Abstract

Traditional subsistence and artisanal fisheries provide sustenance, employment and income to vast numbers of Pacific islanders, and are of great importance to national economies and food security. The pervasive lack of subsistence fisheries data across the region and the worrying number of accounts of collapsing stocks and species extinctions are of growing concern to authorities involved in the management of coastal fishery resources.

The author explores new grounds on how to overcome two fundamental hurdles for the successful management of subsistence fisheries. It is argued that under a scenario of increasing fishing pressures and changing societies, basic data to found management decisions upon, and awareness of the new generation towards the vulnerability of their resources are fundamental.

The proposed way of achieving both is through the “Artisanal Fisheries Student Census”. Secondary schools integrate an assignment into their science curriculum, within the framework of which students get lectured on coastal resources and fisheries, and then record their household’s fishing activity over a short period of time. The collected data flow back to competent authorities who analyse them and make them available for fisheries management purposes. The paper describes in some detail key considerations for the successful implementation of such a programme.

Introduction

The terms subsistence fisheries and artisanal fisheries are not readily separated. They generally exploit the same resources of the coastal environment. They are also sometimes referred to as coral reef fisheries. While the adjectives *subsistence* and *artisanal* generally hint at the fate of the catch in how it is intended to be used (eaten/sold), *coral reef* describes the environment the fishery exploits. For matters of simplicity, the term to be used in this paper is *artisanal fisheries*, and stands for small-scale, capital extensive, community based fishery, exploiting coastal marine resources. The use of the catch and the exact coastal ecosystem the catch was taken from is of no direct importance in the context of the following discussion.

Background

The case of the importance of artisanal fisheries in the Pacific has been made time and time again. Artisanal fisheries are an important part of the cultural heritage of the people of the Pacific islands, and provide large sectors of the populations with daily sustenance, labour and basic income. Some of the highest consumption rates of seafood world-wide are reported from the Pacific islands, and artisanal fisheries are crucial to national food security and economic welfare.

Yet many coastal ecosystems are not performing very well, overfishing is increasingly becoming a problem, and accounts of collapsing, traditionally exploited stocks and local species extinctions are becoming legion [3] [5] [9] [10] [14]. Reasons, ranging from natural disasters all the way to central authorities failing to deliver sound management of the resources have been invoked. The bottomline being that there is growing cause for concern.
A striking element against this background of sounding alarm bells is the pervasive lack of quantifiable information to describe the current situations, and to compare them with what these were, ten, thirty or fifty years ago. Sound time series of fishing pressures, yields, biological parameters of exploited species and the like do hardly exist in the Pacific. Historical or "equilibrium" exploitation levels are mostly inferred from local knowledge and accounts, and scientific estimates [6]. Independent Pacific Nations who have carried out more than one comprehensive national artisanal fisheries census are few.

For the obvious reason of lacking coastal fisheries data, because of a lacking overall picture of resource performance and exploitation, discrete management and conservation moves in the Pacific often end up being catastrophe driven, and occur at points in time when an exploited species becomes so rare as to face the threat of local extinction [3] [9]. The information such actions are based upon is of the toggle-switch type (*e.g.* there are clams / there are no more clams). Action is remedial in nature, rather than managerial and conservationist.

For reasons of financial and manpower constraints, intensive data collection along modern fisheries science standards is unpracticable in the Pacific context [5] [8]. Governments simply cannot afford the studies, so that the usefulness of modern fisheries science as the foundation to artisanal fisheries management in the Pacific is being openly questioned [6].

However, in a setting of growing populations posing higher demands on the limited natural resources they gain their sustenance from [11], in a setting of new and more efficient fishing gear introductions [14], in a setting of arising urban fish markets and cash-intensive international markets for live reef fish and aquarium species, modern and traditional management systems alike, including those which are reported to have been successful in the past, are confronted to the challenge of change [4]. Confronting these pressures blindfolded, *i.e.* without access to basic resource information, is not a good idea.

Confronting change: A case for data and for awareness

The fact that scientists and sociologists have not yet managed to devise a system to collect meaningful artisanal fisheries data in a sustainable and timely manner in the Pacific, should not deter us from searching for new ways of eventually succeeding. The question to ask is not "*Should we keep trying at all?*", but rather "*How can we make it work and what kind of data can we get?*".

Data are crucial in obtaining a picture of what a resource looks like and how it evolves [1] [5]. Management decisions based on trends obtained from the analysis of time series are achieved with a higher degree of comfort. Data allow us to "measure", what management decisions achieve over time, and allow for adjustments to be made. Without resource information, no matter in which form it comes, monitoring and evaluation of adopted management regimes is very difficult and highly subjective [12]. In the same line of thought, it is not important whether the management systems we are looking at be traditional or modern.

Fishing communities world-wide have proven skills in fooling themselves, when it comes to explaining why the fish they want to catch are gone, or why the fish they used to catch were twice as large. Explanations for reduced catches are colourful and can range from cyclones having hit the shores thirty years ago [7], all the way to the firm belief, that the targeted fish are still there, but that they have become so clever they can't be caught anymore. Rarely do we hear accounts of fishing communities blaming themselves for overfishing stocks and jeopardising the resource base through the use of destructive fishing methods. One invoked reason for this is the rapid loss of traditional knowledge within rural communities (as a function of change and modernisation) [13], and a concomitant limited understanding of resource dynamics and the impacts of interactions.

For decades, authors have pointed out the need for awareness raising within the young generation, in order to help them to an understanding of the importance, the value, the natural dynamics and the vulnerability of their coastal resources, which one day will be for them to exploit and to sustain [13]. Without this fundamental understanding, and the adopted sense that the exploitation of the coastal resources is not only a privilege, lest a God given right, but goes hand in hand with duties and responsibilities towards these same resources, there will be no easy way to management, whether it be community or government based.

How to raise awareness? Communities can be approached through the media, the churches, the village councils, the schools, etc., and there are various levels within a community which can be targeted. Cultural implications invariably play an important role in this type of considerations, and must be carefully assessed. Options are plenty. When it comes to matters of education, the social group which generally displays most potential for absorption and for change, and the institution which has most potential for delivery of the message are generally the young and the schools they visit.

The Idea of the Artisanal Fisheries Student Census

The idea to work with students to collect fisheries data is not a new one [2] [15], and is inherently simple and straight forward. The Artisanal Fisheries Student Census (AFSC) is conceived as a partnership programme between the Department of Fisheries and the national education sector, and resides firmly on participatory principles. In a nutshell, the AFSC operates as follows: The Fisheries Department prepares a range of materials (logbooks, teaching support material, workbooks) for a secondary school which participates in the programme. Students from that school log information in their households on fishing activity, bring it back to their school, where it is pooled and sent off to the Fisheries Department, which seeks the information. There, the data are fed into a database, get analysed and stored, and can henceforth be used for fisheries management purposes. The achievements of an operative AFSC are twofold; 1) artisanal fisheries data are generated and 2) awareness for the coastal resources is raised among the young of the fishing communities.

For a process looking this simple, there are numerous hidden mistakes to be made which will make the effort fail. The following points have to be taken into account in order to guarantee the success of the AFSC;

1) *Keeping it simple and cheap*

Classic fisheries surveys are very expensive and demand a large number of trained fisheries personnel. The simple layout of the AFSC is such as to overcome these drawbacks and to generate time series of artisanal fisheries data.

In order to achieve the required simplicity, and maintain it over time, the whole AFSC programme has to be kept rational at all levels. Student logs have to be kept as simple and short as possible. Generating too much data entails manpower time for data input which might not be available. Data to be collected have to be simple and serve a specific analytical cause (*e.g.* time spent at sea + no. of fish caught = CPUE). There is no scope for complicated data and sophistication. The student log, in all its apparent simplicity, has to undergo a thorough streamlining exercise in order to achieve optimum output for minimal input. Also, and most importantly, the simpler the log, the higher the chances of “good quality” data return from the students.

It is one of the characteristics of modern fisheries scientists to be curious and to ask for more and more refined data, in order to feed increasingly complex analytical fishery models. This approach is not sustainable within the context of Pacific artisanal fisheries, and although justified through the inherent biological complexity of the exploited ecosystems, the “*curiosity-trap*” should not be re-activated with the AFSC. It must be actively avoided. The AFSC can generate data, but it is a method which is very clearly limited to simple data, for reasons of both data quality assurance and cost.

2) *Clearly perceived interests*

In order for the workload to be handled successfully and achieve good results, the partners involved in the AFSC programme need a clear vision of their interests. Within the AFSC framework, the involved partners are individual schools and the Fisheries Department.

- *The Fisheries Department*

The interest of the Fisheries Department rests focused in one point, the collection of artisanal fisheries data on a permanent basis. An easy mistake is to only recognise this prime interest, since it lies at the source of the activity as a whole. In order to guarantee the "ongoing" element of the AFSC programme, it is also in the interest of the Fisheries Department to foster good relationships with the participating schools, recognise their interests, and ensure that the commitments by the Fisheries Department towards participating schools are upkept. Failing to do so would entail loss of interest, and henceforth loss of cooperation from participating schools.

- *The participating school*

The interest of the participating school is less focused than it is for the Fisheries Department. Schools integrate the AFSC as an assignment into their science curriculum. The assignment should be preceded by a number of lectures on local coastal resources and their associated fisheries, in order to guarantee the full understanding of the subject by the students. In the ideal case, some of the teaching support material is provided in appropriate format by the Department of Fisheries (handouts, posters, etc.). By doing so, an item of local and practical interest is introduced into the classroom, "tailor made" and provided at no cost from outside the school.

Through understanding the purpose and the importance of the AFSC, through the availability and contemplation of previously collected information in the area, and their direct involvement, students are encouraged to develop a sense of ownership and responsibility towards these resources. They see themselves and their school getting involved in constructive community work, all of which is instrumental in bringing about a positive learning experience, which in turn benefits the school.

3) *A demand based approach*

It is the author's belief, that in a scenario where interests are clear and clearly perceived by the involved parties, a demand based system for cooperation has most potential for success. Partners engage in the activity at their own free will, and actively pursue their own interests by doing so. In the case of the AFSC, this means that a school who wishes to participate, approaches the Department of Fisheries, and asks to become a cooperating school under the AFSC programme.

To this effect, the Fisheries Department has to advertise the AFSC programme publicly, by working through the media and/or the Department of Education, or by directly approaching schools and teachers. The "marketing skills" of the Fisheries Department so become an ingredient at the onset of the programme, which will somehow command the speed at which the programme will take off. Once the scheme gets going, it is geared to develop a momentum of its own, which requires minimal tendering. This point is important again in keeping costs down.

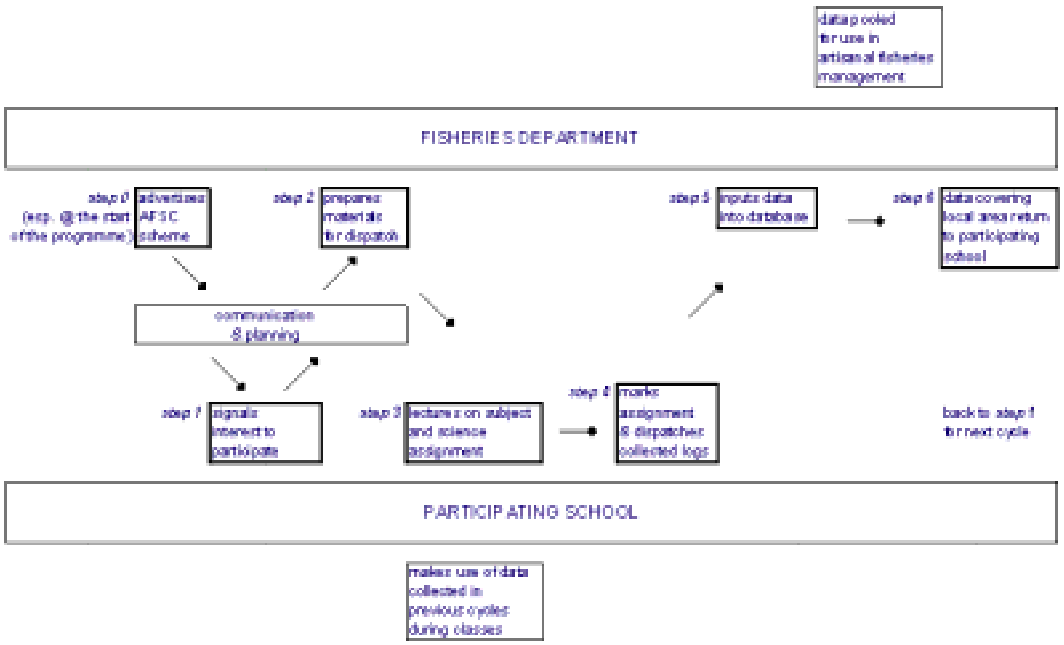
Operational steps of the Artisanal Fisheries Student Census

In order to keep the AFSC programme simple, cheap and flowing, tasks have got to be clearly allocated between the Fisheries Department and the participating schools, and be well planned ahead of time. The best planning framework implemented by the Fisheries Department for the purpose of the AFSC programme is probably one which embraces the official timetable of the national education system, usually subdivided into, terms or semesters.

It is also estimated, that within the Fisheries Department one person should and can be in charge of the entire AFSC programme. The main duties include planning and communication with participating schools, the dispatching and collecting of materials and data handling (input).

The following flow chart (fig.1.) diagramatically represents the discrete steps involved in one cycle of the AFSC programme, leading to the collection of data from one school.

Figure 1. **ARTISANAL FISHERIES STUDENT CENSUS**
FLOWCHART OF THE PROGRAMME CYCLE



The student log book and the data to collect

The student log book, which is produced by the Fisheries Department and dispatched to participating schools, is the heart piece of the AFSC. It is in the student log book where the data get recorded onto daily log sheets. Its design, layout and appeal will be commanding factors for the quality of data returned. In previous trials, students logged information on household fishing activities for one entire week (Monday - Sunday).

It is suggested that the student log book be sub-divided into three distinct parts; 1) the guidelines, 2) a one page questionnaire on student identity, village, and household fishing gear assets and 3) a series of single page log sheets to record household fishing activity (one single page per day). The exact make-up of the student log book will vary from country to country, and will depend on the characteristics of the fisheries it tries to collect data from. The following points describe the suggested general design of the student log book.

1) *The guidelines*

The fisheries department has no direct control over the number and content of lectures that the students get on the subject matter, nor on the provided explanations on how to use and fill out the log book. For this reason, a summary of simple guidelines on how to log the data should be printed at the beginning of the log book. If a student is not sure about how to go about the task, he/she can revert to the guidelines at the front of the logbook to seek clarification.

Should the log sheets ask for the measurements of fished species, then the guidelines should also contain figures of the range of species expected to be reported, and the way they are meant to be measured.

In order to guarantee best understanding of the log book and the involved tasks, the Fisheries Department can also provide the participating schools with a “Student Workbook”, containing a range of training exercises specific to the task of handling the log book.

2) *The first questionnaire: student identity, village, household and fishing gear assets*

The questions on this page are filled in once, and are of socio-economic nature. Questions covering the following topics can be found on this page;

- length of village coastline
- no. of households in village
- no. of people in household
- list of fishing gear owned by household
- use of the catch (eat/sell)
- amount of fish consumed (buy/catch)

From data of this type it is possible to compute general indicators for fishing intensity, as well as analyse some important economical aspects related to rural consumption patterns, sale and purchase of seafood. Some of the information might be available from other sources (*e.g.* national population census). If such is the case, the questions should not be repeated in the questionnaire in order to keep data handling workload as low as possible.

3) *The daily single page log sheets*

For every single day the assignment lasts, one of these sheets is filled out by the student, recording the fishing activity by the members of his/her household. Questions asking for specific information on the household fishing activity of the day and outcome are found on these pages, and can include the following;

- no. people who fished
- no. of fishing trips
- trip duration
- fishing gear used
- catch table (name of species/no. caught/mean length)

From such a small amount of daily data, quite a few indicators can be inferred from. These include species diversity in the catch, mean length of caught species, mean length and mean catch of fishing trips, gear efficiency, gear preference, catch per unit effort, mean household fishing effort, etc. These are all indicators which become of great value to fisheries managers, once they have been collected over a reasonable period of time, and start yielding meaningful trends.

Discussion

The access to time series of fisheries data is of great value as a foundation to management regimes in any kind of fishery. The coincident lack of data and growing need for resource management should induce scientists to look for ways of generating the necessary information. In situations where data collection as a sustained effort has consistently failed, it should be possible to take advantage of the mistakes, by learning from them. The Artisanal Fisheries Student Census is such an effort, which recognises the reasons for previous failures, and tries to overcome these problems by actively avoiding them through the design of a new method.

It is hoped that the Artisanal Fisheries Student Census, which currently stands as a theoretical construction, will find use and implementation in the Pacific region. In order to have the theory substantiating into practical lessons, the FAO Sub-regional Office for the

Pacific Islands, in conjunction with the Fisheries Division of Samoa, is currently executing a project which analyses the potentials of the method in the field, aiming specifically at testing the quality of returned data that an active AFSC programme generates. Hopefully, the lessons drawn from that project and the ones to follow will bring Pacific nations a step closer to eventually achieving sustained artisanal fisheries data collection, and contribute to a brighter outlook for the future management of the coastal resources in the Pacific.

References

[1] Adams, T.J.H. *et al.* (1995) *Research on fisheries in the Pacific Islands region*. SPC/FFA Workshop on the Management of Inshore Fisheries in the South Pacific Islands, Background Paper 36, South Pacific Commission, Nouméa

[2] Baird, I.G. *et al.* (1997) *Participatory student research increases awareness of sustainable fisheries management*. PLA notes, Int. Inst. Envir. Dev., no. 30, pp.50-53

[3] Brown, I.W. & Fielder, D.R. (1991) *The coconut crab: aspects of the biology of* Birgus latro *in the Republic of Vanuatu*. ACIAR monograph no. 8, Australian Centre for International Agricultural Research, Canberra

[4] Crocombe, R. (1994) Workshop Overview. in *Traditional marine tenure and sustainable management of marine resources in Asia and the Pacific*. eds. South, G.R. *et al.* International Ocean Institute - South Pacific, Suva, pp. 291-300

[5] Dalzell, P. *et al.* (1996) *Coastal fisheries in the Pacific Islands*, Oceanography and Marine Biology: an Annual Review. **34**, pp. 395-531

[6] Dalzell, P. (1998) *The role of archaeological and cultural-historical records in long-range coastal fisheries resources management strategies and policies in the Pacific Islands*. Ocean and Coastal Management (Special Issue). **40**, nos. 2-3, pp. 237-252

[7] Foale, S. (1998) *Assessment and management of the Trochus fishery at West Nggela, Solomon Islands: an interdisciplinary approach*. Ocean and Coastal Management (Special Issue). **40**, nos. 2-3, pp. 187-205

[8] Johannes, R.E. (1997) *Traditional coral-reef fisheries management*. in Life and Death of Coral Reefs. ed. Birkeland, C., Chapman and Hall, pp. 380-385

[9] King, M. & Fa'asili, U. (1998) *A network of small, community-owned village fish reserves in Samoa*. Parks (IUCN). **8**, no. 2, pp.11-16

[10] McManus, J.W. (1997) *Tropical marine fisheries and the future of coral reefs: A brief review with emphasis on Southeast Asia*. Coral Reefs. **16**, suppl. pp. s121-s127

[11] Pomeroy, R.S. (1994) *Management options for small-scale fisheries*. in The Management of Coral Reef Resource Systems. eds. Munro, J.L. & Munro, P.E., ICLARM, Manila, pp.78-81

[12] Staples, D. (1997) *Indicators of sustainable fisheries development*. in Developing and Sustaining World Fisheries Resources. The State of Science and Management. eds. Hancock, D.A. *et al.*, Collingwood - Australia, CSIRO, pp. 719-725

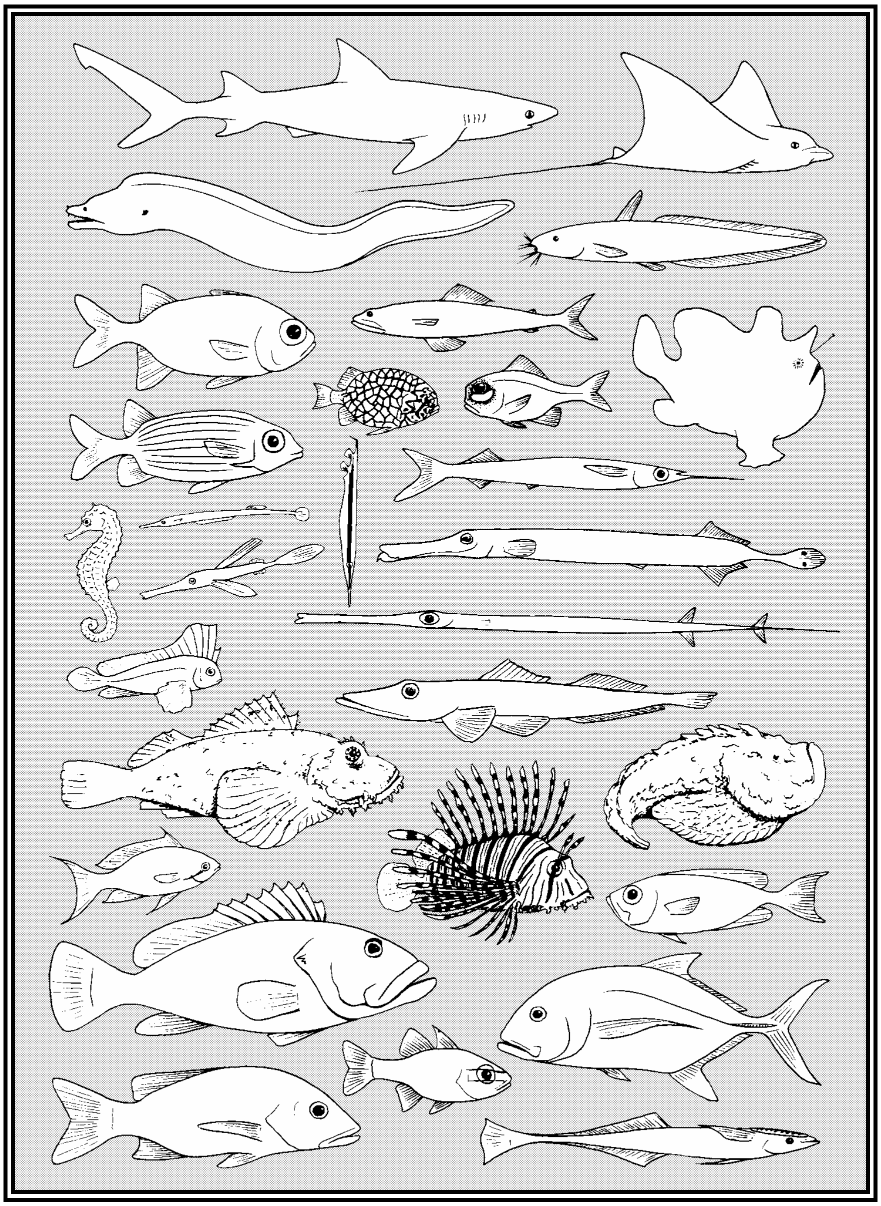
[13] UNESCO (1981) *Marine and coastal processes in the Pacific: ecological aspects of coastal zone management.* Report of a UNESCO seminar held at Motupore Island Research Centre, University of Papua New Guinea, 14-17 July 1980, **16**, UNESCO Reports in Marine Science

[14] Yeeting, B. & Wright, A. (1989) *A review of the status of fisheries resources in Tarawa Lagoon, Republic of Kiribati*. FFA Report No. 89/16, Forum Fisheries Agency, Honiara

[15] Zann, L.P. *et al.* (1991) *The inshore fisheries resources of Upolu, Western Samoa: coastal inventory and database.* FAO/UNDP Field Report No. 5, Food and Agriculture Organisation & United Nations Development Project, Apia.

Annex 3 Teaching Aids

1999 Artisanal Fisheries



Student Census

TEACHING SUPPORT MATERIAL

Contacts...

whom to talk to when you have got questions

At the FAO office in Apia

Mr Gilles Hosch
Project Co-ordinator

tel: 22127
fax: 22126

At the Department of Fisheries in Apia

Mr Kelvin Passfield (AusAID)
Fisheries Adviser

tel: 25506
fax: 20037

Mr Autalavou Taua
Extension Officer

tel: 20369
fax: 24292

The artisanal fisheries of the South Pacific

what are they? why are they important?
why do they get censused?

The South Pacific area is a vast expanse of ocean doted by roughly two dozen island countries. These countries are characterised by relatively small surface areas, often spread over numerous islands and large distances, and relatively small populations. Altogether, disregarding Papua New Guinea with its large land mass and population, there are only some 2.7 million people living scattered across the South Pacific islands.

Blessed with so much sea and given so little land, a look at the map will suffice to underline the fact that the ocean features as the top natural resource of this area and its people. The fisheries of the South Pacific play prominent roles from social, economic and nutritional perspectives. Much of every day life of many South Pacific islanders revolves around fishing and fishery related activities. Fishing provides incomes for families and national governments, and in no other geographical area in the world is the overall yearly *per capita* consumption of fishery products as high as in the South Pacific. In Samoa, typically some 50 to 75 per cent of dietary protein comes from marine food stuffs. In other South Pacific countries like the Cook Islands, the share of *marine* protein in the diet is even more important.

There is a general confusion in terms in the literature as to the exact meaning of the notion *artisanal fishery*. For matters of simplicity, *artisanal fishery* will stand for small-scale, capital extensive[1], inshore[2], community based fishery. In this context, the concept will be interchangeable with similar notions like *subsistence fishery* or *small-scale commercial fishery*.

The resources exploited in the artisanal fishery are both the fish of the reef (*e.g.* surgeonfish, wrasses, parrotfish, groupers, trevallies...), as well as the different groups of marine invertebrates inhabiting the various inshore coastal environments (*e.g.* sea cucumbers, marine snails, crabs, octopus...). Each individual group of animals is caught using a range of fishing gear, which is more or less specific, both to the group of animals it intends to catch, and to the environment (or habitat) it is being used in. In this way, a drop line[3] will be used for fishing in the deeper waters of the outer reef slope, targeting larger predators such as snappers and groupers, while a hook and line[4] can be used inside the lagoon to target smaller preys like surgeonfish, for instance.

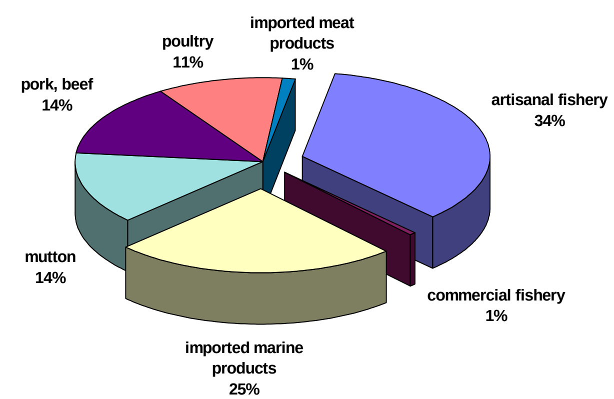
The large catch of marine fish and invertebrates channelled to the village communities through the combined yields of many thousands of individual fishing

[1] as opposed to capital intensive, involving bank loans and expensive fishing gear
[2] referring to the near coastal, the lagoon, the reef & the outer reef slope waters (opposite of high seas *or* oceanic)
[3] baited line with a lead weight making it sink into deeper water, always used from a paopao or a dinghy
[4] baited hand-held line with little or no weight, mainly used in conjunction with the paopao

efforts are the reason for artisanal fisheries to feature as a focal point on the agenda of national resources monitoring, assessment and management. This is illustrated by the following numbers; In 1997, the catch of artisanal fisheries in Samoa was an estimated 4,600 tons. This compares with "only" 1,838 tons (official figure for 1997) of commercial offshore catches (mainly tuna) harvested by Samoa's *alia* long-lining fleet. Virtually the whole of that commercial offshore catch was exported to canneries in American Samoa[5]. It follows from this, that 98.4 per cent of the catch consumed locally originates from the artisanal fishery. 3,234 tons of sea food products, mainly canned fish, were imported into Samoa in 1997.

In a typical rural Samoan setting, the total protein supply of a household can be broken down into the components represented in figure 1. From this it is possible to obtain a very clear understanding of the important contribution of the artisanal fishery catch to the nutritional balance of an individual, as well as to national food supply and food security. It is also important to realise, that the 4,600 tons of catch from the artisanal fishery represent a cash equivalent of roughly WST 25 million at market retail value[6], which has of course weighty implications for the export-import balance of Samoa and the national economy. With the understanding of these figures, the importance of the artisanal fisheries to South Pacific island countries becomes clear.

Fig.1. Sources of rural protein supply



Fisheries in general exploit living natural resources, which, no matter how plentiful and unlimited they may seem, are indeed limited. Every stock of fish and invertebrates evolves along principles and laws of population or stock dynamics. Every given ecosystem and habitat harbours a precise number of individuals of a certain species, and can therefore only support a finite amount of fishing pressure[7]. If the fishing for a specific resource (*e.g.* giant clams) causes more individuals to be removed from a stock by fishermen, than the whole stock can replace through natural reproduction, then the fishery for that specific stock becomes unsustainable, and damage starts to be inflicted upon the resource base. This induces a natural and healthy stock to shrink in size and alter in age structure, to such a point where it cannot achieve successful or meaningful reproduction within its natural cycle anymore. At this point, any stock faces the threat of local extinction. This has been the case for two giant clam species in Samoa, of which the one stock is now extinct, and the other has become so rare in most places, that it is functionally extinct[8].

[5] 96.4 per cent of the offshore commercial catch was exported in 1997
[6] retail price taken at 5.5 tala per kg
[7] *fishing pressure* can be described as the mortality caused within a stock as a result of fishing activity
[8] this means that the population cannot recover, as there are not enough mature individuals left in the population to reproduce successfully

In order to avoid such irreversible ecological damage to a resource so important, it becomes a necessity to monitor the resource, to analyse the trends in fishing pressure and landings, and to recognise potential problems before they grow out of hand. In order to be exploited sustainably and at optimum levels, a resource needs to be managed with care, hence avoiding the risk of causing precious stocks to collapse or to go extinct.

Fisheries management is a relatively new and complex science. It fosters the potential of counteracting the natural dynamics of overfishing. Doing so, it applies a range of management measures to stocks, in order to guarantee their continued existence, as well as their continued exploitation and lasting incumbent benefits to the fishing communities. Such management options are extremely diverse and resource specific, and range from fishing gear limitations (*e.g.* banning the use of dynamite) over seasonal ground closures to the creation of fish reserves, just to name a few...

In order to enable the resource owners (central government / village community / individuals) to manage inshore fisheries resources, there is a need to first collect information on the current state and exploitation of the resource, <u>and</u> to analyse the development of the resource over time. The development trends of a resource over time can only be detected and analysed when data on resource condition and exploitation have been collected at regular time intervals in the past.

The classic way of collecting data on artisanal fisheries is through the *household survey* and the *creel census*. The household survey is an interview which is conducted in a number of households in a village, gathering information about household income and assets, household fishing practices and fishing gear, fish usage[9] and general eating habits. The creel census on the other hand, is an interview which is carried out at fish landing sites or on the fishing grounds, asking fishermen for information on their fishing trips. Sought data include time spent fishing, the type of fishing gear used, the number of people on the trip and the fishing grounds fished on. Furthermore, fishermen will be asked to show their catch, so that the different species of fish and invertebrates can be recorded, measured and counted. In order for the information collected in household surveys and creel censuses to be representative of the current state of affairs within an area (*e.g.* a district or an entire island), a lot of these household surveys and creel censuses have to be conducted.

By nature, household surveys and creel censuses, brain children of western fisheries science, generally involve a lot of trained manpower and coincident high costs. More often than not, South Pacific island countries lack funds and skilled personnel to carry out these “classic” fisheries surveys on a regular basis. Hence, for lack of data, it proves difficult for these nations to acquire a clear picture of the state of their inshore resources, and to manage them efficiently. In the meantime, some of these resources continue to dwindle under the increasing pressures of growing populations and the uses of new, technologically more advanced and more efficient fishing gear.

[9] *fish usage* refers to whether caught fish is sold, given away or consumed within the household

Our aim is to examine, whether we can remedy to this problem encountered in small island countries across the South Pacific. The riddle we want to solve with and through the student census is;

> **Is there a way to collect information on artisanal fisheries in the South Pacific in a more appropriate, more effective and more meaningful manner?**

The Coral Reef and its Inhabitants

important animal groups in coral reef fisheries

Coral reefs are amongst the most diverse ecosystems in the world[10]. They also feature amongst the most fragile. Coral reefs are located in the warm and clear tropical waters of equatorial latitudes all around the world. A healthy reef can be portrayed as an undivided living entity, which is composed of a myriad individual creatures. All these creatures, ranking from the hermatipic[11] coral polyp to the preying reef shark, simultaneously form, share and exploit the coral reef, filling specific niches, crucial to the balanced climax condition and health of the undisturbed reef.

Coral reefs are only to be found around land masses, where water quality allows their establishment and continued existence. Three aspects play crucial parts in terms of water quality; 1) the water temperature must remain well above 20° C throughout the year; 2) the water must be very clear in order to allow maximum light penetration, and; 3) nutrient levels in the water must be very low in order to prevent turbidity and excessive algal growth. Compromised water quality entails compromised performance of the coral reef ecosystem. Often, human developments in the coastal zone lead to the deterioration of coastal water quality. One such example is the clearing of mangrove forests. Mangroves act like filters for fine sediments of terrestrial origin. Once the mangrove forests are cleared, river sediments are not retained anymore, causing turbid reef waters and increased nutrient loads, all of which impinge on coral growth.

Natural disturbances to the coral reef include coral-eating crown-of-thorns starfish outbreaks, tidal emersion of the reef during exceptionally low tides, and cyclone damage. Cyclones can kill off live coral down to depths of 30 meters. In Samoa, cyclones Ofa and Val (1990 & 1991) represent such occurrences, during which large areas of intact reef around Upolu and Savai'i were completely destroyed. The rate of recovery of the reef after such occurrences depends chiefly on the presence or absence of other (natural or human) disturbances, while complete recovery can take as long as one hundred years.

Reef cross-sections and the succession of habitats along a transect running from shore to sea vary widely. External factors such as latitude, wind exposure, marine currents and fresh water run-off all impact on the exact make-up of a reef system in any given geographical location. A "typical" fringing reef cross-section is represented in figure 2.

The most important group of animals in the coral reef community consists of the diverse array of hermatipic coral species. Through their secretion of limestone

[10] with the term *diversity*, ecologists apply a measure to the number of different species and taxonomic groups of plants and animals sharing a common habitat

[11] in opposition to soft corals like sea anemones, hermatipic corals are so called hard corals, depositing limestone structures, which form the "backbone" of the reef. Most hermatipic corals are colonial.

structures, which form their skeleton, corals come forth as the builders of reefs. Most South Pacific islands are of volcanic origin. Their fringing and barrier reefs are “sitting” on volcanic bedrock, and are entirely made up of limestone which has been deposited by corals over aeons of time. Therefore, coral reefs can be pictured as flourishing and thriving ecosystems, aggregating on top of graveyards of gigantic dimensions.

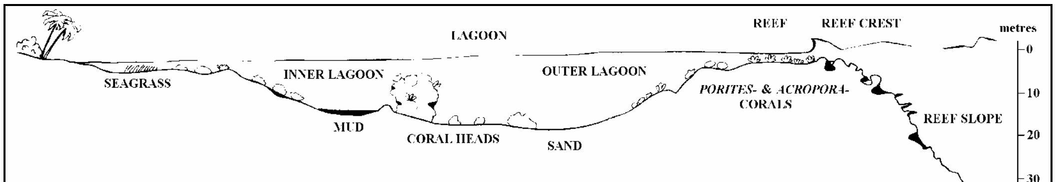


Fig.2. Transect across typical fringing reef

Although plant growth is limited in intact coral reef systems, algae are yet to be encountered. Algal growth occurs in nearshore lagoon areas, where nutrient run-off from land enriches the waters enough to sustain benthic algal growth in modest proportions. Specific communities of fish (esp. juveniles) and invertebrates roam these “algal gardens”. There is also some growth of calcareous algae taking place on the reef. These encrusting algae contribute to the amalgamation of dead coral rubble into coherent limestone substrate, and are thus of importance in the on-going process of reef formation and build-up.

The most important alga is not visible to the human eye. The zooxanthella *Symbiodinium microadriaticum*, a unicellular dinoflagellate[12], lives in symbiosis[13] within the tissues of hermatypic corals. Zooxanthellae perform a crucial biological function. The mutual exchange of algal photosynthates and cnidarian[14] metabolites provide the key to the prodigious biological productivity and limestone-secreting capacity of reef corals.

Next to the reef-building corals, there is a significant number of other invertebrate phyla inhabiting the reef. The most conspicuous and important invertebrate groups are the following;

Echinodermata[15]: the echinoderms contain the mostly scavenging or predatory starfish (*Asteroidea*), the grazing sea-urchins, the sand-dwelling sand-dollars (*Echinoidea*), and the sand-filtering family of sea cucumbers (*Holothuroidea*), sometimes referred to as bêche-de-mer. All of these animals are important contributors to the dynamical equilibrium of the ecosystem, and sea-urchins and bêche-de-mer are both important species to the fishermen, who process parts of these animals into various forms of value added seafood products.

Mollusca[16]: the molluscs are a diverse group, containing the snails (*gastropoda*), the bivalves (*bivalvia*) and the cephalopods (*cephalopoda*). All of these groups contain

[12] dinoflagellates are a diverse group of unicellular, mostly planktonic algae, which are often associated to coastal algal blooms and seafood poisoning
[13] symbiosis denotes the living in close association of two dissimilar organisms. In this case, the association is of mutualistic nature, where both organisms derive a direct benefit from the association.
[14] from the word *Cnidaria*, which is the phylum (*i.e.* animal group) all soft corals, hard corals, and medusas belong to
[15] derived from Greek roots (*echinos & dermis*), and signifies “*spiny skin*”
[16] from Latin *molluscus*, signifying *soft nut* or *soft fungus*. The word relates to the soft body of molluscs, which has no inner nor outer skeleton

species which are important in coastal fisheries. Snails like the trochus or the turban shell are valued both for their shells and/or their meat. These two herbivorous species play important roles in various South Pacific island economies. There are also the predatory snails (*e.g.* cone shells), and some are found parasitising bivalves, the distant mollusc cousins of snails. The bivalves are mostly sessile animals, which spend their entire lives in the same spot. The most sensational bivalves of the Southern Seas are the giant clams, which can have shells growing to sizes of more than 1 metre across. The black lip pearl oyster is a species which is of economical importance in pearl producing countries like French Polynesia, the Cook Islands and Fiji. Bivalves feed by either siphoning in sediment and digesting the organic content, or filter feed, by filtering suspended organic particles out of the water column. Octopuses, squids and nautilus shells make up the cephalopod group. The beautiful shell of the nautilus stands as evidence for the membership of these intelligent animals within the mollusc phylum. Octopus and squid are valued seafood items, while the shell of the nautilus is an attractive cash earner in the souvenir industry. All cephalopods are predators.

Crustacea[17]: the crustacean radiation[18] is phenomenal. Over 40.000 known species exploit about every single niche in the marine environment. They rank from fully planktonic[19] and microscopic individuals to sedentary[20] ones, reaching up to 20 kilograms in weight. From all the groups evolved within this phylum, there are only three of interest to the artisanal fisherman. These are the shrimps, the crabs and the lobsters, all belonging to one and the same crustacean order, the decapods (*Decapoda*). Decapods are mostly scavengers and predators.

Next to the invertebrate phyla, there are the ever so colourful and numerous vertebrate inhabitants of the coral reef, namely the fish. While invertebrates are generally associated to substrate bound niches and therefore less easy to spot, the fish are conspicuous, out and about, claiming the water column their own. Fish come in all sizes, colours and trades; some are large, monochromatic and predatory, like the great silver-flanked barracuda, others are tiny and fluorescent, dwelling in the interstitial water spaces of coral heads. There are some 25.000 known species of fish. They are the most diverse and successful group of vertebrate animals.

Fish fall into two phylogenically distinct groups, the bony fishes (*Osteichthyes*) and the cartilaginous fishes (*Chondrostei*), of which the first group is by and large the most abundant in total numbers of species and also in numbers of species represented in the coral reef ecosystem.

The evolutionary older and more primitive group, the cartilaginous fishes, includes the sharks and the rays. One of the more primitive morphological[21] features of these fishes is the lack of a swimbladder. The skeleton of cartilaginous fishes consists of pure cartilage, which is structurally weaker than bone. There are only few species of sharks and rays inhabiting the reef environment. The important task of reef health

[17] from Latin *crusta*, signifying *rind* or *crust*. The word relates to the chitinous (hard) exoskeleton of crustaceans
[18] the *radiation* of a phylum refers to its division into different groups and families of animals, having conquered distinctive niches, habitats and ecosystems over evolutionary time
[19] a creature is said to be *planktonic*, when it spends its whole life suspended within the water column
[20] opposite of *planktonic*, spending its life associated to a substrate
[21] from *morphology*, which describes body form, body parts and their functions

police[22] is performed by sharks, high ranking predators feeding primarily on other fish. Rays feed mostly on benthic invertebrates such as molluscs and crustaceans.

The bony fishes of tropical marine environments are best subdivided into functional groups, which relate to their respective habitats and communities. The groups we can easily identify in a coral reef ecosystem are *inshore fish*, *coral reef fish*, *offshore demersal fish* and *pelagic fish*. These four discrete fish communities exploit four very distinctive environments within the coral reef ecosystem (see fig.2.). These are; a) the sheltered inshore waters, including nutrient rich, productive mangrove areas and estuaries; b) the coral reef itself, a highly energetic[23] three dimensional[24] environment yielding the highest diversity of fish species; c) the deep waters of the outer reef slope; and d) the open water column of both the lagoon and the oceanic waters lying beyond the reef crest.

Inshore fish: as stated earlier, some fish roam inshore waters as juveniles. Some emperors and trevallies belong to this category. Others, like the mullet, use inshore waters on a seasonal basis as breeding grounds. Typical representatives of this group are garfish, perches, mullet and goatfish. These fish are important in inshore fisheries. The mullet, for instance, is traditionally fished in Samoa during its September inshore breeding migration, using fish traps.

Coral reef fish: coral reef fish tend to be associated to a particular spot (in various cases one specific coral head) throughout their adult lives, and are thus highly territorial. Their bright colouring and ritual swimming patterns serve the cause of territory demarcation and defence. Typical representatives are angel-, damsel- and surgeon fish. The larger, predatory reef fish are often less colourful and roam larger areas in search of prey. Illustrative examples include emperors and snappers.

Offshore demersal fish: off the reef slope, in the deep waters near the sea floor, at depths of around 200 meters, all coral growth has ceased. In this light deficient and colder environment, deep-water snappers make their living. Representatives include the red snapper and the rusty jobfish. These fish form the basis of valuable outer reef fisheries in various South Pacific countries, which generally lie beyond the reach of artisanal fishermen, because of more serious equipment requirements. In Samoa, the fishery targeting these deep water species was originally developed during the mid-seventies, making use of the *alia* fitted with four handreels[25].

Pelagic fish: all of the pelagic fish are predators hunting for smaller fish in the surface waters of the lagoon and the open ocean. Pelagic fish commonly encountered around the open waters of coral reefs are barracudas and Spanish mackerels. These large fish are caught in the artisanal fishery, but do not contribute nearly as much to the total artisanal fisheries catch as inshore and coral reef fish do.

The bulk of the overall artisanal fisheries catch is made up of inshore and coral reef fish species.

[22] in ecology, the concept of *health police* implies that the tendency of top predators to “weed out” the weaker and/or diseased individuals within a prey stock contributes to the maintenance of thriving and healthy gene pools within prey species populations

[23] *energetic* due to the strong currents prevailing in shallow waters on the reef

[24] *three dimensional* due to the coral head outcrops which project into the water column, giving rise to shelters, tunnels and other confined water spaces

[25] both *alia* and “Samoan” handreel were originally designed and built for this particular type of fishery by FAO

Another (non-fish) vertebrate group of importance to artisanal fisheries, more for its conservation value, rather than for being a major contributor to the catch, is the family of sea turtles. Much alike to the history of giant clam exlpoitation, the fishery for sea turtles has induced worrying reductions in stock sizes of certain turtle species in the past. This gave rise to various turtle protection schemes across the Pacific, and also in other parts of the world.

There are three known turtle species in the South Pacific. These are the hawksbill turtle, the green turtle and the leatherback turtle. All of these enjoy some degree of protection in most South Pacific island states. Turtles are valued both for their meat and their shells. Turtle shells were traditionally crafted into shields for warfare by some indigenous Pacific people. A range of other customary practices and traditional cults also relate to the turtle. Turtles are agile, air-breathing swimmers, which lay and bury their eggs on sandy beaches, well above the water line.

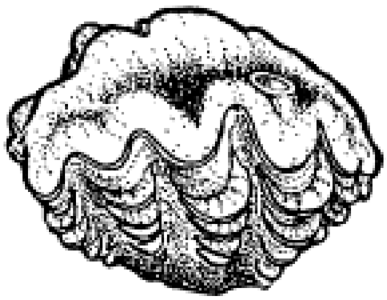
All these animals, vertebrates and invertebrates alike, make up the pool of natural resources from which the artisanal fisheries draw their daily, seasonal and yearly catches. All the different species are interwoven into an intricate net, which is generally referred to as the "food web". Within this highly dynamic and interconnected network, every single species performs a precise role, both as an exploiter, and as a "service provider". Disturbances at any level of the food web will cause knock-on effects to directly related components within the system. As stated earlier, disturbances can be of natural or human origin. Fisheries, when conducted within reasonable limits, fit into the food web as a comprehensive component, and a healthy balance between all components, including human fishing, is achieved and can be maintained. Any disturbance of unreasonable magnitude though, will cause the network to collapse, and losses in productivity ensue.

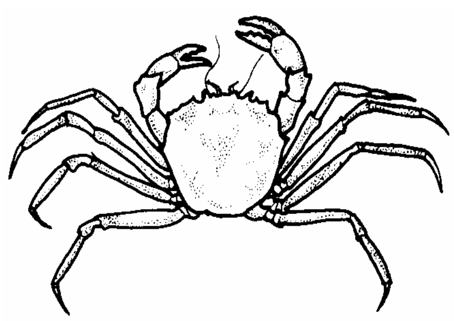
For this reason, the artisanal fisherman has got to be pictured as an integral part of the system. Within this perspective, the fisherman ranks as the top predator and "inhabitant" of the coral reef ecosystem. His rank as top predator provides privileges, but it also entails duties[26]. The nature of our fishing, and more importantly the very perception of our duties towards our environment, which provides us with our daily sustenance, ordains whether the delicate ecosystem we exploit is going to strive, or whether it is going to suffer.

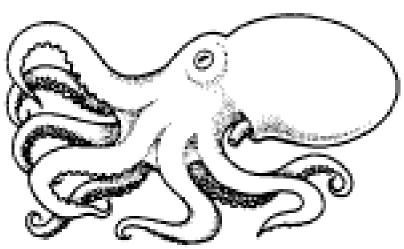
[26] *What will the sharks prey upon, after they have finished off the fish?*

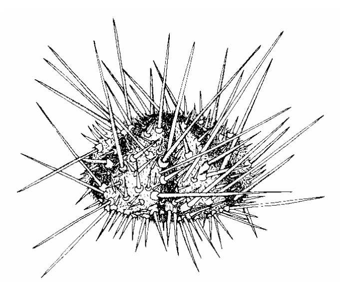
Student Workbook Solutions

linking animals to their scientific groups









- CRUSTACEAN
- ECHINODERM
- BIVALVE
- GASTROPOD
- CEPHALOPOD

Student Workbook Solutions

logging the daily catch

Table 1. Catch of the Day

	name	how many?	middle length (cm)
1	parrotfish	6	43(or 44)
2	surgeonfish	6	18(or 20)
3	trevally	3	55
4	garfish	3	34
5	grouper	1	72
6	barracuda	1	109
7	octopus	1	22
8			
9			
10			
others	no. species:	no. fish:	

Student Workbook Solutions

The three stories and the log tables

Story 1

Table 2. Fishing Trips

	no. people [1]	fishing gear used	area fished [2]	trip length (hrs)	no. canoes/dinghies	day/night/ both	village waters [3]
1	1	drop line	outer slope	4	1 canoe	both	no
2							
3							
others	no. trips				total hours:		

1) only from your household **2**) near shore / mangrove / lagoon / reef / outer slope **3**) "yes" if fishing was done exclusively in village waters, otherwise "no"

Story 2

Table 2. Fishing Trips

	no. people [1]	fishing gear used	area fished [2]	trip length (hrs)	no. canoes/dinghies	day/night/ both	village waters [3]
1	3	gill net	lagoon	2	–	day	yes
2	2	buckets	lagoon	2	–	day	yes
3							
others	no. trips				total hours:		

1) only from your household **2**) near shore / mangrove / lagoon / reef / outer slope **3**) "yes" if fishing was done exclusively in village waters, otherwise "no"

Story 3

Table 2. Fishing Trips

	no. people [1]	fishing gear used	area fished [2]	trip length (hrs)	no. canoes/dinghies	day/night/ both	village waters [3]
1	1	handline	lagoon	2.5	1 canoe	both	yes
2	1	8 crab traps	mangrove	3	–	day	yes
3							
others	no. trips				total hours:		

1) only from your household **2**) near shore / mangrove / lagoon / reef / outer slope **3**) "yes" if fishing was done exclusively in village waters, otherwise "no"

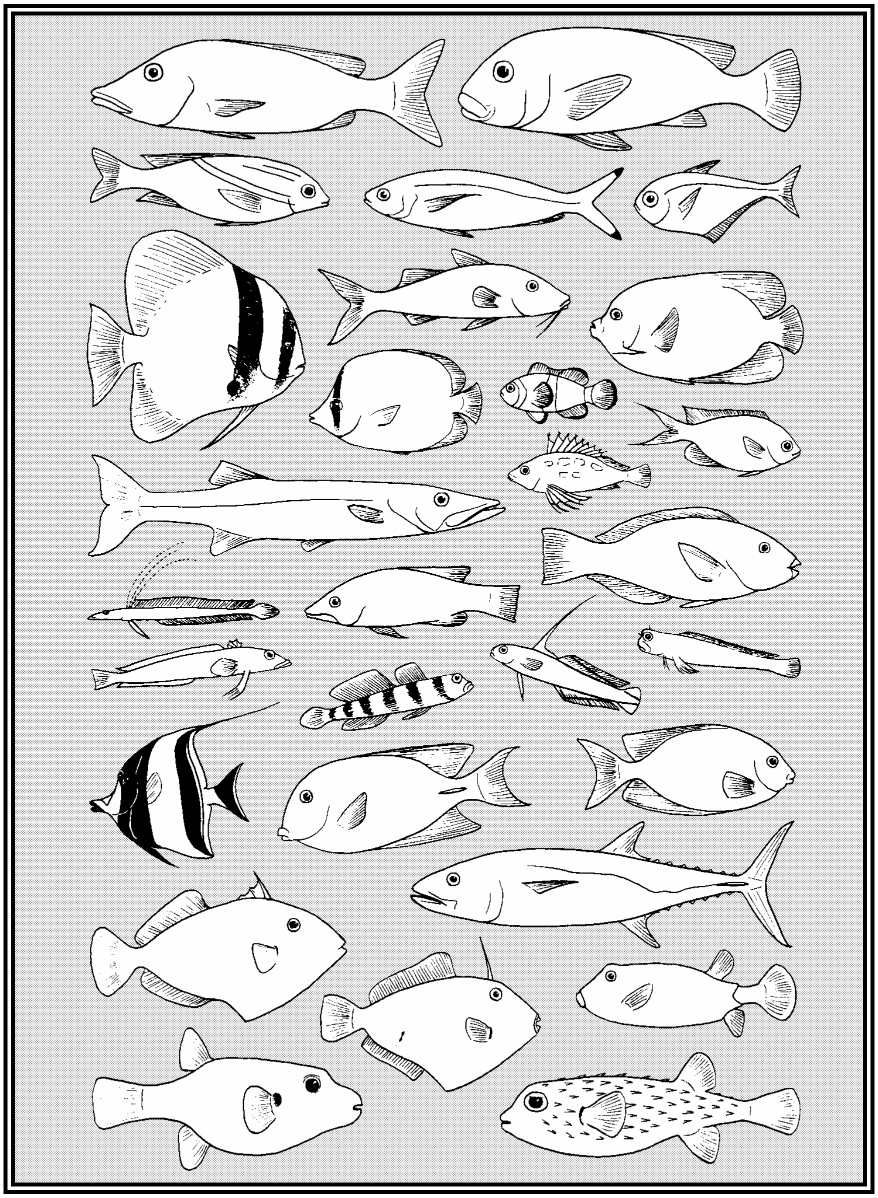
Student Workbook Solutions

The mutiple choice questions

1. The student census collects information on	fishing methods used by your household	✔
	household eating habits	✔
	your parents' fishing skills	☐
2. The success of the student census depends on	every individual effort in collecting information	✔
	the amount of fishing done in your household	☐
	the quality of collected information	✔
3. The information recorded by the census will	give an idea of the total number of fish caught	✔
	lead to a ban on fishing	☐
	help to recognize problems in the fishery	✔
4. Recording of wrong information will	make my family look great	☐
	distort the general picture of the survey	✔
	endanger the team effort and spirit	✔
5. Your household should	be told what your assignment is about	✔
	fish more during the census period	☐
	not change its fishing habits because of the census	✔
6. The term *seafood* applies to	marine and freshwater fish	☐
	all marine fish and figota	☐
	marine food items of both plants and animals	✔
7. The term *fishing trip*	is always linked to the use of a canoe or a dinghy	☐
	only applies to a group of people fishing	☐
	means a specific fishing event done by one or more people	✔
8. The term *species* refers to	a group of animals which God created on the 4^{th} day	☐
	all animals with specific uses to man	☐
	one precise animal or plant (*e.g.* the Indian Elephant)	✔
9. The term *bivalves* refers to	a group of aquatic animals with two shells	✔
	an animal species	☐
	fish of the coral reef	☐
10. Giant clams are *invertebrates* because	they do not move	☐
	they have no backbone (vertebral column)	✔
	they filter water	☐
11. Dynamite fishing is criticised because	it is loud	☐
	it kills everything	✔
	it damages the reef and reduces future catches	✔

Annex 4 Student Exercise Book

1999 Artisanal Fisheries Student Census



STUDENT EXERCISE BOOK

Dear Friend of the Sea,

This year, you and your school are participating in a very valuable effort to collect information on the coastal fishery of the Aleipata district. This project tries to obtain a better understanding about the marine resources in Aleipata, and by doing so, hopes that you and your classmates will benefit from your involvement by gaining a more complete understanding of these resources yourselves.

The work involved is fun and easy going. Learning by doing, the project asks you to observe the fishing activities of your household for a week, and record the information in a standard format within the “Student Log Book” that you will be given.

In order to train yourself at recording the information over the week, this Exercise Book will serve you as a training guide. There are four small exercises you can complete. The first one helps you getting a grip on scientific names for groups of marine animals (*link them up*). The two following exercises (*log the catch* & *log the trips*) help you to see how daily fishing information is recorded into the tables, which are part of your Student Log Book. With the last exercise (*checking my understanding...*) you can test your general understanding of the project and the coastal fisheries, as it has been explained to you in class.

When the project is completed, the information that you have collected along with your classmates will be pooled and analysed by the Food and Agriculture Organisation of the United Nations (FAO). Once analysed, you will be provided with a summary of the obtained statistics. Here you will find estimates of how many people fish in Aleipata, what fish is caught most, how much fish is caught in an hour, and much more... This will show you where your family’s activities are situated in the general picture, and will provide you with an idea of how important fishing is in your community in general.

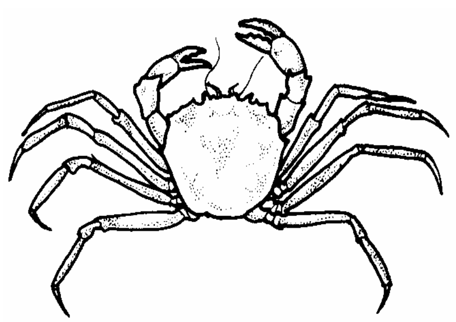
Enjoy!

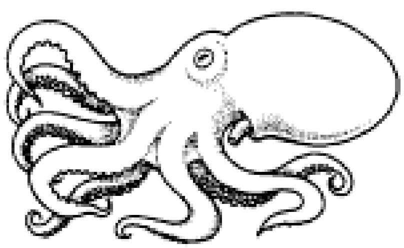
Your Name: ____

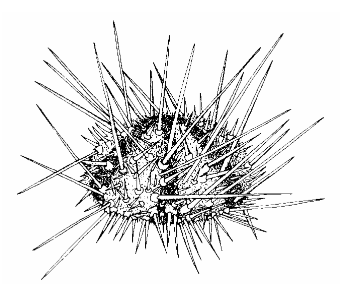
Your Class: ____

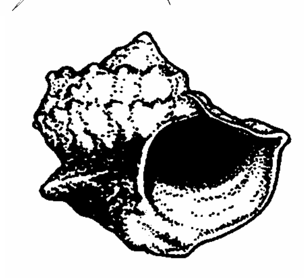
link them up

what scientific groups do these animals belong to?





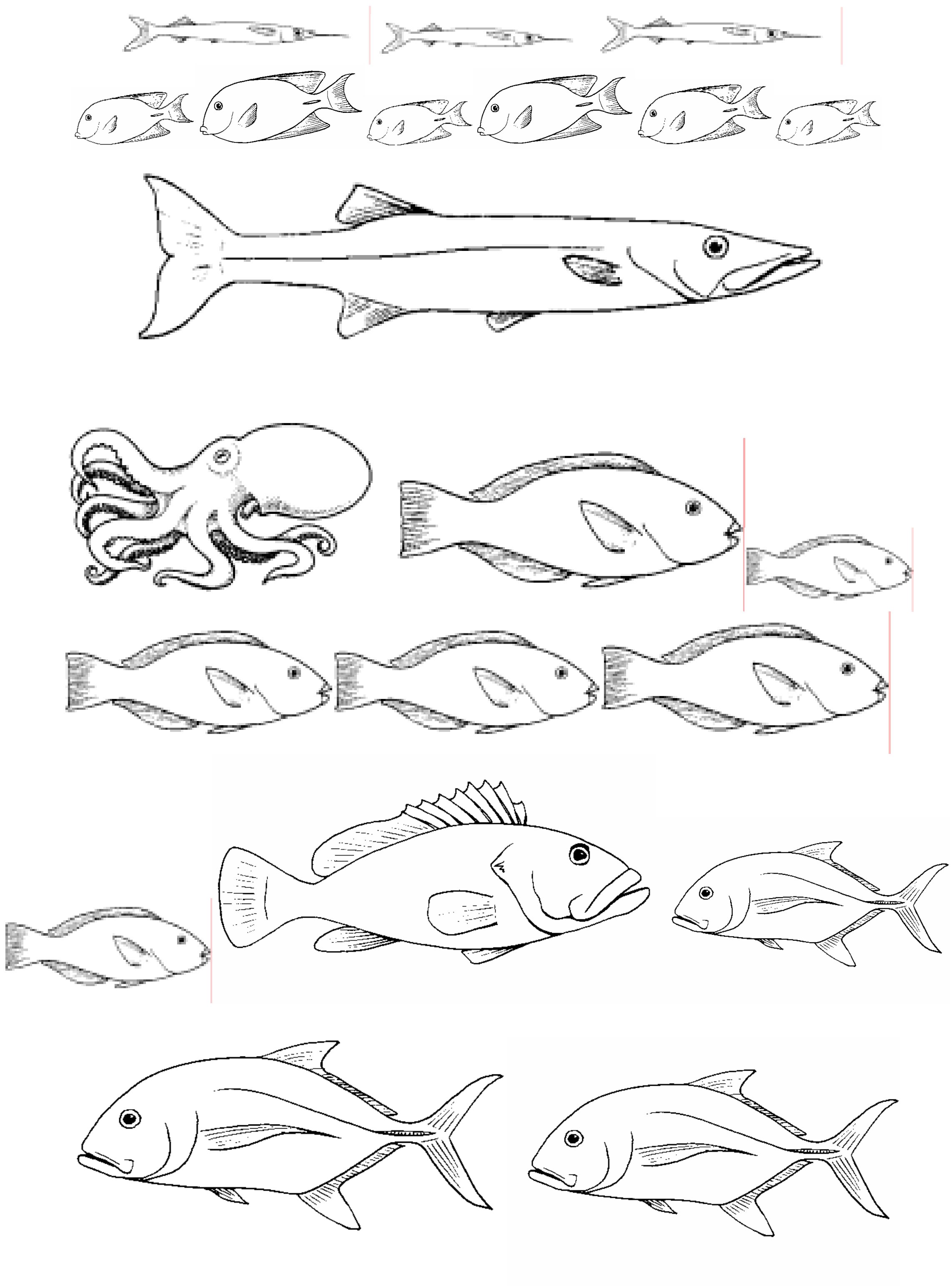




- CRUSTACEAN
- ECHINODERM
- BIVALVE
- GASTROPOD
- CEPHALOPOD

log the catch

this is today's catch!



log the catch (ctd)

count, measure & record the catch in the table below (table 1. in your daily log sheets).
(for the purpose of this exercise, 1mm on paper will be reported as 1 cm in the log below)

Table 1. Catch of the Day

	name	how many?	middle length (cm)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
others	no. species:	wt estimate (kg):	

log the trips

the following stories tell the day’s fishing of a household.

Story 1

At around half past four that morning, my father got up to go fishing. He took his droplines, and walked down to the beach, to where his Paopao was lying. He shoved it into the water, got in, and oared off into the lagoon. Father always fishes by himself, as he likes the quietness of the sea, and enjoys to have some time on his own. That morning, there was a spring high tide, and it was easy for him to get across the reef into the deep water. Around this time of the year, father sometimes gets out there to catch schoaling big-eye trevallies on the drop-off.

He was back by half past eight, and had caught quite a few trevallies and a sizey grouper, all of which guaranteed a decent feast for the whole household and our neighbours that same evening.

Story 2

After school, three of my brothers went fishing. It was around half past two in the afternoon. They waded off into the lagoon with a long gill net, their minds set on catching a whole bunch of smaller reef fish in the shallow lagoon, just a few hundred meters offshore from where our house sits, right next to our village fish reserve. For some reason, they believe that fishing close to the reserve increases their chances of catching more fish!

During the same time, two of my sisters, with their buckets, waded off into the shallow lagoon towards the other end of the village, to collect sea cucumbers and sea urchins. All five were back two hours later to show off their respective catches.

Story 3

Yet another rainy summer day in early February. An early riser, my older brother took the canoe at five o’clock in the morning and oared off into the deeper lagoon to go handlining. He managed to bring home a few reef fish at half past seven, but overall, his catch was not impressive.

Later on in the day, sometime in the afternoon, my mother went, baited and set our 8 crab traps in the mangroves, and checked and retrieved the catch over a period of roughly three hours, laying her hands on a nice catch of crabs.

log the trips (ctd)

reproduced below you find the trip table related to each story.
report the fishing trips in the tables provided.
(these tables correspond to table 2. in your daily log sheets)

Story 1

Table 2. Fishing Trips

	no. people [1]	fishing gear used	area fished [2]	trip length (hrs)	no. canoes/dinghies	day/night	village waters [3]
1							
2							
3							
others	no. trips				total hours:		

1) only from your household **2**) near shore / mangrove / lagoon / reef / outer slope **3**) "yes" if fishing was done exclusively in village waters, otherwise "no"

Story 2

Table 2. Fishing Trips

	no. people [1]	fishing gear used	area fished [2]	trip length (hrs)	no. canoes/dinghies	day/night	village waters [3]
1							
2							
3							
others	no. trips				total hours:		

1) only from your household **2**) near shore / mangrove / lagoon / reef / outer slope **3**) "yes" if fishing was done exclusively in village waters, otherwise "no"

Story 3

Table 2. Fishing Trips

	no. people [1]	fishing gear used	area fished [2]	trip length (hrs)	no. canoes/dinghies	day/night	village waters [3]
1							
2							
3							
others	no. trips				total hours:		

1) only from your household **2**) near shore / mangrove / lagoon / reef / outer slope **3**) "yes" if fishing was done exclusively in village waters, otherwise "no"

checking my understanding...

Tick the correct box (more than one correct answer per question is possible)
Go for gold!

1. The student census collects information on	fishing methods used by your household	□
	household eating habits	□
	your parents’ fishing skills	□
2. The success of the student census depends on	every individual effort in collecting information	□
	the amount of fishing done in your household	□
	the quality of collected information	□
3. The information recorded by the census will	give an idea of the total number of fish caught	□
	lead to a ban on fishing	□
	help to recognize problems in the fishery	□
4. Recording of wrong information will	make my family look great	□
	distort the general picture of the survey	□
	endanger the team effort and spirit	□
5. Your household should	be told what your assignment is about	□
	fish more during the census period	□
	not change its fishing habits because of the census	□
6. The term *seafood* applies to	marine and freshwater fish	□
	all marine fish and figota	□
	marine food items of both plants and animals	□
7. The term *fishing trip*	is always linked to the use of a canoe or a dinghy	□
	only applies to a group of people fishing	□
	means a discrete fishing event done by one or more people	□
8. The term *species* refers to	a group of animals which God created on the 4th day	□
	all animals with specific uses to man	□
	one precise animal or plant (*e.g.* the Indian Elephant)	□
9. The term *bivalves* refers to	a group of aquatic animals with two shells	□
	an animal species	□
	fish of the coral reef	□
10. Giant clams are *invertebrates* because	they do not move	□
	they have no backbone (vertebral column)	□
	they filter water	□
11. Dynamite fishing is criticised because	it is loud	□
	it kills everything	□
	it damages the reef and reduces future catches	□

Annex 5 Household Survey Questionnaire

General Information

1 Name of interviewer
2 Date of interview
3 Time of interview AM PM
4 Village name (& no. of households in village)
5 Name of household member

Household Information

6 No. of household members
7 No. regular income earners
8 Main household income (circle as appropriate): **farming** / **fishing** / **both** / **neither**

Seafood Consumption Information

9 Was there fresh seafood eaten in the household yesterday yes no
10 How much? (specifiy numbers & animals)
11 No. of seafood tins consumed / week (indicate size of tins)
12 Does the household **buy or receive** fresh/frozen seafood? yes no
13 if so, how much a week (in numbers)?
14 How is the household catch used?

eaten @ home		%
given away		%
sold off		%
	100	%

Fishing Gear Inventory

15 How many of the following does the household own? (indicate no. & size if applicable)

canoe	
dinghy	(indicate outboard engine)
line&hook	
trolling line	
seine net	
gillnet	
thrownet	
drive-in net	(fixed)
trap	(fixed)
	(moveable)
goggles	
u/w spear	

throw spear ______
uw torch ______
scuba kit ______
other ______

Fishing Methods Information

16 Rank fishing methods used by household;

gleaning	
hook & line	
trolling line	
gillnetting	
seining	
thrownetting	
throw spearing	
swim & spear	
scuba & spear	
fish trap	
crustacean trap	
dynamite	
ava niukini	
bleach	
other	

Fishing Ground Information

17 Does household fish exclusively in village waters? ______ yes ☐ no ☐
18 if not, what percentage is spent fishing outside village waters? ______ %

19 Rank areas fished by household according to importance;

near shore	
mangrove	
lagoon	
reef	
outer slope	

Fishing Intensity Information

20 No. of people fishing in household per week ______
21 No. of trips / person / week ______
22 How many people went fishing yesterday? ______

Annex 6 Creel Census Questionnaire

General Information

Name of interviewer ______________________________
Date of interview ______________________________
Village name ______________________________
Interview location ______________________________

Trip Information

No. people on trip ______________________________
Trip start (time) __________________________ AM PM
Duration (in hrs) ______________________________

Gear Information

Canoe __________________________ yes no
Dinghy __________________________ yes no
Main gear / fishing method ______________________________

Fishing Ground Information

Trip exclusively in village waters? __________________________ yes no
Rank areas fished during trip;

near shore	
mangrove	
lagoon	
reef	
outer slope	

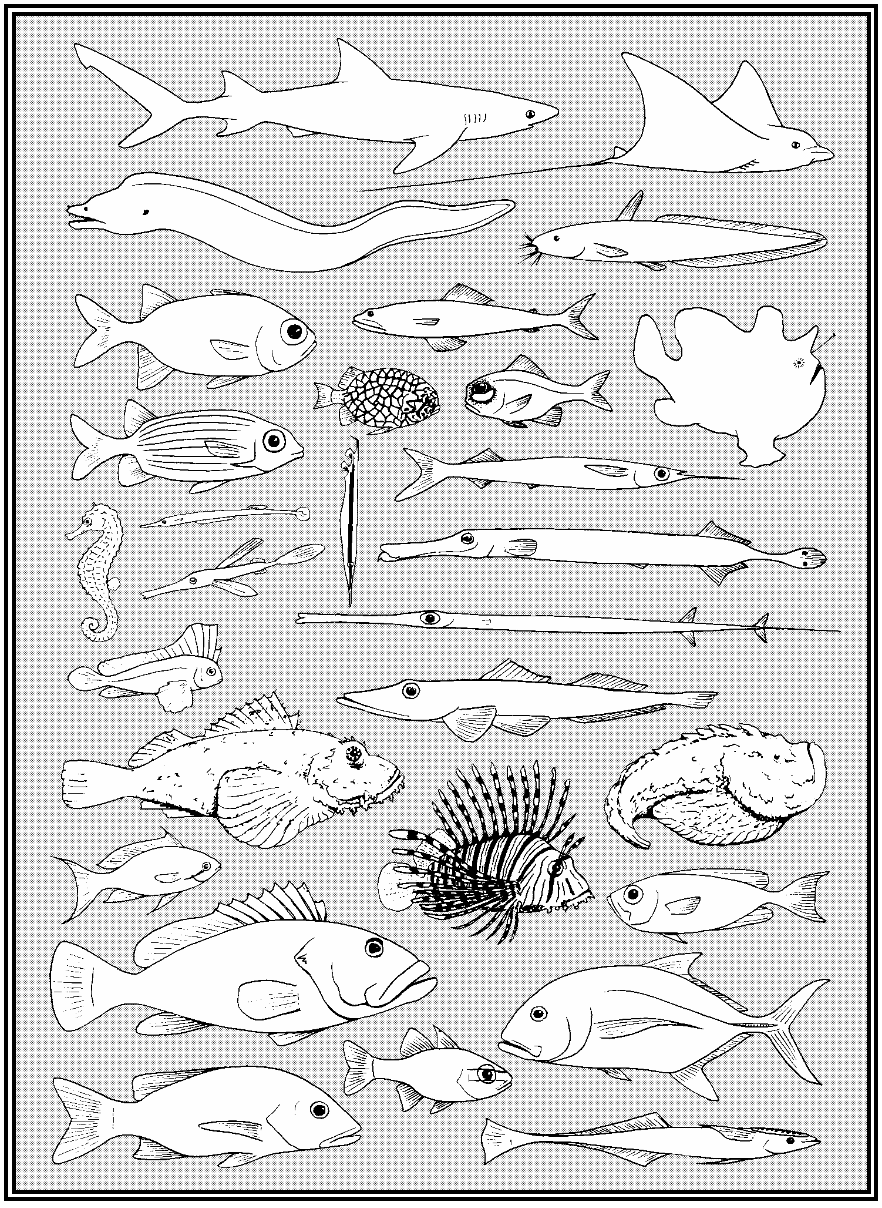
Catch Log

Species	how many	min. length	max. length	av. length
		(in cm)		

Intended fate of the catch	eat at home	%
	give away	%
	sell off	%
		100%

Annex 7   Student Census Logbook

1999 Artisanal Fisheries Student Census



STUDENT LOG BOOK

Guidelines

General Guidelines

1. Please make sure your handwriting is neat and easily readable.
2. Explain your assignment to your household, and make sure the members of your household understand the assignment, its purpose and its importance.
3. Always fill in the daily log sheets toward the end of the day, in order to allow for the recording of night catches.
4. You might not be able to measure and log catches at certain times of the day. Encourage your household members to help you in collecting the data and answering the questions.
5. Make sure to record **all seafood** fished **from the sea** by the members of your household every day. Being thorough and doing so will guarantee the success of this survey.
6. **This is not a contest!** Do not over-report household catches and other information. It will make our common effort and the survey fail.

The Frontpage Questionnaire

7. The *Frontpage Questionnaire* is a one page questionnaire which is filled out once. It is divided into four different headings.
8. Please answer the questions 1 to 11 under *About You and Your College...* and *About Your Household...* at the beginning of the week. These questions are important to find out information about your identity and your household.
9. The questions 12 to 14 under the headings *Dividing the Catch...* and *Eating Fish...* should be answered toward the end of the week. This will leave you the necessary time to observe what, and how much seafood is used, eaten, bought and sold in your household.

Filling in the daily log sheets

10. In this log book, there is one log page for every day of the week, including Saturday and Sunday. Always make sure that you are logging your information for the correct day.
11. Should you mess up a log sheet page, there is one spare blank page at the back, which you can use in stead. If you have to use it, make sure to point to that page, and write the name of the day into the blank top left hand corner.
12. The questions under the headings *For Starters...* and *About fishing today...* have to be filled out every day. They try to measure, how much seafood is consumed in your household every day, and whether there was any fishing done.
13. The term **seafood** in these questions applies to all plants and animals of marine origin, which are consumed by humans.

Table 1. Catch of the Day

14. In this table, the catch of your household is recorded on a daily basis.
15. Record the common Samoan name of the fish, figota, algae and other species in the catch, how many of them were caught, then measure and record the size of an average sized individual of that species to the nearest cm (*i.e.* neither the biggest, nor the smallest, but the individual in the middle).
16. Should you use up all 10 lines, the remaining catch is recorded under *others* as number of different species and total number of fish.
17. Limu is recorded in numbers of wrappings (ofu) it represents.
18. If nobody in your household fished on a given day, then table 1. and table 2. must remain empty for that day!

Table 2. Fishing Trips

19. This table seeks detailed information about every single fishing trip done by members of your household on a given day.
20. A **fishing trip** is defined as a discrete effort of one or more people engaging in a common fishing activity (either wading, swimming or using a boat), using a specific method and/or fishing gear, then coming back to shore and landing the catch.

21. If members of your household went on a fishing trip with members of another household, only record the number of people from your household, and only report your household's share of the catch (in table 1).
22. Under the heading *fishing gear used*, be specific about types of nets or traps used (*e.g.* gillnet, castnet, seine net, fixed fish trap, moveable crab trap, etc.).
23. Under the heading *area fished*, you can only put one of 5 options, namely *near shore* / *mangrove* / *lagoon* / *reef* or *outer slope*. These correspond to the different coastal environments that are found in Aleipata.
24. Under the heading *day*/*night*, indicate whether the fishing trip took place during hours of darkness (*night*), hours of daylight (*day*) or both (*both*).
25. Under the heading *village waters*, indicate if the fishing trip took place within the traditional fishing waters of your village (by marking *yes*), or whether some or all of it took place beyond those traditional boundaries (by marking *no*).
26. Should there be more than 3 trips undertaken by your household in one day, and you run out of space in the table provided, record the number and total duration of the surplus trips in the 4^{th} line under *others*.

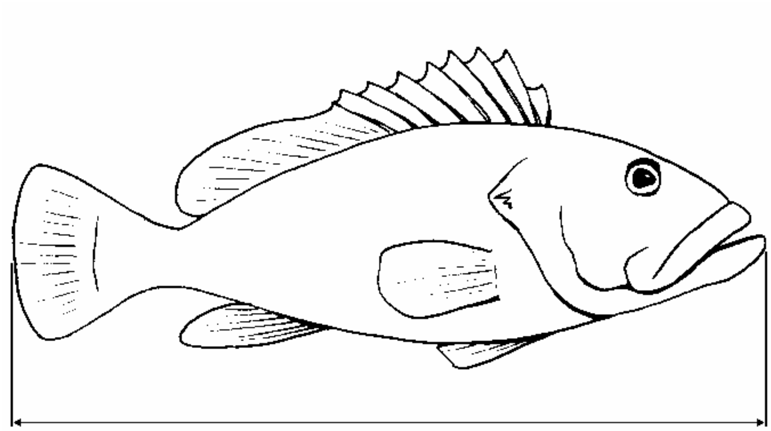
Remarks

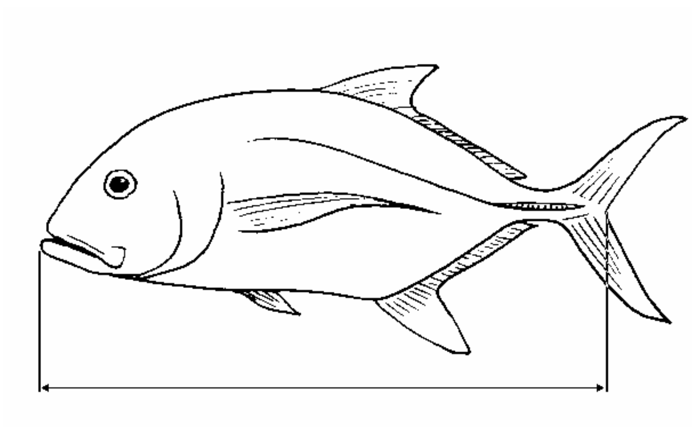
27. Under the heading *Remarks*, you can add comments, if you feel that you could not report the day's activities accurately within the space provided, or if you feel that there is some important information that should be reported.

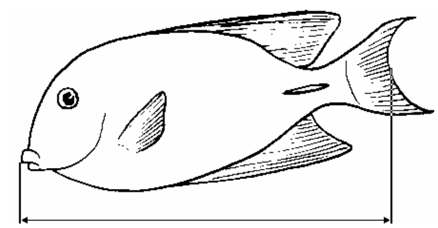
Guidelines for taking measurements

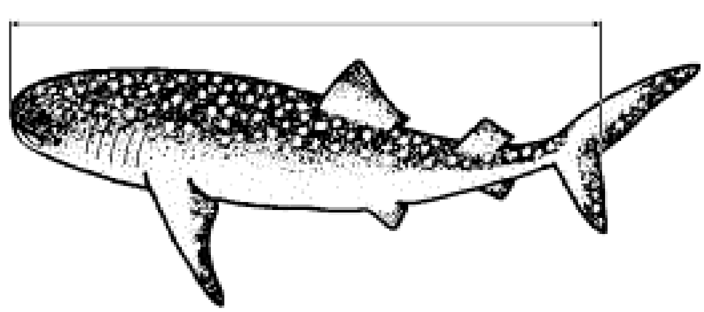
28. There is a ruler printed onto the back cover of this log book which you can use to take the measurements.
29. Measurements of fished animals must be taken according to the diagrams outlined on the following 4 pages. Measurements are taken along the axes indicated by the double-pointed arrow.

Fish



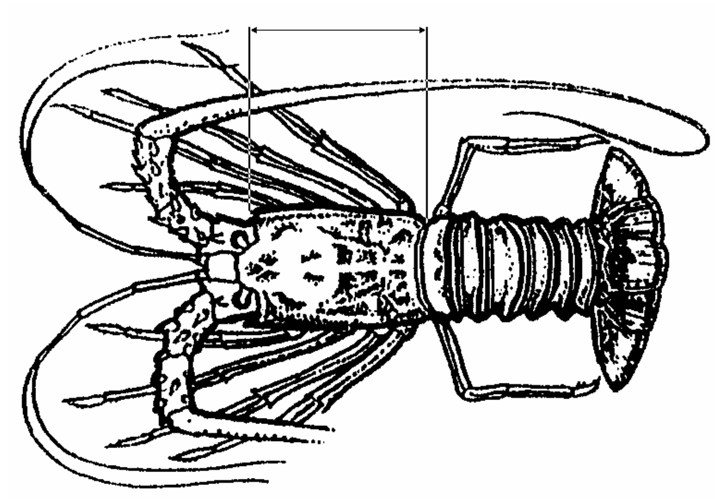


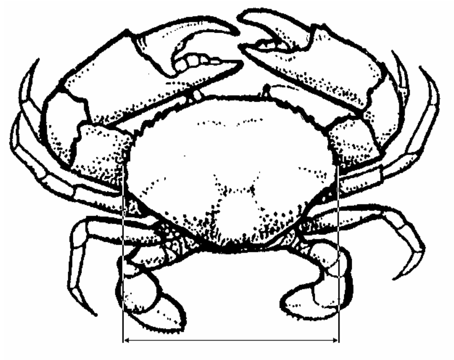


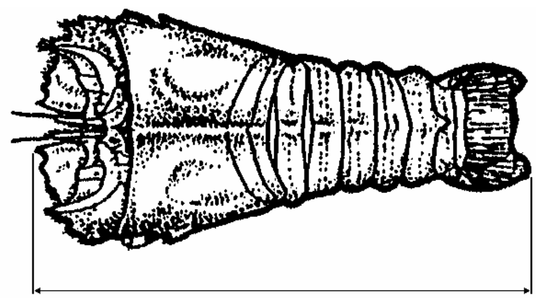


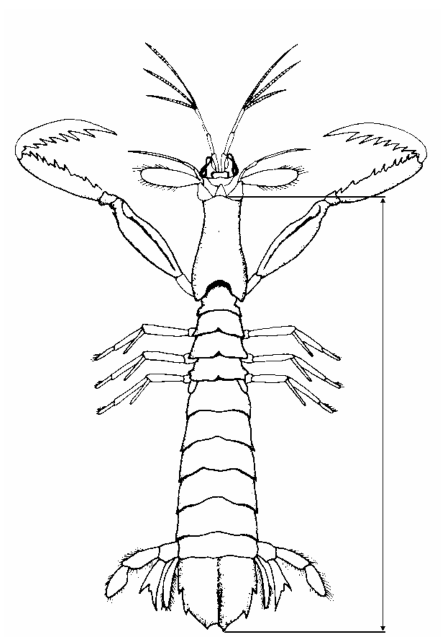
Invertebrates

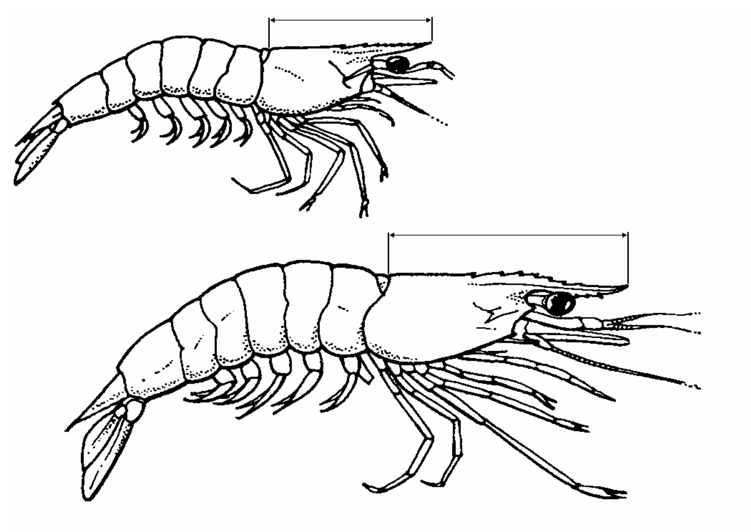
Crustaceans



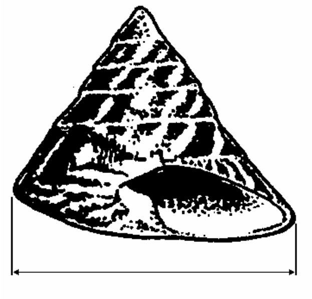


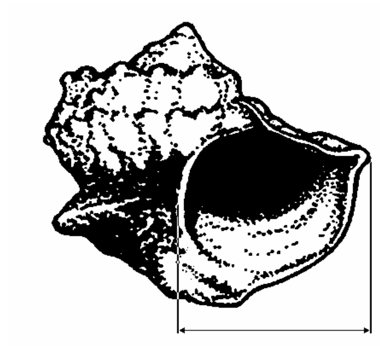




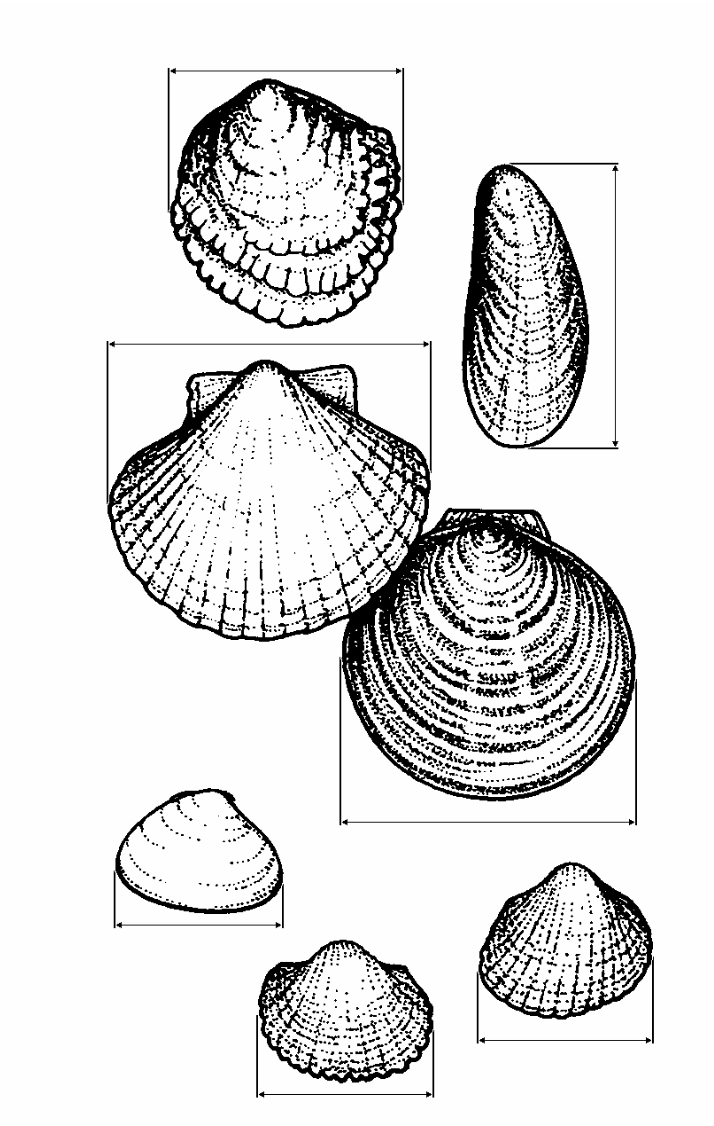


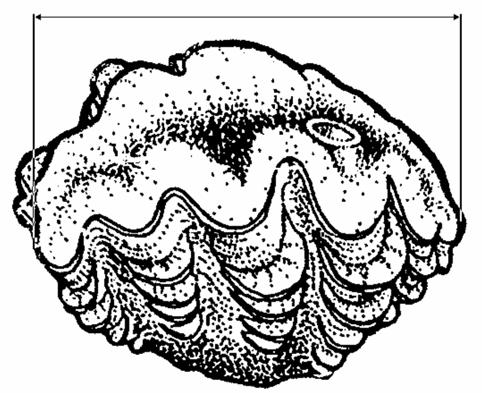
Gastropods



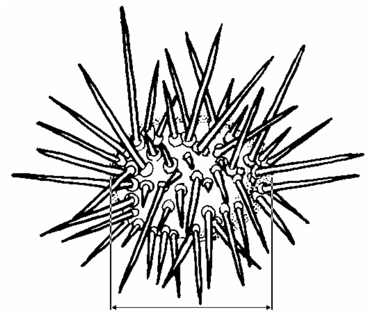


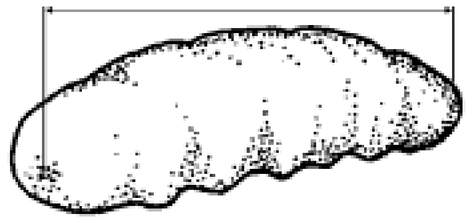
Bivalves



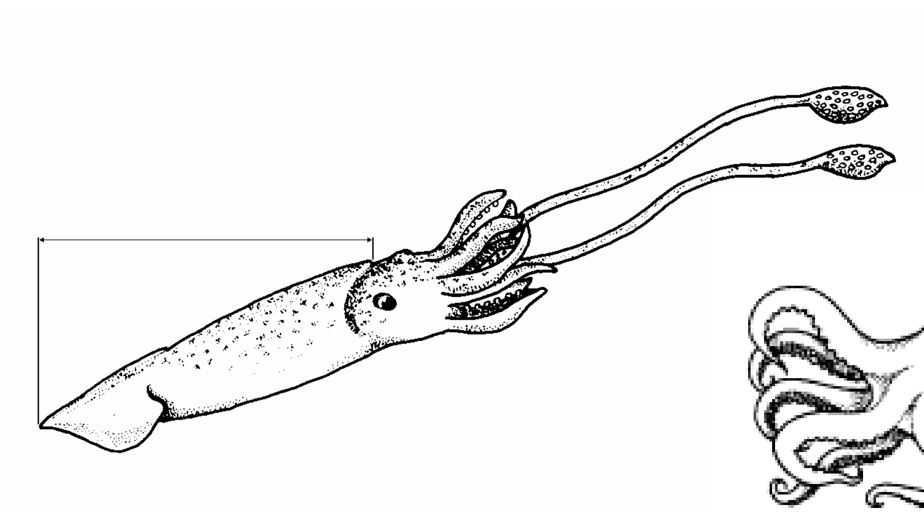


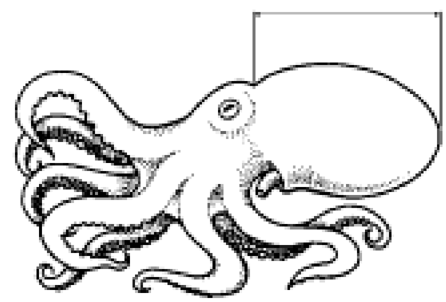
Echinoderms



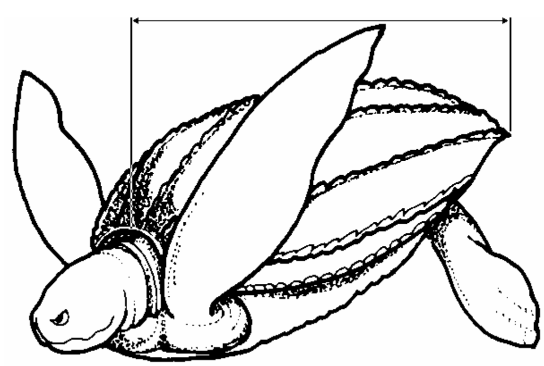


Cephalopods





Turtles



Frontpage Questionnaire

About You and Your College...

1 Name of your Teacher

2 Your name | boy | girl |

3 Your age

4 Your class

5 Your Village

6 Dates of the survey: Monday, ... to Sunday, ...

About Your Household...

7 How many people are there in your household?

8 How many of these have got a regular income?

9 Main household income? (please circle) **farming / fishing / both / neither**

10 How many boats are there in your household? (indicate outboard engines)

dinghy:

canoe:

11 What fishing gear is owned by your household? (please indicate number and size)

line&hook:

trolling line:

seine net:

gillnet:

thrownet:

drive-in net: (fixed)

trap: (fixed)

(moveable)

goggles:

u/w spear:

throw spear:

uw torch:

scuba kit:

other:

Dividing the Catch...

12 How many different people fished in your household over the week?

13 How is the catch of your household used?

eaten at home	%
given away	%
sold off	%
	100 %

Eating Fish...

14 Does your household regularly **buy or receive** fresh/frozen seafood? | yes | no |

Daily Log Sheet

For Starters...

	Yes	No
any seafood eaten today, which was caught by your household ?		
any tinned fish eaten in your household today?		
if so, how many cans and what size?		
any bought or received seafood eaten in your household today?		
if so, how much (in numbers)?		

Concerning fishing today...

	Yes	No
was there any fishing done in your household today?		

Table 1. Catch of the Day

	name	how many?	middle length (cm)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
others	no. species:	no. of fish:	

Table 2. Fishing Trips

	no. people[1]	fishing gear used	area fished [2]	trip length (hrs)	no. canoes/ dinghies	day/night	village waters [3]
1							
2							
3							
others	no. trips:				total hours:		

1) only from your household **2**) near shore / mangrove / lagoon / reef / outer slope **3**) "yes" if fishing was done exclusively in village waters, otherwise "no"

Remarks:

note: 1 sheet provided for every day, plus one spare

Annex 8 Species List: Samoan Names

Samoan Name	English Name	Family / Order
A'u	long tom	belonidae
Afa	mullet	mugilidae
Afulu	gold-lined goatfish	mullidae
Agae	mullet	mugilidae
Akaka	grouper	serranidae
Ali	flounder	pleuronectidae
Ali'ao	topshell	trochidae
Alili	turban shell	turbinidae
Alogo	blue-lined surgeon fish	acanthuridae
Anae	mullet	mugilidae
Asiasi	yellowfin tuna	scombridae
Atu	skipjack tuna	scombridae
Atule	big-eye scad	carangidae
Aua	mullet	mugilidae
Ava	milkfish	chanidae
Ava'ava	crescent perch	theraponidae
Avaava moana	grunts / sweetlips	haemulidae
Fagu sea	sea cucumber viscera	holothuroidea
Fai	sting ray	batioidei
Faisua	giant clam	tridacnidae
Fee	octopus	octopoda
Filoa	emperor	lethrinidae
Fuga	parrotfish	scaridae
Fuga asi	parrotfish	scaridae
Fuga mata pua'a	lavender-headed	scaridae
Fuga usi	parrotfish	scaridae
Fugafuga	sea cucumber / brown	holothuroidea
Fugamatapuaa	lavender-headed	scaridae
Fugamea	parrotfish	scaridae
Fugausi	parrotfish	scaridae
Gague	topsail drummer /	kyphosidae
Galo	humphead parrotfish	scaridae
Gatala	grouper / cod	serranidae
Gau	seahare	anaspidea
Gofu	stonefish	synanceiidae
Ia faiava	goatfish (?)	mullidae
Ia sega	emperor	lethrinidae
Iasina	gold-lined goatfish	mullidae
Iaui	conger	congridae
Iliilia	stripe-faced unicornfish	acanthuridae
Ise	garfish	hemirhamphidae
Iu sega	emperor	lethrinidae
Kifikifi	butterfly fish	chaetodontidae
Kiko	golden-lined rabbitfish	siganidae
Koko	opah	lampridae
Laea	parrotfish	scaridae
Laga	parrotfish	scaridae

Lague	topsail drummer	kyphosidae
Lai	leatherskin	scombridae
Lalafi	wrasse	labridae
Lalafutu	pompana / dart	carangidae
Laumei	turtle	chelonidae
Limu	sea grapes	caulerpaceae
Lo	rabbitfish	siganidae
Loli	blackfish (sea cucumber)	holothuroidea
Lupo	jack	carangidae
Lupoka	jack	carangidae
Lutu	seargeant major	abudefdufinae
Mafilaugutu	blubberlip snapper (?)	lutjanidae
Mako	silver biddy	gerreidae
Malai	paddletail snapper	lutjanidae
Malau	soldierfish	holocentridae
Malau mata puta	soldierfish	holocentridae
Malau tui	blood-spot squirrelfish	holocentridae
Malauli	trevally	carangidae
Malava	rabbitfish	siganidae
Malie	shark	carchariniformes
Mama'o	redfish	holothuroidea
Mama'o faisua	redfish (?) (sea cucumber)	holothuroidea
Manini	convict surgeonfish	acanthuridae
Masimasi	dolphinfish	coryphaenidae
Mata pula	bigeye	priacanthidae
Mataelele	emperor	lethrinidae
Matamu	emperor	lethrinidae
Mataniu	emperor	lethrinidae
Matapoga	mullet	mugilidae
Matu	silver biddy	gerreidae
Matulau	goatfish	mullidae
Moaga	(yellow) goatfish	mullidae
Moo	blanquillos / tilefish	malacanthidae
Mu	red emperor/bass	lutjanidae
Mufiloa	emperor	lethrinidae
Mugausi	parrotfish	scaridae
Mutu	sergeant major	abudefdufinae
Pa'a	crab	portunidae
Paalimago	mudcrab	portunidae
Paia	wahoo	acanthocibiidae
Pakupaku	vase shell	vasidae
Pala	wahoo	acanthocibiidae
Palaau	spider conch	strombidae
Palani	surgeonfish	acanthuridae
Palu sega	flower snapper	lutjanidae
Palugutusiliva	rusty jobfish	lutjanidae
Papa	coral trout	serranidae
Papata	slipper lobster	scyllaridae
Patagaloa	wrasse	labridae
Pau ulu	black spinefoot	siganidae
Peapea	moorish idol	zanclidae

Poge	surgeon fish	acanthuridae
Pone	surgeon fish	acanthuridae
Pone iusina	surgeonfish	acanthuridae
Pone sina	surgeonfish	acanthuridae
Ponepone	surgeonfish	acanthuridae
Pu	helmet shell	cassidae
Pusi	moray eel	muraenidae
Sa'u	marlin	istiophoridae
Saesae	unicornfish	acanthuridae
Saesae ume	unicornfish	acanthuridae
Safole	flagtail	kuhliidae
Sapatu	barracuda	sphyraenidae
Sapoanae	great trevally	carangidae
Savane	blue-banded sea perch	lutjanidae
Sea	pricklyfish	holothuroidea
Sue	tobies/puffers/pufferfish	canthigasteridae
Sugale	wrasse	labridae
Sumu	filefish / triggerfish	aluteridae
Sumusumu	triggerfish	balistidae
Tagi	togtooth tuna	scombridae
Tamala	black-tail snapper	lutjanidae
Taoato-ama	trumpetfish	fistulariidae
Taotao	pipefish	fistulariidae
Tasina	gold-lined goatfish	mullidae
Tatanu	goatfish	mullidae
Tatu	porcupine fish	diodontidae
Taui	conger	congridae
Taulaia	goatfish	mullidae
Tautauama	trumpetfish	fistulariidae
Tautu	porcupine fish	diodontidae
Tifitifi	butterfly fish	chaetodontidae
Tivao	bream	lutjanidae
Tolo	flathead (?)	platycephalidae
Tu'u'u	angelfish	pomacanthidae
Tugane	venus shell	veneridae
Tuitui	boring urchin	echinoidea
Ula	lobster	palinuridae
Ulua	jack	carangidae
Ume	brown unicornfish	acanthuridae
Vaga	long-spined urchin	echinoidea
Vete	goatfish	mullidae

note: this is the list of all single organisms recorded by the Student Census and the Creel Census surveys. The Samoan names were kept as recorded by students and extension officers, and are so reproduced. Some of these names might not be spelled correctly. A ?-mark denotes a doubt in speciation.

Annex 9 Family/Order List: Length-Weight Conversion Factors

Family / Order	En Group Name	q	b	note 1
abudefdufinae	sergeant majors	0.00030	2.5517	oval&stout
acanthocibiidae	wahoo	0.00000	3.1074	tapering&stout
acanthuridae	surgeon fish	0.00004	2.7851	oval&thin
aluteridae	filefish, leatherjackets	0.00030	2.5517	oval&stout
anaspidea	sea hares			
balistidae	triggerfish	0.00372	2.273	Pseudobalistes flavimarginatus
batioidei	rays			
belonidae	long toms	0.00114	2.06	very elongate
canthigasterida	tobies, puffers			
carangidae	trevallies & jacks	0.00004	2.892	Caranx papuensis
carchariniforme	requiem sharks	0.00000	3.6287	elongate&stout
cassidae	helmet shells			
caulerpaceae	sea grapes			
chaetodontidae	butterfly-, bannerfish	0.00000	3.468	Chaetodon unimaculatus
chanidae	milkfishes	0.00000	3.6287	elongate&stout
chelonidae	sea turtles			
congridae	conger eels	0.00114	2.06	very elongate
coryphaenidae	dolphinfish	0.00000	3.6287	elongate&stout
diodontidae	porcupine fish	0.00000	3.02	FishBase
echinoidea	sea urchins			
fistulariidae	trumpetfish	0.00114	2.06	very elongate
gerreidae	silver biddies	0.00011	2.739	Gerres oyena
haemulidae	sweetlips	0.00030	2.5517	oval&stout
hemirhamphida	garfish	0.00001	2.861	Hemirhamphus far
holocentridae	squirrel-, soldierfish	0.00030	2.5517	oval&stout
holothuroidea	sea cucumbers			
istiophoridae	billfishes	0.00000	3.1074	tapering&stout
kuhliidae	flagtails, bass	0.00030	2.5517	oval&stout
kyphosidae	rudderfishes	0.00000	3.6287	elongate&stout
labridae	wrasses	0.00030	2.5517	oval&stout
lagocephalidae	pufferfish			
lampridae	moonfish	0.00004	2.7851	oval&thin
lethrinidae	emperor fish	0.00030	2.5517	oval&stout
lutjanidae	snappers	0.00005	2.9	Lutjanus argentimaculatus
malacanthidae	blanquillos, tilefish	0.00000	3.6287	elongate&stout
mugilidae	mullets	0.00002	2.984	Mugil cephalus
mullidae	goatfish	0.00006	2.785	Mulloides flavolineatus
muraenidae	moray eels	0.00114	2.06	very elongate
octopoda	octopuses	0.00131	2.8175	Fisheries Division
palinuridae	lobsters	0.00452	2.5786	Fisheries Division
platycephalidae	flatheads	0.00000	3.6285	elongate&stout
pleuronectidae	flounders			
pomacanthidae	angelfishes	0.00030	2.5517	oval&stout
portunidae	swimming crabs			
priacanthidae	bigeyes	0.00000	3.1074	tapering&stout

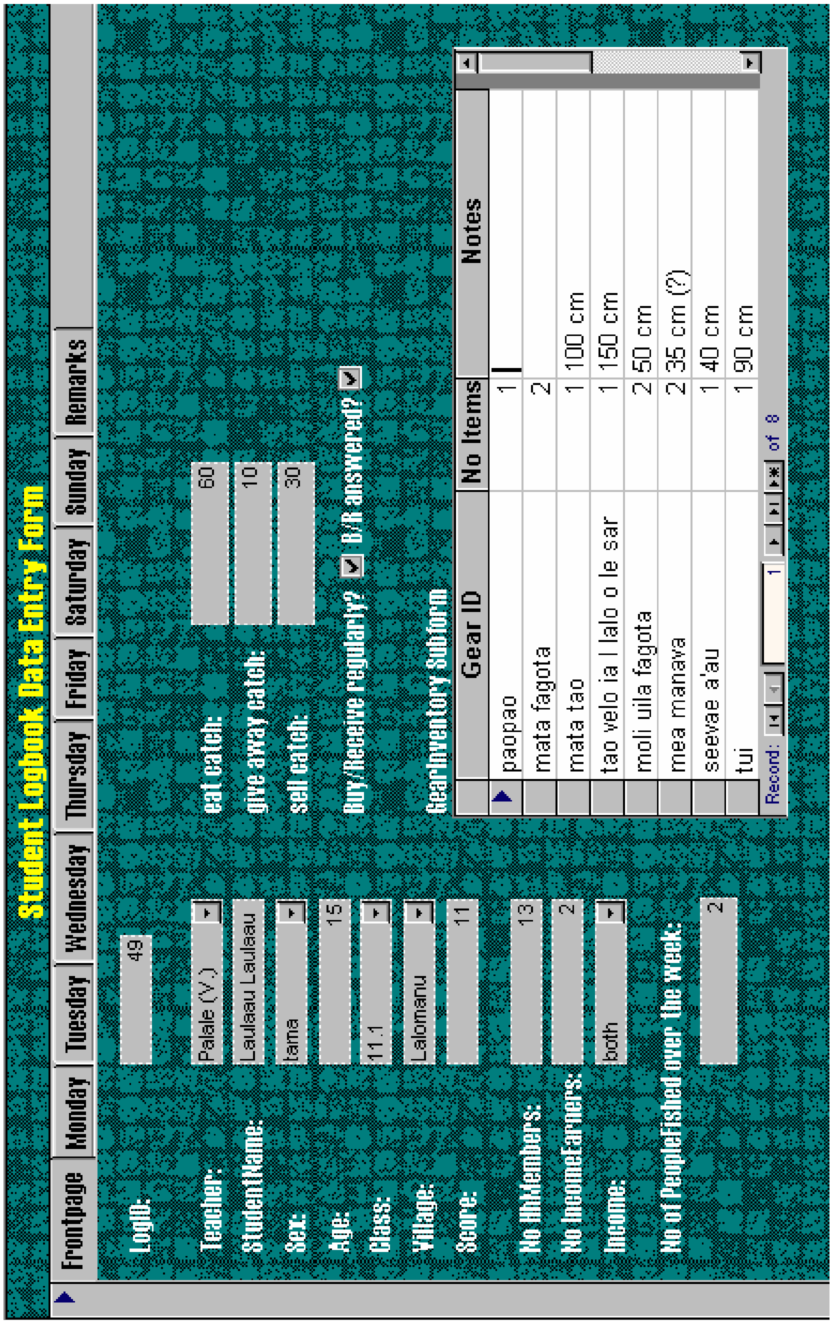
scaridae	parrotfishes	0.00030	2.5517	oval&stout
scombridae	tuna & mackerels	0.00002	2.837	Scomberoides tol
scyllaridae	shovel-nosed lobsters			
serranidae	groupers / cods	0.00000	3.1074	tapering&stout
siganidae	rabbitfish	0.00004	2.7851	oval&thin
sphyraenidae	barracudas	0.00000	3.066	Sphyraena forsteri
strombidae	conches			
synanceiidae	stone fishes	0.00030	2.5517	oval&stout
theraponidae	grunters	0.00004	2.929	Terapon jarbua
tridacnidae	giant clams			
trochidae	trochus shells			
turbinidae	turban shells			
vasidae	vase shells			
veneridae	venus shells			
zanclidae	moorish idols	0.00004	2.7851	oval&thin

note: listed conversion factors fit the $W=qL^b$ equation

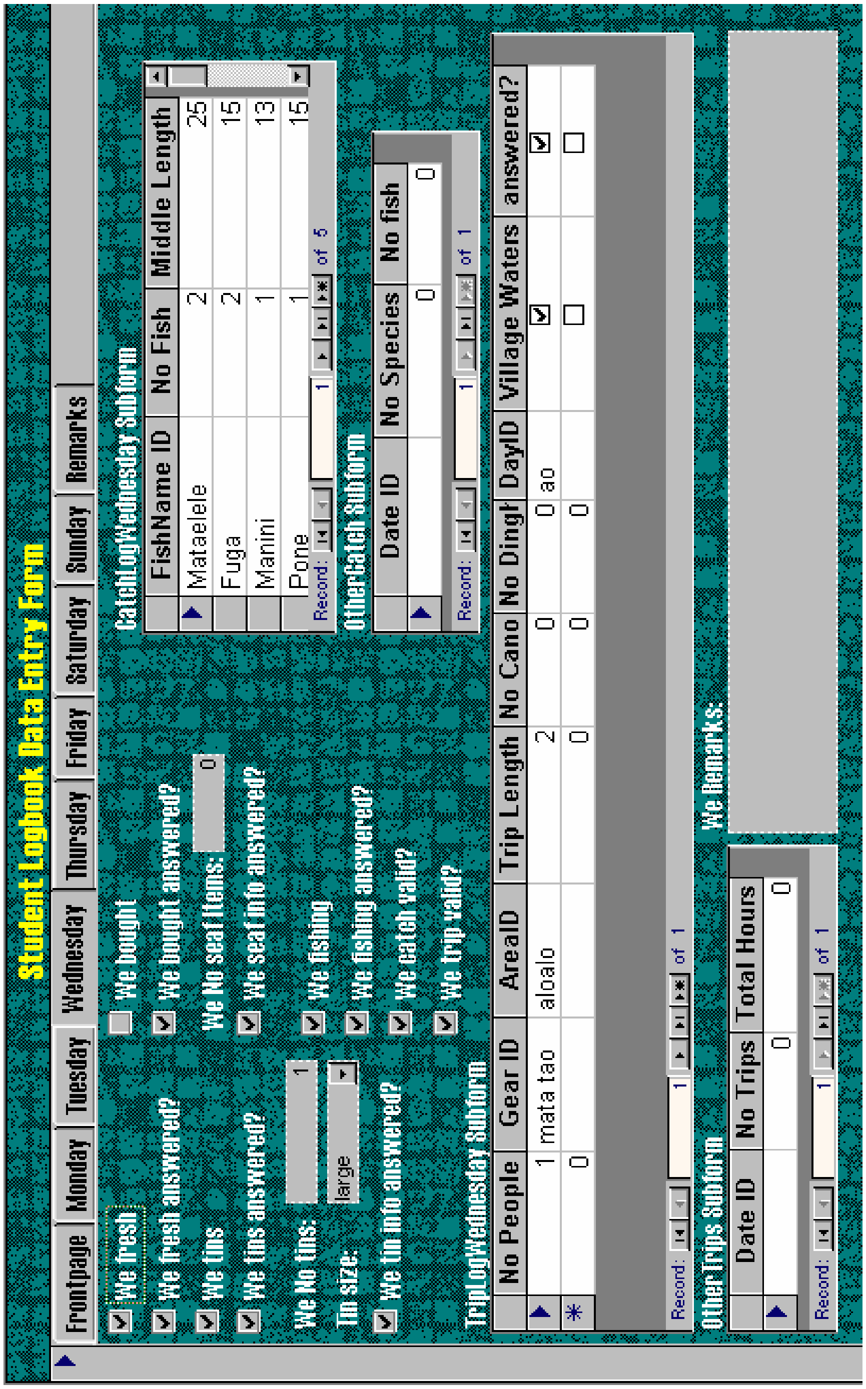
These factors were used to calculate catch estimates in weight, and CPUE. In the last column (note 1), the origins of the factors are listed. Either a general body shape is given, a species name, or Fisheries Division.

The listed factors with a scientific species name under column “note 1” originate from the Rawlinson *et al.* publication (*see* References & Bibliography in Annex 14). The general body shapes originate from a table the Samoan Fisheries Division uses, and the entries annotated with “Fisheries Division” come directly from the database that the Samoan Fisheries Division feeds with market survey data, and which is unpublished.

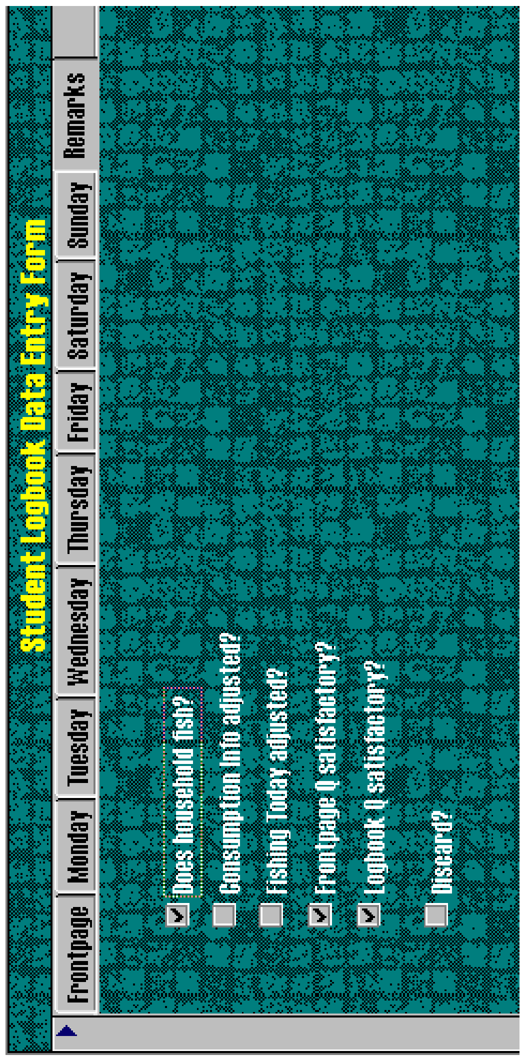
Annex 10 Student Census Database Input Forms



note: SC database input form for the frontpage questionnaire



note: SC database input form for one of the daily log sheets



note: SC database input form for a series of additional quality markers

Annex 11 Web Resources on Operating Student Census Schemes

Pacific Region

Programme SPaRCE (Schools of the Pacific Rainfall Climate Experiment)

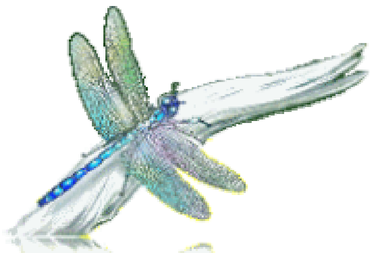
Description *The Schools of the Pacific Rainfall Climate Experiment (SPaRCE) is a cooperative field project involving local meteorological services, elementary, middle school, high school, college, and trade school students from various Pacific islands, atolls, and the U.S. The SPaRCE program (headquartered at the University of Oklahoma in Norman, Oklahoma) began in January 1993 with only a handful of Pacific schools. Since its implementation, the project has quickly grown. There are currently over 160 schools from approximately 22 different countries enrolled.*

Initially, participants are sent two direct-read, plastic rain gauges along with an instructional video tape and manual for placing, reading, and maintaining the rain gauges. A single-use camera is also sent out to make photographic documentation of the rain gauge locations. Most of the SPaRCE sites are on small islands and atolls which have very little funding for computers or special projects. SPaRCE provides environmental education and enhancement of Pacific island science programs. In addition to the first workbook and video, five additional workbooks and videos addressing topics such as global climate, general weather, and Pacific regional climate are sent to participants. As participants progress in the program, they receive additional instrumentation, such as sling psychrometers and max-min thermometers, and other educational materials, such as science posters and science experiment kits.

URL www.evac.ou.edu/sparce/

Selected School URLs www.evac.ou.edu/sparce/sma/wsamoa/alofi/alofi.html
www.evac.ou.edu/sparce/sma/cook/titikaveka/titikaveka.html

Australia

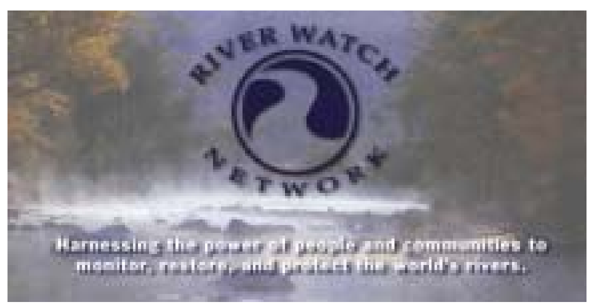


Programme Waterwatch

Description *Waterwatch is a national volunteer water quality monitoring and education program. Landcare groups, schools, other community groups and individuals throughout Australia are involved in Waterwatch.*
Waterwatch helps people to get together with their local governments, water authorities, industry and other organisations to discuss the water quality issues in their catchments and to develop strategies to deal with these issues.
Through the Commonwealth Government's Natural Heritage Trust, Waterwatch provides funding to the community for Waterwatch coordinators and education projects.
Waterwatch Australia is an umbrella program overarching the State programs.

URL www.waterwatch.org.au

United States of America



Programme River Watch Network

Description *RWN brings people together to monitor, restore, and protect their rivers. We work with concerned community members to:*
Define the issues which are most critical to their rivers;
Design and execute scientifically credible studies which assess the condition of the river ecosystem;
Create strategies for conserving rivers through community action.

URL www.riverwatch.org

Selected School URLs www.logan.pvt.k12.co.us/rwatch.htm
www.dawsonschool.org/bcp2000

Annex 12 A Teacher's Assessment on the Benefits of Involving his Students

From: Bill Meyers Sent: 16.06.00
To: Gilles Hosch
Subject: River Watch

Hi Gilles,

I am glad the you have heard of the River Watch program. It is a program organized by the Division of Wildlife in our state. This is a government department which regulates hunting, fishing and monitors the health of wildlife. There are over 200 schools across the state that make measurements of streams near their schools. The data is used by students to learn more about water chemistry, macroinvertebrates and watersheds. The Division of Wildlife uses the data to monitor the condition of streams and rivers throughout the state. Occasionally they will go to court to argue that, for instance, more mining should not be allowed in an area and they will use student collected data to prove their point. In order to be able to do this they have a one week training session for teachers and a few students to learn all of the procedures. The procedures must be followed very carefully so that the data are reliable. I find that the students enjoy the program more because they know that quality is important. If they make a mistake they will throw out the sample and repeat the procedure. They take a lot of pride in their work. This spring we spent a week sampling various points along the creek that passes our school. The students then made a website to present their data. It is http:www.dawsonschool.org/bcp2000. Please look at this for more information and to hear about the program in the students own words. They learned a lot and became very protective of "their" creek. Our website has a link to the Colorado River Watch site which should give you more information on the program.

Please let me know what you think of the students website they love to hear other peoples thoughts. We are looking for constructive criticism as well as positive comments. Let me know if there are other questions that I can answer for you.

All the best,

Bill

Annex 13 The Torres Strait Islands Data Collection Scheme

From: Geoff Williams   Sent: 02.07.00
To: Gilles Hosch
Subject: Torres Strait schools data program

Gilles,

The Torres Strait schools data program is really the best data that is available on the island community catches of turtles and dugongs. The reason for this is that there are no other catch data collection systems operating as extensively as this program. The program covers primary schools(Years 1 to 6) in all fourteen Islander communities.

The way it operates is as follows:

A fisheries officer goes to each school at the beginning of the school year and presents the class with a calendar style poster, explains the collection system, and gives the class some background on how the program will help conserve dugongs and turtles.

The calendar covers the whole year and has pictures and biological information about turtles and dugongs, and there are other posters with other information that accompany it.

The fishery officer also gives the school a quantity of stickers to be placed each day on the calendar, to record how many and what animals have been caught in the community.

There are four different types of stickers for each day: one for turtles, one for dugongs, one for zero catch and one for no recording (due to holidays or whatever).

The aim is to collect information for every day of the year, and some schools do this, generally the level of interest of the teacher is the factor that determines how well the recording is done.

There are other details to be attached to the catch stickers: The dugong sticker also has an additional sticker that shows whether the animal is adult or young, male or female, and if female whether she is pregnant. The turtle sticker also records whether the animal is large or small/medium and whether male or female. There are, as you can imagine, lots of stickers, and the kids enjoy sticking them on the calendar.

One sticker with all this information is placed on the calendar for each animal caught by the community.

A recent additional entry (1998) has been the fisher/hunter's name, to ensure that no double counting of catches occurs.

The data generated can be either very valuable or not of much value, depending on the level of interest of the teacher and kids. There have just been two Islander fishery officers trained to promote the program this year.

Geoff

Annex 14 References & Bibliography

Adams, T.J.H. *et al.* (1995) *Research on fisheries in the Pacific Islands region*. SPC/FFA Workshop on the Management of Inshore Fisheries in the South Pacific Islands, Background Paper 36, South Pacific Commission, Nouméa

Amar, E.C. *et al.* (1996) *Small-scale fisheries of coral reefs and the need for community-based resource management in Malalison Island, Philippines*. Fish. Res., **25**(3-4), pp. 265-277

Amarasinghe, U.S. *et al.* (1997) *Traditional practices for resource sharing in an artisanal fishery of a Sri Lankan estuary*. Asian Fish. Sci., **9**(4), pp. 311-323

Andrews, G.J. & Holthus, P.F. (1989) *Marine Environment Survey – Proposed Aleipata Islands National Park, Western Samoa*. SPREP / SPC

Baird, I.G. *et al.* (1997) *Participatory student research increases awareness of sustainable fisheries management*. PLA notes, Int. Inst. Envir. Dev., no. 30, pp.50-53

Birkeland, C. (1997) *Implications for Resource Management*. in Life & Death of Coral reefs. Birkeland C. (ed.), pp. 411-435, Chapman & Hall, New York

Brody, M.J. (1996) *An assessment of 4th-, 8th-, and 11th- grade students' environmental science knowledge related to Oregon's marine resources*. J. Environ. Educ., **27**(3), pp. 21-27

Brown, I.W. & Fielder, D.R. (1991) *The coconut crab: aspects of the biology of* Birgus latro *in the Republic of Vanuatu*. ACIAR monograph no. 8, Australian Centre for International Agricultural Research, Canberra

Campbell, J. & Townsley, P. (1997) *Participatory and integrated policy processes in small-scale fisheries*. PLA Notes, Int. Inst. Envir. Dev., no. 30, pp. 66-69

Craig, P., Ponwith, B., Aitaoto, F. & Hamm, D. (1993) *The commercial, subsistence and recreational fisheries of American Samoa*. Marine Fisheries Review, **55**(2), pp. 109-116

Crocombe, R. (1994) *Workshop Overview*. in Traditional marine tenure and sustainable management of marine resources in Asia and the Pacific. South, G.R. *et al.* (eds.), International Ocean Institute - South Pacific, Suva, pp. 291-300

Dalzell, P., Adams, T.J.H., Polunin, N.V.C. (1996) *Coastal Fisheries in the Pacific Islands*. Oceanography and Marine Biology: an Annual Review, **34**, pp. 395-531

Dalzell, P. (1998) *The role of archaeological and cultural-historical records in long-range coastal fisheries resources management strategies and policies in the Pacific Islands*. Ocean and Coastal Management (Special Issue). **40**(2-3), pp. 237-252

FAO (1997) *Meeting of South West Pacific Ministers for Agriculture*. Meeting Report. FAO-SAPA, Apia – Samoa, pp. 22

Foale, S. (1998) *Assessment and management of the Trochus fishery at West Nggela, Solomon Islands: an interdisciplinary approach*. Ocean and Coastal Management (Special Issue). **40**(2-3), pp. 187-205

Fox, P. (1986) *A manual of rapid appraisal techniques for Philippine coastal fisheries*. Bureau of Fisheries and Aquatic Resources Research Division (BFAR)

Galvan, A. (1984) *La antropologia de la pesca: problemas, conceptos y teorias*. Santiago de Composetela, Actas de Etnografia Maritima

Gilman, E.L. (1997) *Community based and multiple purpose protected areas: A model to select and manage protected areas with lessons from the Pacific Islands*. Coastal Management, **25**(1), pp. 59-91

Government of Samoa (1997) *Household Income and Expenditure Survey*. Department of Statistics, with assistance from UNDP and SPC

Green, A. (1996) *Status of the coral reefs of the Samoan Archipelago*. 48 pp.

Green, T.G. & Kalua, J.R. (1997) *The myth of sustainability in managed wild fisheries: The economic case for aquaculture subsidies*. <u>in</u> Developing and Sustaining World Fisheries Resources. The State of Science and Management. Hancock, D.A. *et al.* (eds.), pp. 437-442, Collingwood - Australia, CSIRO

Helm, N. (1992) *A report on the market survey of reef & lagoon fish catches in Western Samoa.* Inshore Fisheries Reserch Project Technical Document No. 1, South Pacific Commission, Noumea, pp. 1-5

Itano, D.G. (1996) *The development of small-scale fisheries for bottomfish in American Samoa (1961-1987) [Part 1]*. SPC Fisheries Newsletter, no. 76, pp. 28-32

Johannes, R.E. (1993) *The plight of the Osfish, or why quantitative sophistication is no substitute for asking the right questions*. Naga, **16**(1), pp. 4-5

Johannes, R.E. (1994) *Design of tropical nearshore fisheries extension work beyond the 1990s*. <u>In</u> Traditional Marine Tenure and Sustainable Management of Marine Resources in Asia and the Pacific. G.R. South *et al.* (eds). Suva: International Ocean Institute-South Pacific, pp.162-74

Johannes, R.E. (1997) *Traditional coral-reef fisheries management*. <u>in</u> Life and Death of Coral Reefs. Birkeland, C. (ed.), Chapman and Hall, pp. 380-385

Johannes, R.E. (1998) *Government-supported, village-based management of marine resources in Vanuatu*. Ocean and Coastal Management, **40**(2-3), pp. 127-142

Kailola, P.J. (1996) *Fisheries Development. Fiji*. Technical Report: Review of policies and initiatives to enhance fisheries management and development in Fiji, 105 pp., Rome - Italy, FAO

King, M., Bell, L., Mulipola, A., Sua, T. & Brotman, M. (1989) *Catch composition and yield of artisanal fisheries in Western Samoa*. FAO Paper no. 2. TCP/SAM/8852 (Draft)

King, M. (1991) *Understanding Fisheries in the South Pacific*. USP, produced as part of the FFA Fisheries Awareness Project, pp. 42

King, M. (1993) *Fisheries resources assessment for management*. FAO Terminal Report TCP/SAM/8852, pp. 41, Rome - Italy, FAO

King, M. (1995) *Fisheries Biology, Assessment and Management*. Fishing News Books, Blackwell Science (publ.), 341 pp.

King, M. *et al.* (1997) *Fisheries Extension Manual. Western Samoa Fisheries Extension and Training Project*. MAFF & AusAID, Apia - Samoa

King, M. & Fa'asili, U. (1998) *A network of small, community-owned village fish reserves in Samoa*. Parks (IUCN). **8**(2), pp.11-16

Lam, M. (1998) *Consideration of customary marine tenure system in the establishment of marine protected areas in the South Pacific*. Ocean & Coastal Management, **39**, pp. 97-104

Lambeth, L. (1998) *Fish and marine animals of Samoa. Western Samoa Fisheries Extension and Training Project*. MAFF & AusAID, Apia - Samoa

Maine, R.A. *et al.* (1996) *Participatory analysis, monitoring and evaluation for fishing communities. A manual*. FAO Fish. Tech. Pap., no. 364, 142 pp., Rome - Italy, FAO

Matthews, E. *et al.* (1998) *Fijian villagers adapt to changes in local fisheries*. Ocean & Coastal Management, **38**, pp. 207-224

McClanahan, T.R. *et al.* (1997) *The effects of traditional fisheries management on fisheries yields and the coral-reef ecosystems of southern Kenya*. Environ. Conserv., **24**(2), pp. 105-120

McConnaughey, J. (1993) *American Samoa: analysis of the artisanal fishing fleet, 1986-1992*. 6pp.

McConnaughey, J. (1993) *Fishery resources in Pala Lagoon*. 41 pp.

Mc Grath, D. *et al.* (1993) *Fisheries and evolution of resource management on the lower Amazon floodplain*. Human Ecology, **21**(2)

McManus, J.W. (1997) *Tropical marine fisheries and the future of coral reefs: A brief review with emphasis on Southeast Asia*. Coral Reefs. **16**, suppl. pp. s121-s127

Munro, J.L. (1984) *Yields from coastal reef fisheries*. Fishbyte, **2**(3), pp. 13-15

Munro, J.L. & Fakahau, S.T. (1993) *Appraisal, assessment and monitoring of small-scale coastal fisheries in the South Pacific region*. in Nearshore Marine Resources of the South Pacific, Wright, A. & Hill, L. (eds.), IPS/FFA/ICOD (publ.)

Pomeroy, R.S. (1994) *Management options for small-scale fisheries*. in The Management of Coral Reef Resource Systems, pp. 78-81, Munro, J.L. & Munro, P.E. (eds.), Manila-Philippines, ICLARM

Pomeroy, R.S. & Williams, M.J. (1994*) Fisheries co-management and small-scale fisheries: a policy brief*. 15 pp. , Manila-Philippines, ICLARM

Pomeroy, R.S. *et al.* (1997) *Evaluating factors contributing to the success of community-based coastal resource management : The Central Visayas Regional Project* - *1, Philippines*. Ocean and Coastal Management, **36**(1-3), pp. 97-120

Polunin, N.V.C. & Roberts, C.M. (eds.) (1996) *Reef Fisheries*. London: Chapman & Hall

Postawko, S. & Morrissey, M. (1999) *Schools of the Pacific Rainfall Climate Experiment*. in Proceedings of the Third SPREP Meeting on Climate Change and Sea Level Rise, Nouméa, 1997. Kaluwin, C.& Hay, J. (eds.), SPREP publication, pp. 101-104

Rajasuriya, A. (1996) *Marine sanctuaries and conservation of fishery resources*. Report & Proceedings of the Sri Lanka FAO national Workshop on Development of Community Based Fishery Management. Colombo, 3-5 October 1994, Morris, M.J. *et al.* (eds.), pp. 175-182

Rawlinson, N.J.F., Milton, D.A., Blaber, S.J.M., Sesewa, A. & Sharma, S.P. (1992) *A survey of the subsistence and artisanal fisheries in rural areas of Viti Levu, Fiji*. ACIAR Monograph No. 35, Australian Centre for International Agricultural Research, Canberra

Russ, G. (1994) *The use of refugia for fishery resource management on coral reefs*. in The Management of Coral Reef Resource Systems, Munro, J.L. & Munro, P.E. (eds.), no. 44, pp. 72-75, Manila - Philippines, ICLARM

Russ, G.R. (1996) *Fisheries management: What chance on coral reefs?* Naga, **19**(3), pp. 5-9

Sale, P.F. (1985) *Seminar C; Assessment and Management of Coral Reef Fisheries: Biological, Environmental and Socio-Economic Aspects*. In Proceedings of the Fifth Coral Reef Congress, **4**, Munro, J.L., Williams, D.M. (eds.), Moorea: Antenne Museum National d'Histoire Naturelle, pp. 545-578

Sale, P.F. (1985) *Seminar C; Assessment and Management of Coral Reef Fisheries: Biological, Environmental and Socio-Economic Aspects: Report of the Discussion*. in Proceedings of the Fifth International Coral Reef Congress, **4**, Munro, J.L., Williams, D.M. (eds.), Moorea: Antenne Museum National d'Histoire Naturelle, pp. 579-581

Sale, P.F. (1991) *The Ecology of Fishes on Coral Reefs*. London: Academic Press

Samoylis, M., Carlos, G. (1991) *A survey of reef fish stocks in Western Samoa: Application of underwater visual census methods*. Field Report no. 6, FAO/UNDP SAM/89/002, prepared for FFA, Apia - Samoa, FAO

Saucerman, S. (1994) *The inshore fishery of American Samoa, 1991-1993*. Biological Report Series, pp. 35, Department of Marine and Wildlife Resources, Pago Pago - American Samoa

Staples, D. (1997) *Indicators of sustainable fisheries development*. in Developing and Sustaining World Fisheries Resources. The State of Science and Management. Hancock, D.A. *et al.* (eds.), Collingwood - Australia, CSIRO, pp. 719-725

Townsley, P. *et al.* (1997) *Customary marine tenure in the South Pacific: The uses and challenges of mapping*. PLA Notes, Int. Inst. Envir. Dev., no. 30, pp. 36-39

Tu'avao, T., Kava, V. & Udagawa, K. (1994) *The present situation of fisheries in the Tongatapu island group*. Fisheries Research Bulletin of Tonga, **2**, pp. 27-42

UNDP (1999) *Pacific Human Development Report 1999: Creating Opportunities.* United Nations Development Programme, Suva, Fiji Islands, pp. 122

UNESCO (1981) *Marine and coastal processes in the Pacific: ecological aspects of coastal zone management.* Report of a UNESCO seminar held at Motupore Island Research Centre, University of Papua New Guinea, 14-17 July 1980, **16**, UNESCO Reports in Marine Science

UNESCO (1995) *Fisheries and the Marine Environment*. vol. 6 (of 6) of Marine Science Curriculum Materials for South Pacific Schools, pp. 20-21

Wass, R.C. (1982) *The shoreline fishery of American Samoa: past and present*. In Marine and coastal processes in the Pacific: ecological aspects of coastal zone management, pp. 51-83, J.L. Munro (ed.). Jakarta, UNESCO/ROSTSEA

World Bank (1999) *Voices from the Village – A comparative study of Coastal Resource Management in the Pacific Islands*. Pacific Islands Discussion Paper Series No. 9, pp. 58

Yeeting, B. & Wright, A. (1989) *A review of the status of fisheries resources in Tarawa Lagoon, Republic of Kiribati*. FFA Report No. 89/16, Forum Fisheries Agency, Honiara

Zann, L. (1989) *The status of sea turtles in Western Samoa*. Field Report no. 9, FAO/UNDP SAM/89/002, prepared for SPREP, Apia - Samoa, FAO

Zann, L.P. *et al.* (1991) *The inshore fisheries resources of Upolu, Western Samoa: coastal inventory and database.* Field Report No. 5, FAO/UNDP SAM/89/002, Apia - Samoa, FAO

Zann, L. (1996) *The inshore resources of Savai'i, Western Samoa: coastal inventory and fisheries database*. IDSS/AusAID