RDA International, Inc.

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ASSESSMENT OF BAITFISH RESOURCES IN VAVA'U, TONGA

Pacific Islands Marine Resource Project
Tonga Component
Project No. 879-0020

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1.0 EXECUTIVE SUMMARY

This report provides recommendations for the establishment of a program of research and field investigations to assess the baitfish resources of Vava'u, and ultimately to suggest appropriate levels of sustainable exploitation.

The names of species expected to be encountered are provided in the report, and the proposed survey methodology is described in detail. Draft field survey logs and length-frequency data collection forms are included as appendices.

2.0 INTRODUCTION

In order to complement the proposed development of small-scale longline fishing for tuna, stocks of baitfish are to be assessed on the island group of Vava'u.

Species expected to be encountered during the proposed surveys are listed in Table 1, page 2. Of those species listed, only some sardines, mackerels and particularly scads are likely to be of sufficient size to be acceptable as baits in the proposed longline tuna fishery.

Success of the baitfish assessment survey will depend upon the exclusive availability of a research vessel such as the Tongan Fisheries Division *Albacore* and crew. A sea-going scientific officer will be required to oversee the collection of data.

3.0 AIMS OF THE PROGRAM

The ultimate aims of the proposed survey program are to assess the baitfish resources of Vava'u, and suggest appropriate levels of sustainable exploitation. To achieve these aims, initial tasks are to collect data which allow the estimation of the following:

Biological parameters:

- growth and mortality estimates
- length-weight relationships
- reproductive cycles

Distribution (vulnerability) of the stocks:

- geographic variation
- seasonal variation
- lunar variation

Environmental parameters (on which baitfish abundance may depend):

surface water salinity
surface water temperature
rainfall

Table 1. Baitfish species likely to be encountered in the proposed survey in Vava'u. Percentages refer to the composition of catches made during early and brief South Pacific Commission surveys (from various sources including Lewis et al. 1983, Argue, 1988, as well as Tongan Fisheries Division records). Figures in the Length column indicate the likely maximum fork length of each species.

Family Species	Common Name	Length
Engraulidae (23% of total)	Anchovies	
Stolephorus devesi	gold anchovy	7 cm
Stolephorus indicus	Indian anchovy	15 cm
Thrissina baelama	baelama anchovy	10 cm
Dussumieridae (16.3% of total)	Sprats	
Spratelloides delicatulus	blue sprat	6 cm
Spratelloides gracilis	silver sprat	7 cm
Dussumieria	sharp-nosed sprat	15 cm
Clupeidae (15.5% of total)	Sardines	
Herklotsichthys quadrimaculatus	gold-spot herring	15 cm
Amblygaster sirm	spotted pilchard	20 cm
Sardinella melanura	blacktip sardine	
Atherinidae (19.2% of total)	Silversides	
Atherinomorus lacunosus	broad-banded silverside	10 cm
Hypoatherina ovalaua	Ovalaua silverside	10 cm
Carangidae	Scads	
Decapterus macrosoma	scad	30 cm
Selar crumenophthalmus	bigeye scad, atule	25 cm
Atule mate	yellowtail scad	25 cm?
Scombridae	Mackerels	
Rastrelliger kanagurta	Indian mackerel	>30 cm

The estimation of sustainable yield for such pelagic, and presumably highly mobile, stocks is likely to be difficult. However, it is believed that the proposed survey program will provide sufficient information to allow a judgement on whether or not sufficient resources exist to support a baitfishery, and suggest a level at which stocks may be sustainably exploited.

4.0 SURVEY METHODS

The aims and methods of four different types of surveys are given below. In each case catch details are to be recorded on the Daily Fishing Log Sheets, (sample sheets attached as appendices).

4.1 Area (General) Surveys

Aim: To determine the distribution of species by area.

Method: Carry out fishing at as many locations as possible during the year on a full-time basis. The data from catches made at different times of the lunar month may be "standardized" by reference to the results of the Lunar Month Survey (See Section 4.3). The most productive and easily accessible locations should be selected as standard fishing stations for the Station Surveys.

4.2 Station (Monthly) Surveys

Aim: 1) To estimate biological parameters (growth, mortality, etc.).
2) To investigate seasonal changes in abundance.

Method: Repeat sampling at selected stations at monthly intervals (at the same time of the lunar month, ideally within five days before and after the new moon). This is expected to produce a time-series of length-frequency data, which may be used to estimate growth and mortality, and catch-per-unit-effort figures which will be used to estimate seasonal variations in catch abundance.

4.3 Lunar Month Survey

Aim: To determine the vulnerability of species in relation to the lunar period.

Methods: Carry out fishing at one preferred fishing location over one full lunar month (over twenty-eight days, from one new moon through the full moon to the next new moon). In order not to deplete the local population, a large fishing area should be selected, and fishing should be carried out on approximately every second or third day.

4.4 Stock Depletion Survey

Aim:
1) To determine the catchability coefficient (q) of the sampling gear.
2) To provide approximate estimates of local stock sizes.

Method: Carry out intensive fishing in a selected bay over a short time period (as many hauls as possible in approximately ten consecutive nights - from five days before the new moon to five days after the new moon).

The bay must be selected on the basis that it approximates an isolated stock (in order that migration in or out of the bay may be considered minimal); the time period must be kept short (in order that the effects of natural mortality may be ignored); and the fishing effort should be massive enough to effectively reduce local stock numbers.

Although this experiment may be confounded due to the difficulty of accepting inherent assumptions, the importance of potential results justifies the small amount of field time (less than 1 week) required.

5.0 BASIC DATA COLLECTION

The following three types of information are to be collected in association with each fishing trip and haul (in addition to the fishing and environmental data prompted for in the Daily Fishing Log. See Appendix).

5.1 Catch Data

Catch is to be recorded as the number of "standard buckets" caught per haul. The composition and weight of the total catch will be estimated from an unbiased subsample of a minimum of three buckets, selected at random from each haul.

Notes on obtaining an unbiased subsample of the catch:

1) Empty the net, or braille the total catch, into buckets before commercial processing (record the total number of buckets in the Catch on the Daily Fishing Log).

2) Save three or more standard buckets from different parts of the mixed catch in a separate pile,which will represent the subsample. Note: collect the first bucket and the last bucket to come on board as well as a number of buckets in between for the separate subsample pile. Choose a number of full standard buckets so that at least 300 fish are in the subsample (record the total number of buckets used in the Subsample on the Daily Fishing Log).

3) Record the total weight of the subsample (place fish in a plastic bag hung from a spring balance).

4) Sort the fish in the subsample into species and fill in the details on the back of the Daily Fishing Log.

5.2 Fishing Effort Data

Fishing effort is to be recorded as the number of hauls of either a purse seine, bouki-ami net or other gear. The "size" of the gear used is to be recorded as net length (circumference) in the case of purse seines and as estimated net area in the case of bouki-ami nets.

5.3 Length-Frequency Data

Lengths are to be recorded (caudal fork length to the nearest 0.5 cm) for an unbiased subsample of a minimum of three buckets from each haul.

5.4 Reproductive Condition Data

A selected subsample (from smallest to largest) of about fifty fish of each of the major species should be retained from each night's catch for the assessment of reproductive condition. Each fish is to be measured (caudal fork length to the nearest 0.5 cm) and gonad appearance macroscopically assessed as either male, indeterminate sex, undeveloped female, or developed female.

The following data are to be collected on a reguiar basis, independent of the fishing program.

5.5 Rainfall Data

Monthly rainfall data (mm per month) are to be obtained from meteorological stations. If these are not available from official sources, a simple rain gauge may be constructed and monitored at the RDA office in Vava'u.

The following data are to be collected for each major species during a convenient time of the year.

5.6 Length-Weight Data

Lengths (caudal fork length to the nearest 1 mm) and weight (total fresh weight, blotted dry, to the nearest 0.1 g) are to be recorded for a selected sample of about 300 fish for each of the major species.

Individual fish should be selected to include a wide size range (from smallest to largest).

> NOTE: Once 300 individuals have been processed for each of the major species, it will no longer be necessary to continue to collect individual fish weight information.

6.0 EQUIPMENT REQUIRED

100 copies of Survey Log sheets
200 copies of LENGTH-FREQUENCY DATA sheets
100 large clear plastic bags (approx. 30 x 50 cm)
2 clip-boards
2 measuring boards (0.5 cm intervals)
2 spring balances (range to 1 kg)
2 spring balances (range to 10 kg)
2 thermometers (range to 10 kg)
2 thermometers (range; 10°C to 40°C)
1 pocket refractometer (sea-water range)
1 rain gauge (?)
1 hand-held magnifying glass
2 dissection kits
6 large buckets (4 gallon, or 20 l)

NOTE: The use of an electronic balance will be required for the length-weight analyses only.

REFERENCES

Argue, A.W., 1988. Inshore tropical baitfish: Current resource management knowledge. South Pacific Commission Workshop on Pacific inshore fishery resources, New Caledonia. Working Paper 16. 32 p.

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Gillett, R., 1988. Notes on Pacific Islands *Decapterus*. South Pacific Commission Workshop on Pacific inshore fishery resources, New Caledonia. Background Paper 60. 9 p.

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Lewis, A.D., Smith, B.R. and Ellway, C.P., 1983. A guide to the common baitfishes of the South Pacific Commission area. South Pacific Commission, New Caledonia. Handbook 23. 82 p.

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Sharma, S., 1983. The Fijian baitfishery. South Pacific Commission Workshop on Pacific inshore fishery resources, New Caledonia. Background Paper 14. 18 p.

Tampubolon, G.H., 1988. Growth and mortality estimation of the Indian mackerel (*Rasrtrelliger kanagurta*) in the Malacca Strait, Indonesia. FAO Fisheries Report 389. 519 pp.

APPENDICES

SAMPLE DATA FORMS

BAITFISH: DAILY FISHING LOG

NOTES:
A) Use one log sheet per fishing "night" (from noon to following noon).
B) Record date on start of fishing period (i.e., night of..).
C) Use additional sheet if more than 4 hauls completed in one night.
D) Use a standard six bucket, fish bin or basket to estimate the size of the catch; ALWAYS use this same standard bucket.

DATE: Night of _____ RECORDED BY (NAMES) _____

VESSEL NAME (if applic.) _____ SURFACE SALINITY _____(ppt)

MOON SET (if applic.) at _____ hrs. SURFACE TEMP _____(°C)

SEA STATE (circle one choice): Calm - Ripples - Choppy - Rough

CLOUD COVER (circle percentage): 0% - 20% - 40% - 60% - 80% - 100%

COMMENTS (gear damage, different light used, etc.)_____

_____

GEAR USED:

PURSE SEINE? (tick if yes _____) OTHER? (tick if yes _____)

Circumference of net: _____ (m) Enter details: _____

Stretched mesh size: _____ (mm) _____

TYPE AND NUMBER OF LIGHTS USED_____

NUMBER OF HOURS THAT LIGHT WAS USED BEFORE HAULING _____

CATCH RECORD:

HAUL NO.	FISHING LOCATION *	HAUL TIME	MEAN DEPTH (M)	TOTAL CATCH Number of buckets	SUBSAMPLE ** Number of buckets	WEIGHT(kg) (to 0.1 kg)
1						
2						
3						
4						

* Enter identifying name of haul location; also mark location on chart and attach photocopy to this sheet.

** Subsample at least three buckets from each haul (more for larger fish); choose a number of full buckets so that at least 300 fish are included in the subsample.

For each subsample:
A) Sort into species, and enter numbers in the table over page, and,
B) Measure all, or at least the most abundant species, and enter lengths on the length-frequency sheets.

ENTER THE NUMBER OF INDIVIDUALS PER SUBSAMPLE IN THE TABLE BELOW:

NOTE: To identify fish, use key on reverse of length-frequency sheet as well as SPC handbook number 23 (Lewis et al., 1983)

HAUL NUMBER	1	2	3	4
NUMBER OF BUCKETS SAMPLED				
ANCHOVIES (Engraulidae) -*Stolephorus, Thrissina*				
gold anchovy (*Stolephorus devesi*)				
Indian anchovy (*Stolephorus indicus*)				
Baelama anchovy (*Thrissina baelama*)				
SPRATS (Dussumieriidae) - *Spratelloides, Dussumieria*				
blue sprat (*Spratelloides delicatulus*)				
silver sprat (*Spratelloides gracilis*)				
sharp-nosed sprat (*Dussumieria*)				
SARDINES (Clupeidae) *Herklotsichthys, Amblygaster, Sardinella*)				
goldspot herring (*H. quadrimaculatus*)				
spotted pilchard (*Amblygaster sirm*)				
blacktip sardine (*Sardinella melanura*)				
SILVERSIDES (Atherinidae) - *Atherinomorus, Hypoatherina*				
b/banded silverside (*A. lacunosus*)				
Ovalaua silverside (*H. ovalaua*)				
SCADS (Carangidae) - *Decapterus, Selar, Atule*				
scad (*Decapterus macrosoma*)				
bigeye scad, atule (*S. crumenophthalmus*)				
yellowtail scad, atule (*Atule mate*)				
MACKERELS (Scombridae) - *Rastrelliger*				
Indian mackerel (*R. kanagurta*)				
OTHERS - identify by name, or A, B, C etc., and preserve sample				

NOTE: Fill in all details on the front of this DAILY FISHING LOG sheet. File all LOG and DATA sheets; send photocopies to M. King.

BAITFISH LENGTH-FREQUENCY DATA: DATE..... HAUL NUMBER .....

SPECIES.....

total fish from	buckets
4.0	
4.5	
5.0	
5.5	
6.0	
6.5	
7.0	
7.5	
8.0	
8.5	
9.0	
9.5	
10.0	
10.5	
11.0	
11.5	
12.0	
12.5	
13.0	
13.5	
14.0	
14.5	
15.0	
15.5	
16.0	
16.5	
17.0	
17.5	
18.0	
18.5	
19.0	
19.5	
20.0	
20.5	
21.0	
21.5	
22.0	
22.5	
23.0	
23.5	
24.0	
24.5	
25.0	
25.5	
26.0	
26.5	
27.0	
27.5	
28.0	
28.5	
29.0	
29.5	
30.0	
30.5	
31.0	
31.5	
32.0	X

this indicates 2 individuals

SPECIES.....

total fish from	buckets
4.0	
4.5	
5.0	
5.5	
6.0	
6.5	
7.0	
7.5	
8.0	
8.5	
9.0	
9.5	
10.0	
10.5	
11.0	
11.5	
12.0	
12.5	
13.0	
13.5	
14.0	
14.5	
15.0	
15.5	
16.0	
16.5	
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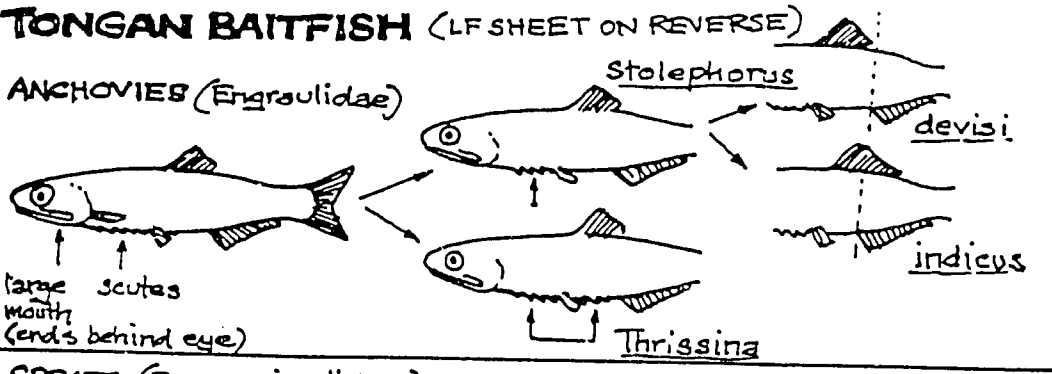
24.5	
25.0	
25.5	
26.0	
26.5	
27.0	
27.5	
28.0	
28.5	
29.0	
29.5	
30.0	
30.5	
31.0	
31.5	
32.0	

SHEET NUMBER.....OF.....FOR THIS HAUL

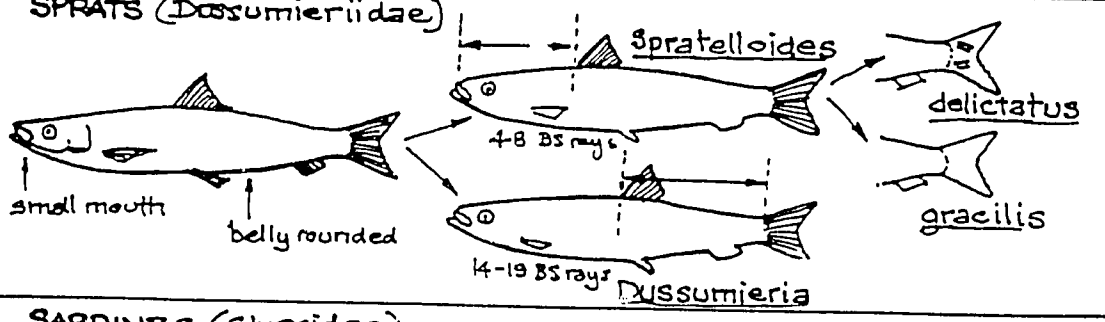
NOTE: Identification details on back of this sheet >>

TONGAN BAITFISH (LF SHEET ON REVERSE)

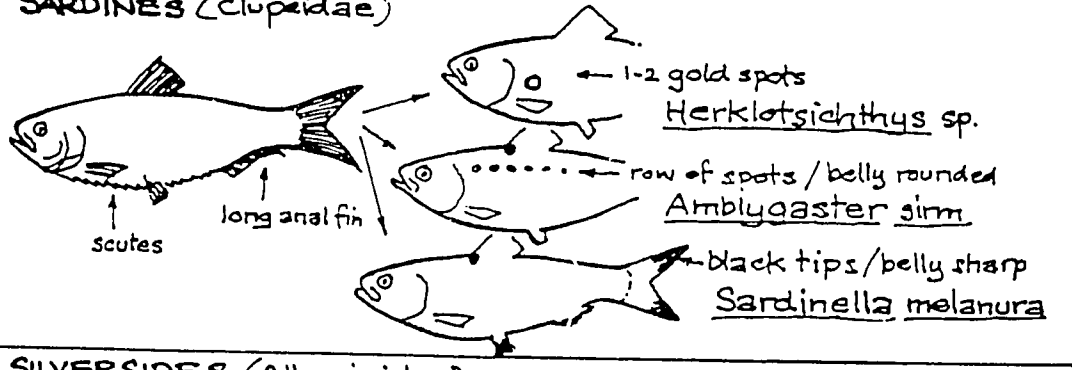
ANCHOVIES (Engraulidae)



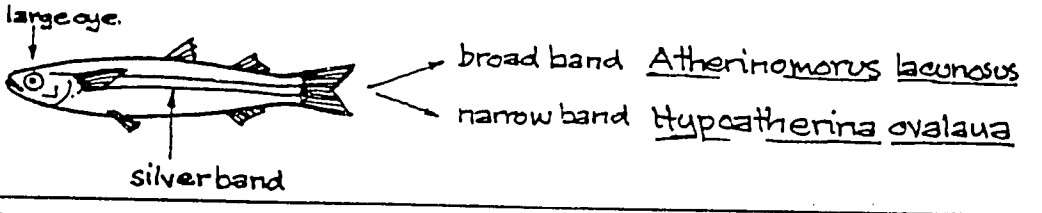
SPRATS (Dussumieriidae)



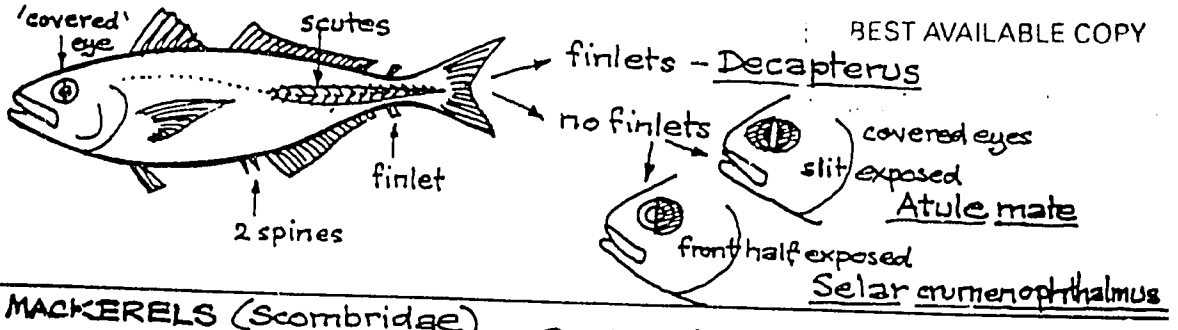
SARDINES (Clupeidae)



SILVERSIDES (Atherinidae)



SCADS (Carangidae)



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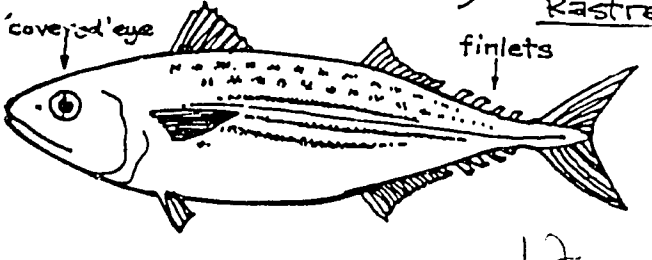
MACKERELS (Scombridae)



SEE SPC HANDBOOK 23 FOR DETAILS ON ALL THE ABOVE SPECIES

M. KING, TONGA, 1992