software packages that also utilize length frequency information. Participants were particularly interested in the MULTIFAN commercial package recently released by Otter Software from Canada. Throughout, it was stressed that attempts should always be made to validate the results of analysis of length-frequency data no matter what method is employed for the analysis.

Participants came from seven countries in the region; Solomon Islands and Kiribati both sent two participants with one each coming from Papua New Guinea, Fiji, Western Samoa, Tonga and Vanuatu. Each brought length data that they or others had collected in their countries. As a result, length frequency data for species from a variety of taxa and habitats including shallow water lethrinids, deep water eteline snappers, pelagic stolephorid anchovies and penaeid prawns were analyzed during the two-week period. The participants thus experienced the application of these methods of analysis to a variety of different data sets and situations.

At the conclusion of the workshop, participants discussed their results during an oral presentation. In addition, they documented their work. The papers that follow in this and subsequent issue of "Fishbyte" are a selection of the results of the two-week programme in Honiara.

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Population Dynamics of the Commercially Important Baitfish Species *Stolephorus heterolobus* in Solomon Islands*

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Introduction

During 1971 and 1972, a survey was carried out by Taiyo Gyogyo of Japan to assess the skipjack tuna, *Katsuwonus pelamis*, and baitfish resources in Solomon Islands waters. This led in 1973 to the signing of a joint venture agreement between the Solomon Islands government and Taiyo Gyogyo, and the development of a local skipjack tuna industry. The Surihama fishermen of Okinawa were employed to operate a fleet of vessels to capture skipjack tuna, utilizing the pole-and-line fishing technique. The pole-and-line industry has grown to such extent that in 1986, a fleet of 34 vessels caught a total of 38,645 tonnes worth $50 million in foreign export earnings for Solomon Islands.

Baitfishing

The pole-and-line method of catching skipjack tuna from surface schools cannot be employed

*Preliminary results based on a paper written during a Workshop on Length-Based Methods in Fisheries Analysis, Dec. 5-17. 1988, Honiara, Solomon Islands.

without a large supply of acceptable live baitfish. Baitfish are small pelagic species which are used to "chum" schools of skipjack to the catcher vessels before fish can be poled onboard.

The catching of baitfish is a separate fishery in time, location and method. Fishing takes place at night from designated baitfishing grounds (mainly lagoonal areas) using a "bouke-ami" (or stick-held liftnet in conjunction with underwater lights).

One of the most important species caught in baitfish catches in Solomon Islands is *Stolephorus heterolobus* (Evans and Nichols 1985).

Sampling

When the pole-and-line fishery started, the data collection was limited to catch reports made by the Fishing Masters. This is the crew member in charge of fishing operations as distinct from the Captain who pilots the boat. The whole system was reviewed as complaints were received from the baitground owners on different aspects of the baitfishery. In 1981, a logbook system was introduced to try to obtain more detailed catch and effort statistics and an observers' programme was initiated so that biological specimens from the catch could be collected for later analysis in the laboratory.

Observers were put onboard commercial vessels and would collect samples of bait from wherever fishing may have taken place each night. This system had the disadvantage that vessels would concentrate their fishing effort at different sites during the year and this meant samples collected were not producing a good time series from any one site. This problem was overcome when the Australian Centre for International Agricultural Research (ACIAR) in 1987 provided funds for collaborative research programme between the Solomon Islands government and the Commonwealth Scientific and Industrial Research Organization (CSIRO) of Australia. The collection of samples is now concentrated at three sites only: Munda, Tulagi and Vona Vona lagoon, a control site where no commercial baitfishing takes place.

The majority of data included in this report comes from samples taken directly from the catches of the pole-and-line vessels. As buckets of bait are being taken from the net and transferred to the baitwells onboard, either the whole bucket or a part of the contents of the bucket are collected in a very fine meshed net. Samples are then preserved in a solution of formaline for later analysis in the laboratory. Prior to the initiation of the collaborative research programme, it had not been possible to collect samples throughout the year as there has always been a closed season to fishing for two to three months starting in either November or December. This closed season is due to the commercial fishermen taking a holiday and has not been enforced as a management measure. Samples are now collected when commercial vessels are not operating by using underwater lights from smaller boats. The mesh size of the net used is the same as employed by commercial vessels (4 mm square), and the samples are therefore, considered to be equivalent to those taken from larger fishing units.

When samples are returned to the laboratory, they are sorted by species and the fork length of each fish is measured to the nearest millimeter. For the analysis of this data, the individual fish lengths have been summed into five millimeter length classes.

This report presents an analysis of length-frequency data of *Stolephorus heterolobus* collected from Munda baitground between 1984 and 1988.

Sample site

There are 84 designated baitfishing grounds in Solomon Islands, boundaries being made by customary ownership rights. There are two areas which have traditionally had a disproportionately high amount of fishing effort due to the fact that they are in close proximity to the fishing bases and vessels tend to go to these grounds after unloading. One of the bases is at Tulagi in the Central Isles Province and the other at Noro in the Western Province. The baitground at Munda is the closest to the base at Noro and so fishing effort has usually been high. Fig. 1 shows the location of the two fishing bases along with Munda baitground.

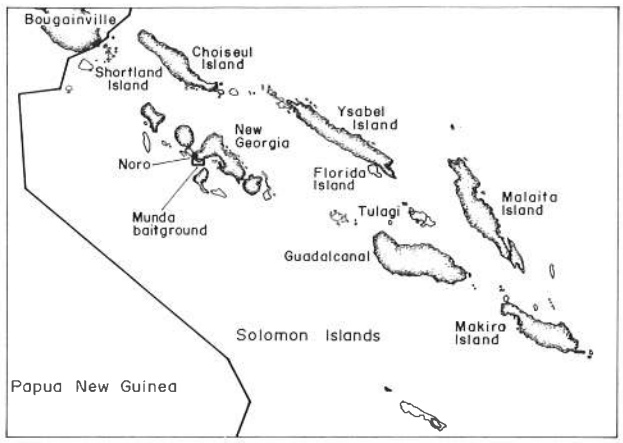

Fig. 1. Map of the Solomon Islands showing Bunda baitground.

Estimation of population parameters

The length-frequency data collected (see examples in Tables 1 to 5) have been analyzed using the computer programs ELEFAN I and ELEFAN II (Gayanilo et al., 1988) in order to try and estimate the growth parameters of *Stolephorus heterolobus* from Munda, Solomon Islands as well as mortality rates and recruitment patterns.

Table 1. Length-frequency data on *Stolephorus heterolobus* collected in 1984 at Munda baitground, Solomon Islands.

ML (mm)	Mar	Apr	Aug	Oct
32.5			5	
37.5			40	1
42.5		1	72	4
47.5		27	85	13
52.5	10	47	55	14
57.5	24	84	35	8
62.5	73	209	6	
67.5	128	199		
72.5	91	125		
77.5	45	37		
82.5	29	4		
87.5	11	1		
Sum	411	734	298	40

The data was analyzed on a yearly basis because of the effects that the season closed to fishing may have on recruitment patterns into the fishery from year to year.

Methodology

1. Length-frequency data were entered into yearly files using ELEFAN 0.
2. A first estimate of L_∞ (asymptotic length) was made using ELEFAN II and the method of Wetherall (1986), as modified by Pauly (1986). Results from each run are shown in Table 6.
3. ELEFAN I was used to obtain estimates of L_∞, K, C and WP. The data for 1985 were used first as this was a more complete set of data than 1984. A range of values for L_∞ was found. First estimates were then corrected using probability of capture data from ELEFAN I (which were used to correct the original data for the effects of incomplete recruitment). The corrected data were then run through ELEFAN I to give final estimates of growth parameters. It should be noted that K values using corrected data did not increase as might be expected since the

Table 2. Length-frequency data on *Stolephorus heterolobus* collected in 1985 at Munda baitground, Solomon Islands.

ML (mm)	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov
32.5					1	12	34		
37.5			2		4	7	112	1	17
42.5			9		13	34	67	3	56
47.5			50	3	44	41	16	26	34
52.5			92	14	168	51	31	49	37
57.5	7	9	119	26	232	76	39	34	63
62.5	5	30	79	38	176	72	117	15	68
67.5	9	58	51	16	92	32	157	16	18
72.5	7	50	22	18	30	1	52	1	4
77.5	3	16	3	18	4		1	1	
82.5		2							
Sum	31	165	427	133	764	326	626	146	297

Table 3. Length-frequency data on *Stolephorus heterolobus* collected in 1986 at Munda baitground, Solomon Islands.

ML (mm)	Mar	Apr	May	Jun	Sept
32.5	12				
37.5	11	3	100		
42.5	2	17	118		
47.5	2				120
52.5	7	2	47	100	90
57.5	14	12	16	118	76
62.5	39	18	5	70	37
67.5	45	14		10	12
72.5	15	5		1	1
77.5	5	1			
Sum	140	52	139	316	566

Table 4. Length-frequency data on *Stolephorus heterolobus* collected in 1987 at Munda baitground, Solomon Islands.

ML (mm)	Mar	Apr	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
22.5	1	1									
27.5	1	2			1	0	3	7			
32.5	8		1		3	65	1	0	67		2
37.5	24		1		6	118	13	0	434		11
42.5	0	3	39		64	190	37	9	852	36	16
47.5	7	24	44		98	162	66	77	687	105	13
52.5	55	96	129	1	122	133	97	572	403	178	9
57.5	158	133	168	1	193	124	166	788	120	134	2
62.5	123	141	95	5	301	92	270	316	48	110	2
67.5	51	36	22	2	156	26	96	32	11	10	1
72.5	5	2	1		21	10	9	7	1	2	
77.5	2				1		1	2			
Sum	434	435	514	9	965	921	757	1807	2630	575	56

Table 5. Length-frequency data on *Stolephorus heterolobus* collected in 1988 at Munda baitground, Solomon Islands.

ML (mm)	Feb	Mar	May	Jun	Jul	Aug	Sept
22.5	6						
27.5	19						
32.5	99						
37.5	212		7			3	9
42.5	144	4	22			7	4
47.5	114	16	11		4	6	3
52.5	109	12	8	10	2	6	0
57.5	64	1	10	56	0	5	1
62.5	14		19	159	2	1	1
67.5	1		9	45	4		3
72.5			2	9	1		
Sum	782	33	88	279	13	28	21

Table 6. Estimates of L_∞ and Z/K obtained using the method of Wetherall (1986).

Year	L_∞	Z/K
1984	99	4.39
1985	82	2.65
1986	82	3.17
1987	75	2.62
1988[a]	-	-

[a]Bad fit of data points.

mesh size of the bait net is such that the smallest size classes of fish are caught and selection effects are negligible. The final results were then used as guide for the runs using the other years' data. Results are shown in Table 7 and Fig. 2.

4. After growth parameters had been obtained, ELEFAN II was run using the catch curve routine and mortality estimates were produced. Final estimates are shown in Table 8.

Catch curves for each year are presented in Fig. 3 (left panels).

5. Recruitment patterns were produced using ELEFAN II. Fig. 4 (right panels) show the patterns produced for each year.

Discussion

The estimates of L_∞ and K are consistent with those of *S. heterolobus* from Papua New Guinea (Dalzell 1984). Dalzell (1984), however, did not consider seasonal growth oscillations which have been included in this analysis. The results show that seasonal growth is important and is to be expected given the temperature fluctuations of between 3 to 4 degrees Celsius during the year at Munda.

Table 7. Growth parameter estimates of *Stolephorus heterolobus* obtained using the ELEFAN I program.

Year(s)	L_∞ (mm)	K (year^{-1})	C	WP
1984[a]	82	2.4	0.50	0.75
1985[a]	82	2.4	0.65	0.40
1986[a]	82	2.4	0.65	0.50
1987[a]	82	2.4	0.65	0.40
1988[a]	81.5	2.4	0.65	0.60
1972, 1976-1981[b]	79	2.6	-	
1972, 1973 and 1981[b]	87	2.4	-	-

[a]this study, Munda baitground.
[b]Dalzell (1984), based on data from Ysabel Passage (1972, 1976-1981) and Cape Lambert (1972, 1973 and 1983), both in PNG.

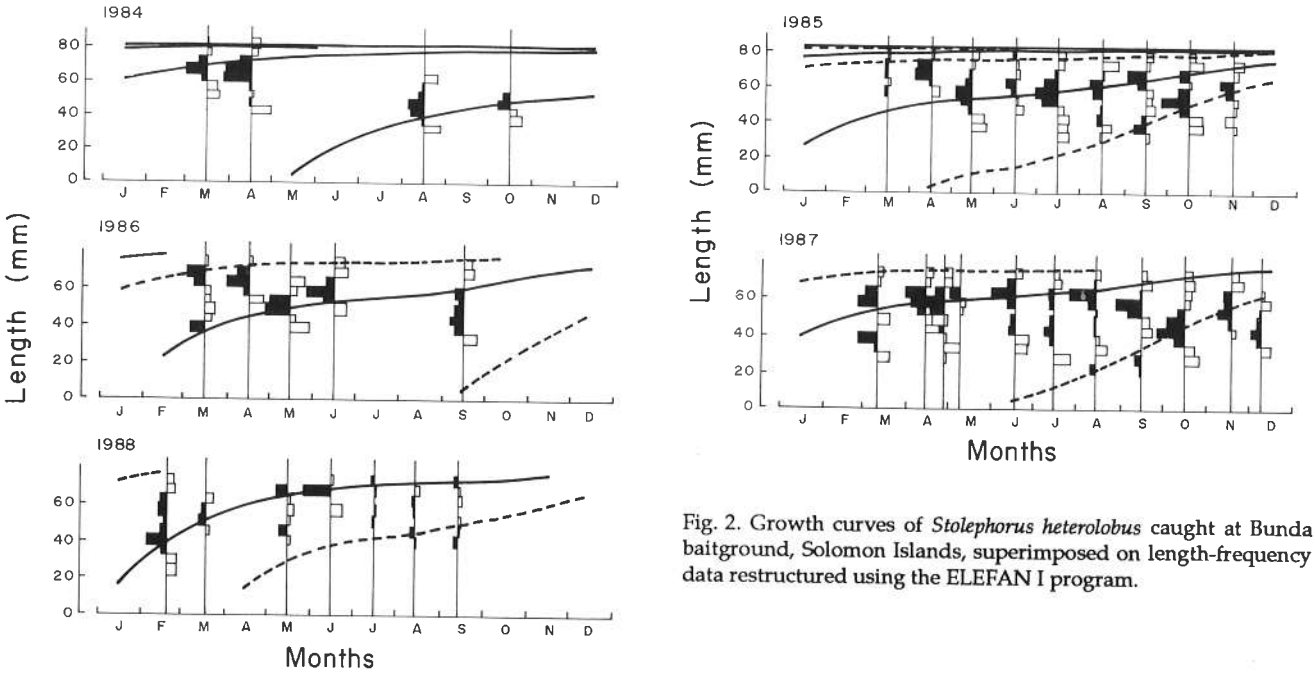

Fig. 2. Growth curves of *Stolephorus heterolobus* caught at Bunda baitground, Solomon Islands, superimposed on length-frequency data restructured using the ELEFAN I program.

Table 8. Mortality estimates obtained using the ELEFAN II program.

Year	Z	M	F	E=F/Z
1984	5.23	4.69	0.53	0.102
1985	6.26	4.69	1.32	0.210
1986	7.66	4.69	2.97	0.388
1987	11.75	4.69	7.05	0.600
1988	6.08	4.70	1.30	0.217
$\bar{X}$	7.40	4.69	2.63	0.303

Table 9. Catch and effort data for Munda baitground, 1984-1988.

	Boat		CPUE	
Year	Hauls	Nights	Buckets	Bkt/Haul
1984	5451	1544	193122	35.4
1985	6010	1711	209000	34.8
1986	3957	1194	144945	36.6
1987	5815	1499	200507	34.5
1988[a]	729	232	28889	39.6

[a](up to Oct.)

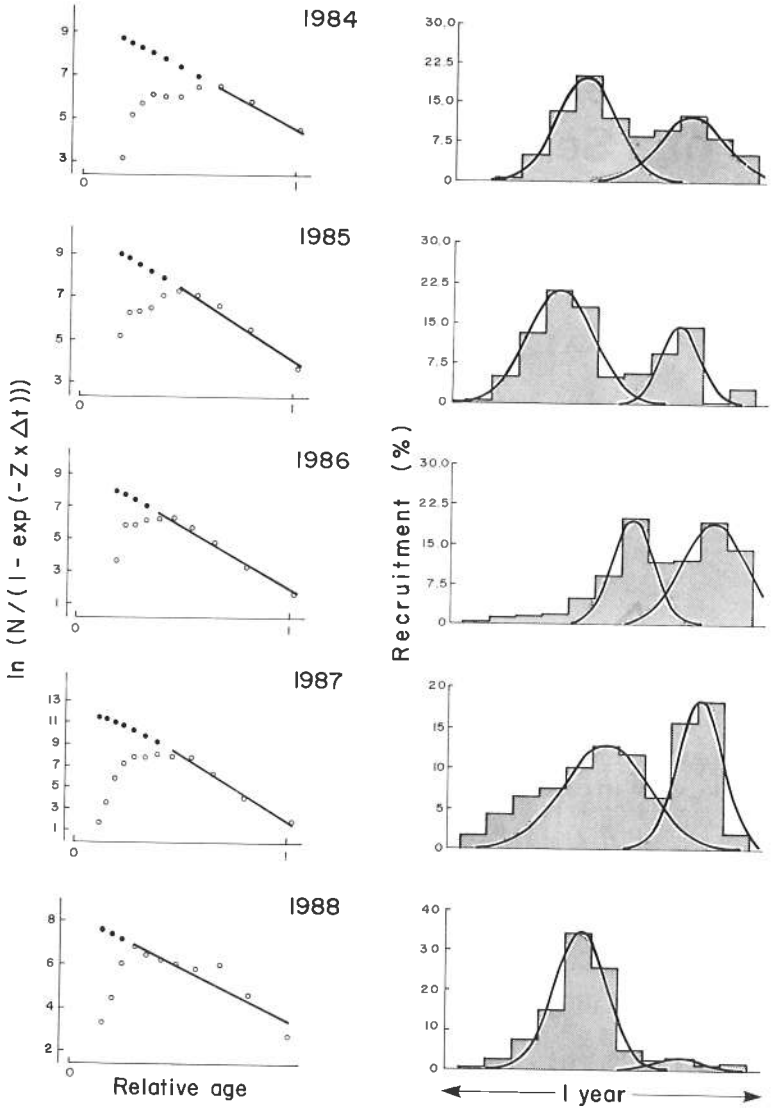

Fig. 3. Length-converted catch curves (left) and recruitment patterns (right) of *Stolephorus heterolobus* caught at Munda baitground, Solomon Islands, 1984-1988.

The mortality rates for *S. heterolobus* are high (Table 8) but are consistent for such short-lived species. The use of catch curves in this instance to determine changes in annual mortality rates is dependent on little variation in the levels of recruitment between years. The annual catch per effort for this species show little variation (Table 9) suggesting that recruitment did indeed vary very little from 1984 to 1988. The generally low exploitation ratios determined from the catch curves are thus indicative of a stock subjected to moderate fishing pressure. These can be averaged to give a mean exploitation ratio of about 0.3.

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