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PROCEEDINGS OF A WORKSHOP ON BAITFISH AND DEEPWATER BOTTOMFISH

Honolulu, Hawaii
17 - 25 November 1992

Pacific Islands Marine Resource Project
Tonga Component
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1.0 EXECUTIVE SUMMARY

A workshop was held at the East West Center of the University of Hawaii, during the period 17 to 25 November 1992. The aims of the workshop were to review and, where applicable, analyze data collected from a) the bottomfish fishery in Tonga, b) the first year of bottomfish surveys in Tuvalu, and c) initial surveys on baitfish resources in Vava'u, Tonga.

1.1 Bottomfish fishery, Tonga

Deep-water snappers, emperors, and groupers have been caught commercially in Tonga since 1980, and data have been collected since late 1986. Fishing effort has decreased from 44 vessels in 1987 to 19 vessels at present, and estimates of fishing costs and returns to fishermen, suggest that profit levels in the fishery are low.

Analyses of the catch data using surplus yield models suggest that a maximum yield of approximately 350 tons of deep-water export species may be sustainable. However, at the level of fishing effort required to take this catch, financial returns (returns minus fishing costs) from the fishery are negative. Profits from deeper-water species are maximized at a lower fishing effort of approximately 500 trips or 16-17 fishing vessels.

As the fishery is export orientated, it is suggested that maximizing profits from the fishery represents the most appropriate management option. Of the management measures discussed, limiting vessel numbers through a vessel registration or licensing system is likely to be the most acceptable. Policing such a management measure is unlikely to be onerous due to the limited number of processors, which would be permitted to purchase deep-water snapper from licensed vessels only.

The 16-17 vessels remaining in the fishery should be encouraged to increase efficiency, perhaps by the installation of hydraulic or electric powered reels, and that methods of fish marketing be examined with a view to aiding exporters maximize the market value of the catch. When profitability from the fishery is maximized, a nominal license fee may be imposed to amortize the costs of managing and policing the fishery. Monitoring the fishery should be continued, at least at the level of collecting catch and effort data.

1.2 Bottomfish surveys, Tuvalu

Fifteen research cruises were completed during the first year of the Tuvalu bottomfish assessment project. Ten different geographical areas were hydrographically surveyed and systematically fished to provide information on bathymetry, species composition, length-frequency, and the distribution of catch-rates by area and depth. Initial analyses of these data were undertaken at this workshop.

Several commercially valuable species of bottomfish were caught (including *Etelis*

carbunculus, Etelis coruscans and *Caranx lugubris*). Mean catch rates were 5.55 kg per line hour for commercial species, and 6.45 kg per line hour for all species combined.

The production of detailed charts showing the distribution of catch rates over the areas fished will allow the targeting of highly productive areas in the second year of the project.

Initial estimates (subject to review) are that commercial fishing costs would be approximately $33000 per vessel (based on 30 trips per year); at the level of catch rates found during the survey, there is some concern that expected local market prices for deep-water fish will cover these fishing costs.

1.3 Baitfish resources, Vava'u, Tonga

Fishing surveys using the government vessel have been running for seven months, although only 24 fishing trips were completed during this period. Length-frequency and catch and effort data have been collected over this period, and reproductive studies began more recently due to delays in obtaining equipment.

Length-frequency data were considered to be of high quality, and the sample sizes are adequate. Initial analyses conducted at the workshop suggested that growth estimates obtained from such data are likely to be reliable. Although catches varied greatly, the mean catch rate over the seven month period was 570 kg per night, and returns on sales were approximately T$2.00 per kg.

Disappointment was expressed with progress in the collection of catch-per-unit-effort data over a 28-day period to determine lunar vulnerability, and in running depletion experiments to estimate stock sizes. At present, crew members have little incentive to go fishing at the period of the full moon (when catch rates are believed to be low), and to commit themselves to the considerable physical effort involved in handling the heavy purse seine net over a sustained period; a depletion experiment is likely to require fishing over at least 10 days (excluding the weekend which is sacrosanct under local customs).

2.0 WORKSHOP PARTICIPANTS

The workshop was held at the East West Center of the University of Hawaii, during the period 17 to 25 November 1992, and was attended by the following personnel (listed in alphabetical order):

Niko Apinelu	Department of Fisheries, Tuvalu
Paul Dalzell	South Pacific Commission, Noumea
Lindsay Chapman	Formerly South Pacific Commission (visitor)
Wayne Haight	NMFS, Hawaii
Michael Kane	RDA Acting Manager, Project Support Office
Michael King	RDA Consultant
Sarah Langi	RDA, Tonga
Viliami Langi	RDA, Tonga
Tevita Latu	Ministry of Fisheries, Nuku'alofa
Siola'a Malimali	Ministry of Fisheries, Nuku'alofa
Jeff Polovina	NMFS, Hawaii
John Rowntree	RDA Senior Economist
Stanley Swerdloff	RDA Project Leader, Tonga
Sosaia Tulua	Ministry of Fisheries, Nuku'alofa
Falasese Tupau	Department of Fisheries, Tuvalu

3.0 WORKSHOP AIMS AND STRUCTURE

The aims of the workshop were to review, and, where applicable, analyze data collected from a) the bottomfish fishery in Tonga, b) the first year of bottomfish surveys in Tuvalu, and c) initial surveys on baitfish resources in Vava'u, Tonga.

To cover the diverse interests of Island participants, and to allow the most beneficial use of available time, the workshop program was left relatively unstructured, and subject to change at the request of participants. The following is a general outline of the program.

Tuesday 17 November

1. Welcome to participants by Michael Kane.
2. Introduction by Jeff Polovina.
3. Discussion groups (separate):
   - A. Tonga bottomfish data analysis (S.Langi, T.Latu, S.Tulua).
     - 1. Dynamic production models (J.Polovina, D.Kobioshi).
     - 2. Equilibrium production models (M.King, P.Dalzell).
   - B. Tuvalu bottomfish data analysis (F.Tupau, N.Apinelu).
     - 1. Data manipulation and analysis (W.Haight).

Wednesday 18 November

Separate groups:

1. Tonga bottomfish data analysis (S.Langi, T.Latu, S.Tulua).
   - A. Dynamic production models (J.Polovina, D.Kobioshi).
   - B. Equilibrium production models (M.King, P.Dalzell).
2. Tuvalu bottomfish data analysis (F.Tupau, N.Apinelu).
   - A. Data manipulation and analysis (W.Haight).

Thursday 19 November

1. Tonga bottomfish data analysis (S.Langi, T.Latu, S.Tulua).
   - A. Dynamic production models (J.Polovina, D.Kobioshi).
   - B. Equilibrium production models (M.King, P.Dalzell).
2. Tuvalu bottomfish data analysis (F.Tupau, N.Apinelu).
   - A. Data manipulation and analysis (W.Haight).

Friday 20 November

1. Yield analyses of bottomfish data by Michael King.
2. Economic analyses of bottomfish data by Michael King.
   - A. Tonga and Tuvalu data - estimated fishing costs.
   - B. Tonga data - estimation of Maximum Economic Yield.
3. Management options for bottomfish fisheries by Michael King.
   - A. Appropriate fisheries regulations.
   - B. Monitoring the fishery.

Monday 23 November

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1. Baitfish studies in the Pacific by P. Dalzell (paper provided as Appendix A)
2. Baitfish studies in Vava'u, Tonga by V. Langi.
3. Separate groups:
   A. Tonga bottomfish data analysis (with M. King and P. Dalzell).
   B. Baitfish data analysis (with M. King and P. Dalzell).
   C. Review of Tuvalu fishing costs estimates (with J. Rowntree).
   D. Review of Tonga fishing costs estimates (with J. Rowntree).

Tuesday 24 November

1. Separate groups:
   A. Tonga bottomfish review (S. Langi, L.Latu, S.Tulua).
   B. Baitfish data analysis (M.King, P.Dalzell, V.Langi, S.Malimali).
   C. Tuvalu data analysis (W.Haight, N.Apinelu, F.Tupau).
2. Evening Workshop Dinner in Pagoda Hotel Tea Room.
   Guests: Steve Pollard, Phil Helfrich, Sitivini Halapua, and Bob Schroeder.
   A. Keynote address by John Rowntree.
   B. Presentation of Certificates to Participants.

Wednesday 25 November

1. Separate groups (finalization of reviews):
   A. Tonga bottomfish (S. Langi, T.Latu, S.Tulua).
   B. Baitfish (M.King, P.Dalzell, V.Langi, S.Malimali).
   C. Tuvalu bottomfish (W.Haight, N.Apinelu, F.Tupau).

Three full reports are expected to be produced and their production aided by the above program:

1. Tonga bottomfish (T.Latu, S.Tulua - for the Tongan government, and assisted by S.Langi).
2. Tonga baitfish (V.Langi, S.Malimali).
3. Tuvalu bottomfish (W.Haight, N.Apinelu, F.Tupau).

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4.0 BOTTOMFISH FISHERY, TONGA

Deep-water snappers, emperors, and groupers have been caught commercially in Tonga since 1980, and data have been collected since late 1986. Biological results available are consistent with a resource which is fragile, involving slow growing species with long life-spans and limited habitats.

Due to the lack of reliable estimates of biological parameters, it was decided to use production models based on catch and effort data to assess the fishery. Measurement of effort was based on a fishing vessel completing an average of 30 trips of approximately 5 days duration per year; an average of 3.5 reels is used for 3 days fishing in each 5-day trip. Although fishing time has been recorded as 13 hours per day, it is likely that the average is approximately 7 hours per day; due to the problems in measuring fishing hours (fishermen do not have watches), the number of fishing trips was used as the unit of fishing effort. Catch and effort data are summarized in Table 1.

Production models were based on fishing effort expended in deep-water (on the sea-mounts) and presumably targeting the five export species. Dynamic production analyses appeared to produce no meaningful results. Both the Fox and Schaefer equilibrium production models were based on a reasonable linear fit of the catch-per-effort data, and result in estimates of sustainable yields of about 350 tons for all deep-water species (Fig. 1), and 210 tons for the two most common species (Fig. 2).

Table 1 Annual catch (tons) of component species and fishing effort in the Tongan deep-slope fishery between 1986 and 1992

Species	1986*	1987	1988	1989	1990	1991	1992*
Pristipomoides filamentosus ...	60.09	137.34	91.95	85.24	20.29	36.48	41.50
Pristipomoides flavipinnis ...	21.38	24.00	22.53	15.44	3.33	5.33	-
Etelis coruscans ...	18.08	82.13	71.17	110.75	115.81	104.35	17.89
Epinephelus carbunculus ...	6.68	44.92	16.05	11.29	10.04	15.80	15.43
Epinephelus morrhua ...	21.71	17.04	10.47	8.76	1.98	3.25	6.54
Epinephelus septemfasciatus..	57.62	110.09	26.72	37.51	31.22	45.65	1.73
Lethrinus chrysostomus ...	0.04	32.88	65.01	34.49	9.58	16.30	-
Other species ...	24.96	65.63	147.64	99.78	21.91	29.43	32.25
Total landings	210.57	514.04	451.55	403.26	214.16	256.58	115.34
Effort (trips)	214	1409	1091	885	491	608	569
Effort (reel hours)	15764	103562	80189	65048	36089	44688	41821
CPUE (kg/trip)	983	365	414	457	436	422	202
CPUE (kg/reel hour)	13.30	4.96	5.63	6.20	5.93	5.74	2.76
% of catch sampled	55	24	55	41	45	40	88
Fleet size	32(?)	37	44	36	30	27	19

* Data for years 1986 and 1992 based on a short sampling period.

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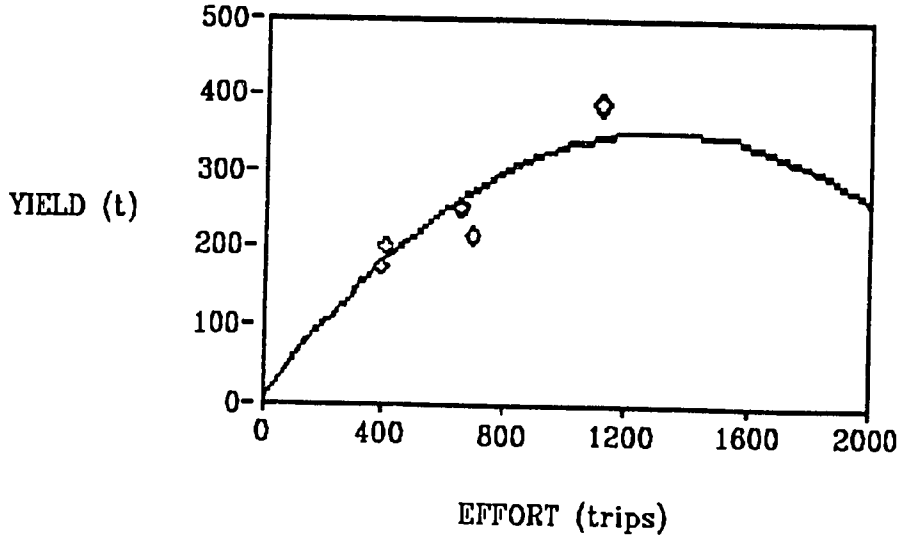

FIG. 1 The relationship of yield (annual catch in tons) of all five deep-water species to fishing effort (number of trips) in the deep-water snapper fishery in Tonga.

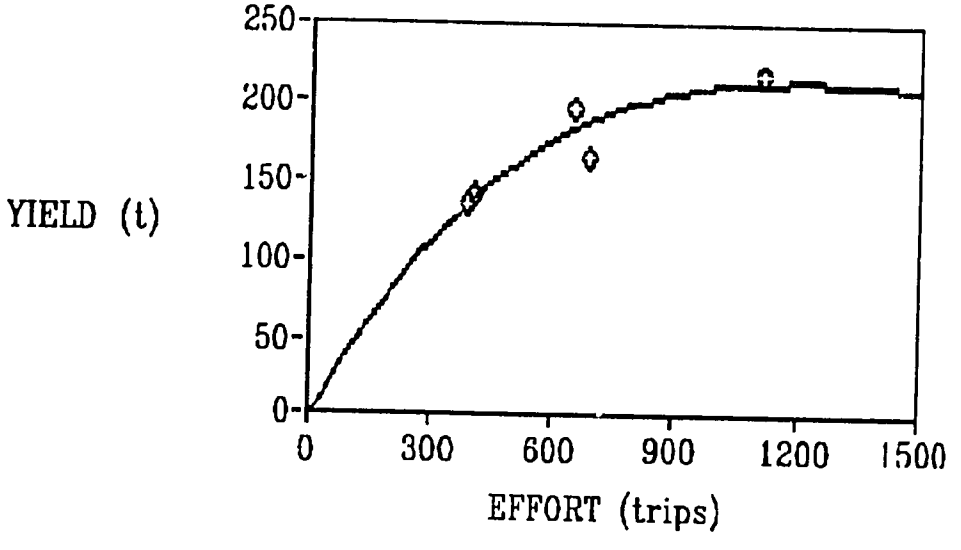

FIG. 2 The relationship of yield (annual catch in tons) of *Etelis coruscans* and *Pristipomoides filamentosus* to fishing effort (number of trips) in the deep-water snapper fishery in Tonga.

Financial data collected in Vava'u by S.Langi (Table 2) are based on what is believed to be a typical deep-water snapper fishing operation in 1992.

Table 2 Estimated fishing costs of a deep-water snapper fishing vessel operation in Tonga

	COST (T$)
INITIAL INVESTMENT:	
Fully equipped vessel*	26 000
FIXED COSTS (per year):	
Vessel loan repayments (11%)**	2 860
Vessel amortization over 10 yr	2 600
Repairs & maintenance	2 000
Insurance (non-comprehensive 4.5%)	1 170
Total fixed costs (per year)	8 630
RUNNING COSTS (per trip):	
Crew payments	450
Fishing gear replacement	32
Fuel	105
Food, etc.	29
Bait (@ T$ 4.65/kg)	52
Ice (@ T$ 0.15/kg)	62
Repairs per trip	17
Miscellaneous	29
Total running costs (per trip)	776
Total running costs (per year***)	23 280
TOTAL ANNUAL COSTS (T$)	31 910

* Vessel price subsidized by Tongan government
** All but 4 vessels believed to be currently repaying loans
*** Based on 30 trips of 5 days duration (3 fishing days) per year

A break-even curve (where returns to fishermen just balance the total cost of fishing) was produced (Fig. 3) from the data in Table 2. This suggests that, at a price to fishermen of T$3.00 per kg, long-term mean catch rates from a commercial vessel would have to be greater than 5 kg per line hour to be profitable.

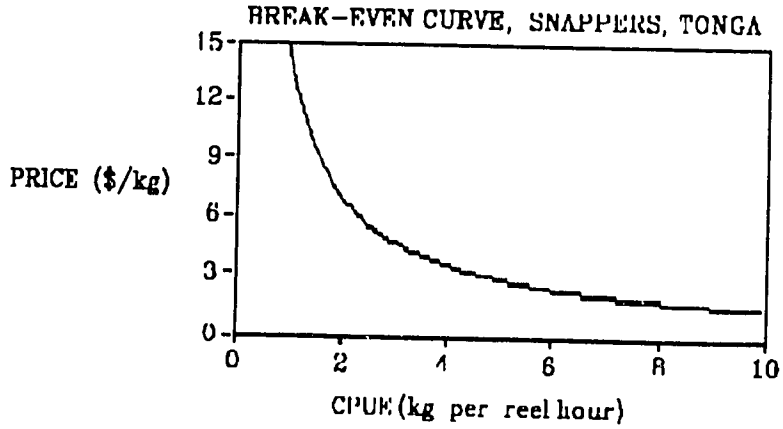

FIG. 3 Breakeven curve for a typical snapper fishing vessel in Tonga. The curve show the relationship between catch rate (kg per reel hour) and fish price ($ per kg) required to just balance the cost of fishing.

The fishing cost data from Table 2, and an average price per kg of $3.00 were also used to superimpose a fishing cost line on a surplus yield curve in terms of revenue (Fig. 4). Profits from deeper-water species are maximized at a lower fishing effort of approximately 500 trips, or 16-17 fishing vessels.

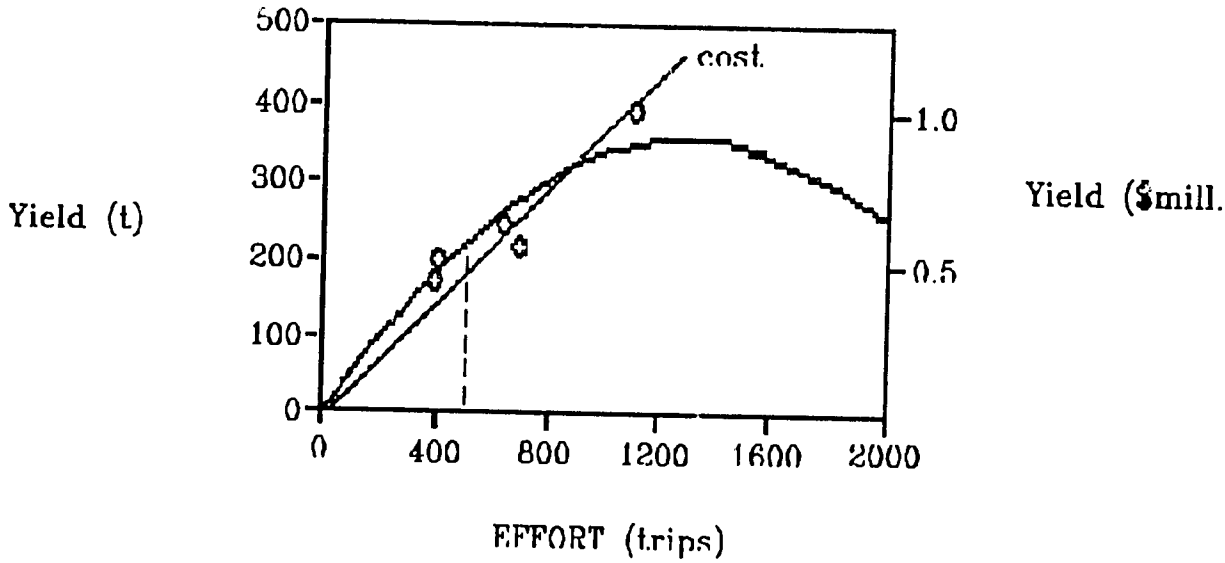

FIG. 4 The relationship of revenue (curve) and fishing costs (straight line) in T$ millions to fishing effort (number of trips) in the deep-water snapper fishery in Tonga.

As the fishery is export orientated, it was recommended that the deep-water snapper fishery be managed on the basis of maximizing profits to fishermen and the country

Of the management measures discussed, limiting vessel numbers through a vessel registration or licensing system is likely to be the most acceptable. Policing such a management measure is unlikely to be onerous due to the limited number of processors, which would be permitted to purchase deep-water snapper from licensed vessels only.

The 16-17 vessels remaining in the fishery should be encouraged to increase efficiency, perhaps by the installation of hydraulic or electric powered reels, and that methods of fish marketing be examined with a view to aiding exporters maximize the market value of the catch. When profitability from the fishery is maximized, a nominal license fee may be imposed to amortise the costs of managing and policing the fishery. Monitoring the fishery should be continued, at least at the level of collecting catch and effort data.

5.0 BOTTOMFISH SURVEYS, TUVALU

Fifteen research cruises were completed during the first year of the Tuvalu bottomfish assessment project. Ten different geographical areas were hydrographically surveyed and systematically fished to provide information on bathymetry, species composition, length-frequency, and the distribution of catch-rates by area and depth. Initial analyses of these data were undertaken at this workshop.

A total of 1508 depth soundings and GPS positions were used to produce 15 hydrographic charts of surveyed areas; an example is shown in Fig. 5. These charts will be overlaid with information on catch-rates for each fishing operation. The production of detailed charts showing the distribution of catch rates over the areas fished, will allow the targeting of highly productive areas in the second year of the project.

A total of 5807 kg of fish belonging to 44 different species was caught during 1992; of this total catch, 4997 kg of fish belonged to 24 marketable species. Major commercial species are listed in Table 3. Mean catch rates were 5.55 kg per line hour for commercial species, and 6.45 kg per line hour for all species combined.

Table 3 Catch rates (kg per line hour) of the major component species in the Tuvalu bottomfish surveys, 1992

Species	Catch rate (kg per line hour)
Etelis carbunculus	0.96
Etelis coruscans	0.95
Caranx lugubris	0.69
Aphareus rutilans	0.48
Pristipomoides filamentosus	0.37
Pristipomoides zonatus	0.31
Pristipomoides flavipinnis	0.29
Epinephelus septemfasciatus	0.45
Epinephelus morrhua	0.28
Other species	
Total	5.55

To coincide with financial analyses carried out on the Tongan deep-water fishery, where detailed fishing costs have been collected, a similar exercise was completed for

Tuvalu. As there is no commercial fishing on bottomfish in Tuvalu at present, expected costs were used as an example of the methodology involved. However, initial estimates are that commercial fishing costs, based on 30 fishing trips per year, would be approximately $33000 per vessel (Table 4). At the level of catch rates found during the survey, there is some concern that expected local market prices for deep-water fish will cover these fishing costs.

Table 4 Estimated fishing costs ($A) of a proposed commercial fishing vessel operation for deep-water snapper in Tuvalu

	COST (A$)
INITIAL INVESTMENT:	
Fully equipped vessel	35 000
FIXED COSTS (per year)	
Vessel loan repayments (11%)	3 850
Vessel amortization over 10 yr	3 500
Repairs & maintenance	3 000
Insurance (non-comprehensive 4.5%)	1 575
Total fixed costs (per year)	11 925
RUNNING COSTS (per trip):	
Crew payments	400
Fishing gear replacement	20
Fuel	90
Food, etc.	30
Bait	60
Ice	50
Repairs per trip	20
Miscellaneous	30
Total running costs (per trip)	700
Total running costs (per year*)	21 000
TOTAL ANNUAL COSTS ($)	32 925

* Based on 30 trips per year

6.0 BAITFISH RESOURCES, VAVA'U, TONGA

A summary of baitfish survey results in other Pacific Islands was presented by Paul Dalzell (see Appendix A), and an initial analysis of baitfish data collected in Vava'u was submitted by Pita Hurrell, a Tongan fisheries student whose project work has been supported by RDA.

In Vava'u, fishing surveys using the government vessel have been running for seven months, although only 24 fishing trips were completed during this period. Length-frequency and catch and effort data have been collected over this period, and reproductive studies began more recently due to delays in obtaining equipment.

The length-frequency data was considered to be of high quality, and the sample sizes are adequate; an example set of length-frequency data for the sardine, *Amblygaster sirm,* is shown in Table 5. Initial analyses conducted at the workshop suggested that growth estimates obtained from such data are likely to be reliable. Although catches varied greatly, the mean catch rate over the seven month period was 570 kg per night, and returns on sales were approximately T$2.00 per kg.

Disappointment was expressed with progress in the collection of catch-per-unit-effort data over a lunar month to determine lunar vulnerability, and in running depletion experiments to estimate stock sizes. At present, crew members have little incentive to go fishing at the period of the full moon (when catch rates are believed to be low), and to commit themselves to the considerable physical effort involved in handling the heavy purse seine net over a sustained period; a depletion experiment is likely to require fishing over at least 10 days (excluding the weekend which is sacrosanct under local customs).

Table 5 Length-frequency data by date for the sardine, *Amblygaster sirm*

LENGTH (mm)	Apr 13	Apr 29	Jun 25	Jul 4	Aug 4	Aug 31	Sep 30	Oct 26
<125		0.2	1.9	0.1				
125		1.3						
130	3.3	0.9						
135	4.6	2.3	0.5					
140	4.6	3.9						
145	9.2	7.2						
150	13.2	8.6	0.9	0.1				
155	9.9	9.4	3.7	0.3		0.1		
160	11.8	7.8	7.5	1.2	0.8	0.3		
165	5.3	5.6	5.1	1.5	2.0	1.0		
170	8.6	2.8	8.4	4.3	2.5	2.8		
175	5.9	3.9	7.9	5.3	4.8	5.0		0.3
180	3.9	3.1	10.7	7.6	7.6	5.6	3.2	2.7
185	2.0	3.4	6.1	5.1	4.8	8.2	8.1	9.8
190	2.6	3.2	3.7	5.7	9.6	9.7	8.1	13.4
195	2.0	4.4	7.5	9.5	10.5	9.4	17.7	13.9
200	5.9	9.7	7.5	13.2	13.9	12.0	18.5	16.3
205	3.3	8.2	5.1	14.6	11.3	12.3	17.7	17.8
210	1.3	7.2	8.9	13.3	13.3	12.0	5.6	11.9
215	0.7	3.5	5.1	10.2	8.5	9.2	8.1	8.6
220	2.0	1.3	4.2	4.2	6.5	7.7	4.8	4.7
225		1.3	1.4	2.8	0.8	2.3	4.0	0.6
230		0.5	2.3	0.6	1.4	1.4	3.2	
235			0.9	0.3	1.1	0.5		
240				0.1		0.3	0.8	
245		0.5	0.5		0.3	0.1		
>245		0.1						

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APPENDIX A

NOTES ON SMALL PELAGIC FISHES FROM THE SOUTH PACIFIC SUITABLE FOR TUNA LONGLINE BAIT

By
Paul Dalzell
SPC Fisheries Programme
New Caledonia

Notes on small pelagic fishes from the South Pacific suitable for tuna longline bait

by
P.Dalzell
SPC Fisheries Programme,
New Caledonia

Paper prepared for USAID-RDA Workshop on bottomfish and baitfish resources and management in the South Pacific, 15-25 November 1992, Honolulu, Hawaii

Abstract

A short review and summary is presented of the fisheries and biology of sardines mackerels and scad that might be used for longline bait in the South Pacific. Little information is available on the abundance of small pelagic resources in the Pacific Islands, but the data available suggest that the small size of these stocks will be modest in comparison to neighbouring Souteast Asia. Some methods to estimate stock size are explored, including an analysis of experimental fishing for roundscads at Niue that suggest that depletion type experiments may be an appropriate means of doing so.

This paper was presented a part of the baitfish workshop. November 23-25, 1992. The paper may be obtained in its entirety by contacting the author, Paul Dalzell at SPC Fisheries Programme, New Caledonia.