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Recreational Fishing in Coffin Bay: Interactions with the Commercial Fishery

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ABSTRACT

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Recreational boat fishers using the Coffin Bay boat ramp between January and June 1990 were interviewed to obtain information on their fishing activities. Recreational boat fishing is an important activity in Coffin Bay. The majority of fishers targeted King George whiting (Sillaginodes punctata), which accounted for over half the total catch. The average catch rate of King George whiting per angler hour was 1.25 fish. Information was obtained on the value fishers place on recreational fishing. These data were included in a simple model of the fishery to evaluate the economic benefits of changing the current allocation of fish between commercial and recreational fishers. The analysis indicates that it may be desirable to reduce recreational fishing and increase commercial fishing in Coffin Bay. Further research is required to verify this finding.

INTRODUCTION

Fish stocks are frequently exploited by both commercial and recreational fishers. Effective management of such fisheries requires information on the fishing activity of participants, and an analytical framework to assess the impact of policy decisions on the user groups. Many fisheries management agencies have information available on the commercial fishery (obtained from fishers' catch and effort returns). However, there is often little information available on the recreational fishery, and even less information available on an analytical framework to assess policy impacts.

This project was initiated as a pilot study to collect information on recreational fishers in the South Australian Marine Scalefish Fishery at Coffin Bay and to develop a framework for analysing interactions between commercial and recreational fishers.

The specific objectives of the project were:

1. to collect data on recreational fishing activity in the Coffin Bay area.

2. to elicit information on the value of fish in commercial and recreational uses.

3. to develop an analytical framework to estimate the benefits to commercial and recreational fishers from implementing policies to change the share of catch between the two sectors.

METHODS

Area Description

Coffin Bay is a renowned fishing area for both commercial and recreational fishers. The area is well known for its catches of King George whiting (Sillaginodes punctata).

Recreational fishing from boats and the shore is popular. The waters in the bay are sheltered and the Coffin Bay "Ledge" provides shore fishers with access to waters in which King George whiting can be regularly taken. Boat ramps are located at Coffin Bay and Farm Beach (see Figure 1).

Closures apply to commercial and recreational net fishers with part of the Bay permanently closed to netting (see Figure 1). There is also a seasonal netting closure on a larger portion of the bay between November 1 and May 1 (see Figure 1). At the opening of the netting season in May, a large number of itinerant commercial net fishers travel to Coffin Bay in the belief that the build-up of numbers of fish during the closed season improves the viability of fishing.

Commercial and recreational line fishers are permitted to fish all waters at any time during the year.

Sampling Frame

The sampling frame for the study was defined as all recreational boat fishers using the Coffin Bay boat ramp between the hours of 0630 and 1830 during the period January 1 to June 30 1990, excluding the Easter period.

Sample Design

Previous studies of recreational fishing (e.g. Hill 1986) have shown that there is considerable variation in the number of boats using the ramp each day. Stratified random sampling was used to improve the precision of estimates.

The days within the survey period were stratified into four groups:

1. Weekends

   This stratum included all weekends excluding those associated with public holidays (long weekends) and school holidays.

2. Weekdays

   The weekdays stratum included all weekdays except public and school holidays.

3. Public Holidays

   Public holidays were defined as any public holiday, and in the case of long weekends, the Saturday and Sunday of the weekend were also classified as public holidays.

4. School holidays

   School holidays included all weekdays and weekends during the school holiday periods.

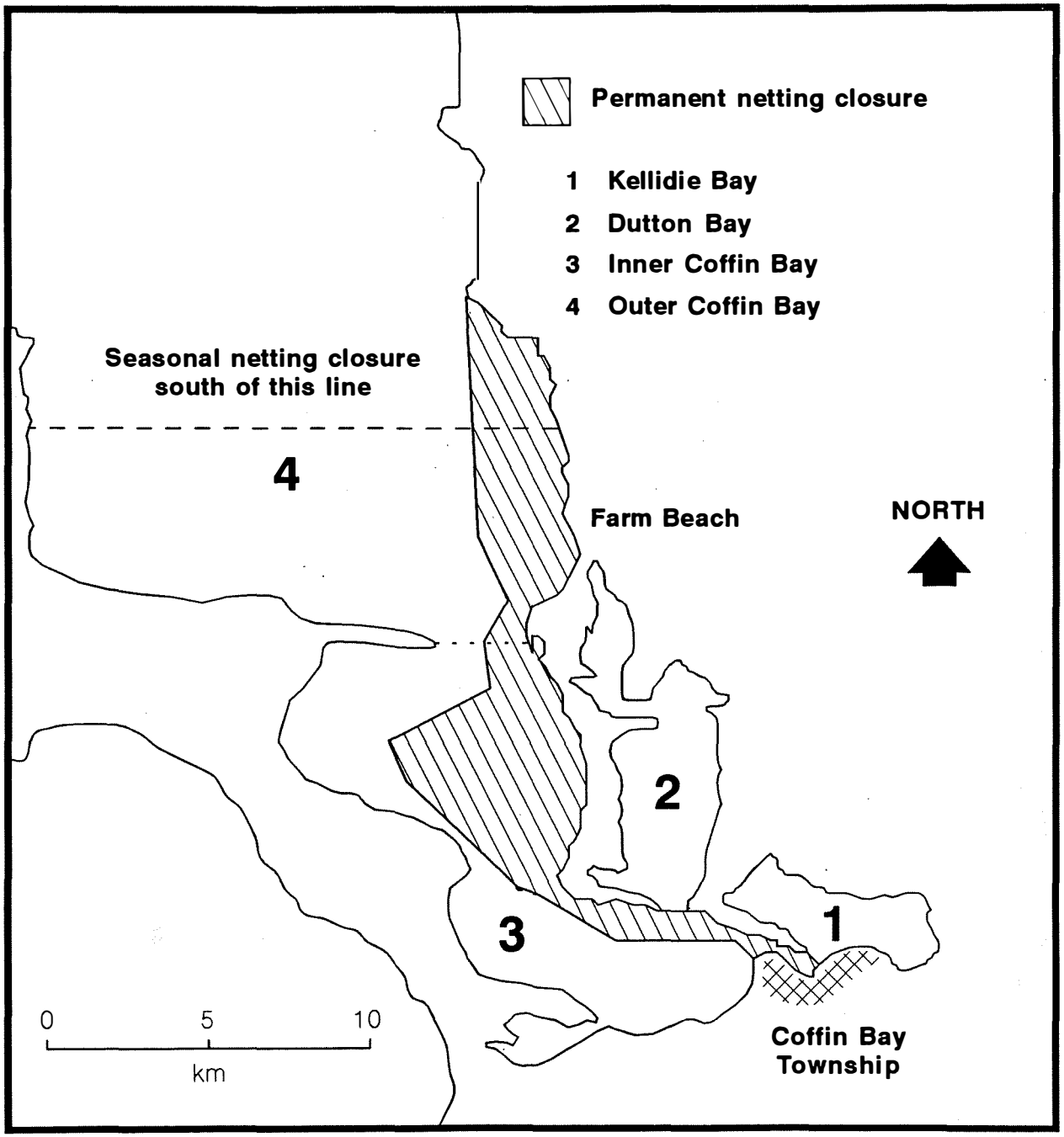

Fig. 1. Map of Coffin Bay showing netting closures and fishing areas.

Catch rates and participation rates were expected to vary throughout the sampling period. Thus the sampling period was further stratified into 6 time periods (corresponding to months).

Method of Collecting Data

Individual respondents were approached at random as they returned from their fishing trip, and asked if they would participate in the survey. A personal interview questionnaire (Appendix 1) was used to collect the data. A spokesperson for each boat completed the questionnaire. Data collected related to the boat trip undertaken on the day of the interview.

Observations on the number of empty boat trailers at the Coffin Bay boat ramp were made on the hour between 0700 and 1800 hours. The recording sheet used is shown in Appendix 2.

Estimation of Stratum Totals for Fishing Effort, Catch and Catch Rate

Total Fishing Effort

Let b_{ijk} denote the number of boat trailers at the ith count time on day j in stratum k

t_i denote the time between the i-1 and the ith count times

n_{ik} denotes the n number of counts conducted at time i in stratum k.

The average number of boat trailers counted at time i in stratum k is

$$b_{ik} = \sum_j b_{ijk} / n_{ik}$$

The estimated daily boat effort (DBE) in stratum k is

$$DBE = \sum_i (b_{ik} * t_i)$$

Total boat effort in stratum k (E_k) is

$$E_k = DBE * \text{Number of days in stratum k}$$

Total boat effort during the sampling period (E) is

$$E = \sum_k E_k$$

As outlined in Hill (1986), total boat effort includes commercial and non-fishing boat effort as well as recreational boat fishing effort. Therefore

Recreational Boat Fishing Effort = Total Boat Effort

Commercial Fishing Effort

- Non-Fishing Boat Effort.

Commercial fishing effort was estimated from data collected on the number of commercial fishers returning to the boat ramp each day. Recreational fishers interviewed were asked to estimate the proportion of time they had spent fishing. These data were used to adjust the estimates of total boat effort for non-fishing effort.

Catch Rate

Let CR_k denote catch rate specified as fish caught per hour fished in stratum k;

c_{sijk} denote the catch of species s by the ith fisher on day j in stratum k.

e_{ijk} denote the hours fished by the ith fisher on day j in stratum k.

Average catch rate of species s in stratum k is

$$CR_{sk} = \sum_i \sum_j c_{sijk} / \sum_i \sum_j e_{ijk}$$

Total Catch

Total catch of species s was estimated using

$$TC = \sum_k \left[\begin{array}{l} \text{Total recreational} \\ \text{boat fishing effort} \\ \text{in stratum k (hrs)} \end{array} * \begin{array}{l} \text{Catch of species s per unit} \\ \text{effort in stratum k (number of} \\ \text{fish per hour)} \end{array} \right]$$

Analysis of Survey Data

Survey data were summarised and results are presented by month and survey group strata. Two way analysis of variance was used to test for differences between strata.

RESULTS

Sample Size

During the survey period, 629 boats were selected for interview (Table 1). Professional fishers were approached on 49 occasions (7.8% of the sample). The number of recreational boaters using their boat for activities other than fishing was 71 (11.3%). The remaining 509 respondents (81.0%) undertook some fishing during their boat trip. The data presented below relate to these 509 fishers, 28 of which indicated that fishing was not the primary purpose of their boat trip.

The number of recreational boat fishers interviewed by survey strata, along with the number of days on which interviews were held in each strata, is provided in Table 2. The average number of interviews per day was highest in January (11.8) and lowest in June (3.0). These data indicate that there was significant variation in participation throughout the survey period.

Table 1. Classification of Survey Respondents - January to June 1990

	NUMBER	% OF TOTAL	% OF RECREATIONAL
RECREATIONAL BOATERS			
Full-time Fishing	481	76.5	82.9
Part-time Fishing	28	4.5	4.8
Not Fishing	71	11.3	12.2
Total	580	92.2	100.0
PROFESSIONAL FISHERS	49	7.8	
TOTAL	629	100.0	

Table 2. Recreational Boat Fishers Interviewed - January to June 1990

	PERIOD	NUMBER OF INTERVIEWS	NUMBER OF SURVEY DAYS	AVERAGE PER DAY
JANUARY	School Holidays	141	12	11.8
	Sub-Total	141	12	11.8
FEBRUARY	Weekdays	43	6	7.2
	Weekends	18	2	9.0
	Sub-Total	61	8	7.6
MARCH	Weekdays	47	5	9.4
	Weekends	55	5	11.0
	Sub-Total	102	10	10.2
APRIL	Weekdays	25	3	8.3
	Weekends	24	3	8.0
	School Holidays	61	5	12.2
	Sub-Total	110	11	10.0
MAY	Weekdays	33	8	4.1
	Weekends	24	3	8.0
	Public Holidays	11	3	3.7
	Sub-Total	68	14	4.9
JUNE	Weekdays	6	5	1.2
	Weekends	1	1	1.0
	Public Holidays	20	3	6.7
	Sub-Total	27	9	3.0
TOTAL	WEEKDAYS	154	27	5.7
	WEEKENDS	122	14	8.7
	PUBLIC HOLIDAYS	31	6	5.2
	SCHOOL HOLIDAYS	202	17	11.9
	TOTAL	509	64	8.0

Total Fishing Effort

The average number of boat trailers recorded at each count time in each stratum is provided in Appendix 3. Total recreational fishing effort during the survey period was estimated to be 15 145 hours (Table 3). Recreational fishing effort was highest in January (4 945 hours) declining to 326 hours in June.

Table 3. Recreational Boat Fishing Effort (hours) Coffin Bay Boat Ramp - January to June 1990

MONTH	STRATA	EFFORT	MONTHLY TOTAL	STANDARD ERROR	RELATING STANDARD ERROR (%)
JANUARY	School Holidays	4945	4945	467	9.43
FEBRUARY	Weekdays	1917		168	8.79
	Weekend	669	2586	147	22.00
MARCH	Weekdays	1997		120	6.02
	Weekend	1092	3089	131	12.03
APRIL	Weekdays	1396		55	3.91
	Weekend	440		53	11.94
	School Holidays	839	2675	108	12.90
MAY	Weekdays	871		56	6.41
	Weekend	460		66	14.45
	Public Holidays	193	1524	30	15.57
JUNE	Weekdays	119		15	12.45
	Weekend	54		19	34.64
	Public Holidays	153	326	13	8.24
TOTAL		15145	15145	551	3.64

Catch Rate

Estimates of catch rate per boat hour for the main species by month and survey period are provided in Tables 4 to 9. The average catch rate for all species was 5.7 fish per boat hour. A two way analysis of variance indicated that there were significant variations in catch rate between months and survey period ($P<.01$ and $P<.001$). (The interaction effect was not siginificant, implying that the means for different months and survey periods can be compared, Underwood 1981.) Catch rate varied throughout the survey period, increasing from January through to May. Catch rates during weekdays were always higher than those on weekends or in holiday periods.

Table 4. Average Catch Rate (fish caught per boat hour) in Coffin Bay - January to June 1990

	PERIOD	CATCH RATE	STANDARD DEVIATION
JANUARY	School Holidays	4.15	4.32
	Average	4.15	4.32
FEBRUARY	Weekdays	5.39	3.64
	Weekends	4.45	5.98
	Average	5.11	4.43
MARCH	Weekdays	7.08	4.25
	Weekends	5.31	3.66
	Average	6.12	4.02
APRIL	Weekdays	7.40	6.04
	Weekends	6.72	6.00
	School Holidays	5.10	4.05
	Average	5.97	5.07
MAY	Weekdays	9.72	10.22
	Weekends	7.86	8.84
	Public Holidays	3.98	3.54
	Average	8.13	9.09
JUNE	Weekdays	9.59	5.86
	Weekends	0.46	0.00
	Public Holidays	5.63	4.79
	Average	6.32	5.24
AVERAGE		5.71	5.49

F Values

Month	3.88	P<0.001
Period	5.84	P<0.001
Interaction	0.64	n.s.

The analyses for individual species are provided in Tables 5 to 9. In all cases, the interaction effect was not significant.

The catch rate for King George whiting increased from 1.74 fish per boat hour in January to 5.61 in May (Table 5). The average catch rate declined to 3.64 in June due mainly to poor catch rates on weekends. The low weekend catch rate in June is considered to be unreliable as participation on weekends was reduced due to poor weather. The estimate was based on data obtained from one respondent (who did not catch any fish). The catch rate of King George whiting on weekdays in June was 6.79 fish per boat hour, the highest recorded during the survey period.

Monthly variation in catch rates of garfish, salmon and tommy ruff were also statistically significant. Catch rates for garfish increased from January to April (Table 6). Catch rates for Australian Salmon were variable, being highest in April, May and June (Table 8). The highest catch rates for tommy ruff were recorded in January, March and April (Table 9). There was no clear trend in the catch rates of other finfish species (Table 10).

Table 5. Average Catch Rate (fish caught per boat hour) King George Whiting - January to June 1990

	PERIOD	CATCH RATE	STANDARD DEVIATION
JANUARY	School Holidays	1.74	2.45
	Average	1.74	2.45
FEBRUARY	Weekdays	3.18	2.67
	Weekends	2.51	4.11
	Average	2.98	3.14
MARCH	Weekdays	4.16	3.76
	Weekends	2.78	3.11
	Average	3.42	3.48
APRIL	Weekdays	3.42	3.23
	Weekends	3.38	3.37
	School Holidays	2.68	3.56
	Average	3.00	3.43
MAY	Weekdays	6.53	9.23
	Weekends	5.77	8.00
	Public Holidays	2.51	3.48
	Average	5.61	8.15
JUNE	Weekdays	6.79	6.83
	Weekends	0.00	0.00
	Public Holidays	2.88	3.33
	Average	3.64	4.51
AVERAGE		3.12	4.36

F Values

Month	5.34	P<0.001
Period	3.26	P<0.001
Interaction	0.46	n.s.

Table 6 Average Catch Rate (fish caught per boat hour) Garfish - January to June 1990

	PERIOD	CATCH RATE	STANDARD DEVIATION
JANUARY	School Holidays	0.25	1.01
	Average	0.25	1.01
FEBRUARY	Weekdays	0.61	0.84
	Weekends	0.67	2.83
	Average	0.63	1.66
MARCH	Weekdays	0.92	1.58
	Weekends	0.70	1.13
	Average	0.80	1.35
APRIL	Weekdays	1.31	2.39
	Weekends	0.57	1.03
	School Holidays	0.97	1.64
	Average	0.96	1.74
MAY	Weekdays	0.97	2.26
	Weekends	0.21	0.51
	Public Holidays	0.19	0.35
	Average	0.57	1.64
JUNE	Weekdays	0.40	0.98
	Weekends	0.00	0.00
	Public Holidays	0.30	0.98
	Average	0.31	0.94
AVERAGE		0.61	1.45

F Values

Month	3.54	P<0.01
Period	1.12	n.s.
Interaction	0.84	n.s.

Table 7. Average Catch Rate (fish caught per boat hour) Australian Salmon - January to June 1990

	PERIOD	CATCH RATE	STANDARD DEVIATION
JANUARY	School Holidays	0.28	0.82
	Average	0.28	0.82
FEBRUARY	Weekdays	0.37	0.93
	Weekends	0.47	1.76
	Average	0.40	1.22
MARCH	Weekdays	0.26	0.58
	Weekends	0.25	0.68
	Average	0.25	0.63
APRIL	Weekdays	0.75	1.00
	Weekends	0.93	1.87
	School Holidays	0.53	1.09
	Average	0.67	1.28
MAY	Weekdays	0.89	1.28
	Weekends	0.64	1.76
	Public Holidays	0.24	0.48
	Average	0.70	1.39
JUNE	Weekdays	1.67	2.66
	Weekends	0.46	0.00
	Public Holidays	1.20	2.73
	Average	1.28	2.62
AVERAGE		0.48	1.21

F Values

Month	3.17	P<0.01
Period	0.68	n.s.
Interaction	0.26	n.s.

Table 8. Average Catch Rate (fish caught per boat hour) Tommy Ruff - January to June 1990

	PERIOD	CATCH RATE	STANDARD DEVIATION
JANUARY	School Holidays	1.13	1.80
	Average	1.13	1.80
FEBRUARY	Weekdays	0.91	1.28
	Weekends	0.58	1.77
	Average	0.81	1.44
MARCH	Weekdays	1.29	1.98
	Weekends	1.06	1.88
	Average	1.17	1.92
APRIL	Weekdays	1.64	3.61
	Weekends	1.76	3.09
	School Holidays	0.65	1.40
	Average	1.12	2.50
MAY	Weekdays	0.78	1.32
	Weekends	0.42	0.97
	Public Holidays	0.71	1.42
	Average	0.64	1.22
JUNE	Weekdays	0.28	0.49
	Weekends	0.00	0.00
	Public Holidays	0.43	0.72
	Average	0.38	0.66
AVERAGE		0.99	1.87

F Values

Month	2.98	P<0.05
Period	2.92	P<0.05
Interaction	0.12	n.s.

Table 9. Average Catch Rate (fish caught per boat hour) Other Species (finfish) - January to June 1990

	PERIOD	CATCH RATE	STANDARD DEVIATION
JANUARY	School Holidays	0.75	2.19
	Average	0.75	2.19
FEBRUARY	Weekdays	0.33	0.74
	Weekends	0.22	0.81
	Average	0.29	0.76
MARCH	Weekdays	0.45	0.81
	Weekends	0.52	0.85
	Average	0.49	0.83
APRIL	Weekdays	0.28	0.52
	Weekends	0.09	0.18
	School Holidays	0.26	0.69
	Average	0.23	0.58
MAY	Weekdays	0.55	1.14
	Weekends	0.82	1.31
	Public Holidays	0.33	0.42
	Average	0.61	1.13
JUNE	Weekdays	0.45	0.46
	Weekends	0.00	0.00
	Public Holidays	0.82	2.13
	Average	0.71	1.84
AVERAGE		0.51	1.40

F Values

Month	2.39	$P<0.05$
Period	0.18	n.s.
Interaction	0.42	n.s.

The average number of people fishing in each boat was 2.62 (Table 10). The number of people fishing did not vary significantly between months (results of a two way analysis of variance are provided in Table 10). However, the number of persons under 16 years was significantly higher in the school holiday months of January and April ($P<0.05$).

Table 10. Average Number of People in Boats - January to June 1990

	PERIOD	PEOPLE	STANDARD DEVIATION
JANUARY	School Holidays	2.87	1.08
	Average	2.87	1.08
FEBRUARY	Weekdays	2.74	1.03
	Weekends	2.11	0.83
	Average	2.56	1.01
MARCH	Weekdays	2.17	0.73
	Weekends	2.40	0.85
	Average	2.29	0.80
APRIL	Weekdays	2.28	1.10
	Weekends	2.63	1.10
	School Holidays	2.64	0.97
	Average	2.55	1.03
MAY	Weekdays	2.58	1.44
	Weekends	2.71	1.04
	Public Holidays	3.27	1.01
	Average	2.74	1.25
JUNE	Weekdays	2.50	1.38
	Weekends	2.00	0.00
	Public Holidays	2.75	1.02
	Average	2.67	1.07
AVERAGE		2.62	1.08

F Values

Month	0.15	n.s.
Period	0.21	n.s.
Interaction	0.18	n.s.

The average catch rate per angler hour of the main finfish species was 2.4 fish (Table 11). Catch rate per angler hour increased from 1.59 in January to 2.83 in March and then plateaued. Largest catch rates per angler hour were recorded on weekdays, with the smallest being recorded during school or public holiday periods.

Table 11. Catch Per Angler Hour Recreational Fishers - Major Species - January to June 1990

	PERIOD	CATCH RATE	STANDARD DEVIATIONS
JANUARY	School Holidays	1.59	1.84
	Average	1.59	1.84
FEBRUARY	Weekdays	2.08	1.53
	Weekends	1.99	2.93
	Average	2.05	2.17
MARCH	Weekdays	3.32	1.94
	Weekends	2.40	1.90
	Average	2.83	1.96
APRIL	Weekdays	3.38	2.69
	Weekends	2.96	2.89
	School Holidays	2.13	1.73
	Average	2.59	2.30
MAY	Weekdays	3.65	2.76
	Weekends	2.62	2.48
	Public Holidays	1.37	1.20
	Average	2.92	2.58
JUNE	Weekdays	4.07	1.83
	Weekends	0.23	0.00
	Public Holidays	2.48	2.74
	Average	2.75	2.62
AVERAGE		2.35	2.20

F Values

Month	3.68	P<0.01
Period	7.37	P<0.001
Interaction	0.91	n.s.

The catch rate of King George whiting per angler hour was 1.25 fish. This estimate is comparable with that of Jones (1990) for Franklin Harbour of 1.2 fish per angler hour. Catch rate per angler hour varied significantly between months (highest between March and June) and survey period (higher on weekdays, Table 12).

Table 12. Catch Per Angler Effort Recreational Fishers - King George Whiting - January to June 1990

	PERIOD	CATCH RATE	STANDARD DEVIATIONS
JANUARY	School Holidays	0.65	0.98
	Average	0.65	0.98
FEBRUARY	Weekdays	1.18	1.01
	Weekends	1.02	1.84
	Average	1.14	1.30
MARCH	Weekdays	1.98	1.82
	Weekends	1.25	1.59
	Average	1.58	1.73
APRIL	Weekdays	1.55	1.44
	Weekends	1.58	1.71
	School Holidays	1.06	1.34
	Average	1.29	1.46
MAY	Weekdays	2.26	2.47
	Weekends	1.85	2.19
	Public Holidays	0.81	1.10
	Average	1.88	2.23
JUNE	Weekdays	2.81	2.55
	Weekends	0.00	0.00
	Public Holidays	1.36	2.01
	Average	1.63	2.16
AVERAGE		1.25	1.61

F Values

Month	3.56	P<0.01
Period	5.55	P<0.001
Interaction	0.92	n.s.

Total Catch

The estimated total catch of the major species is provided in Table 13. Over half the fish caught (53.7%) were King George whiting. The next most frequently caught fish were tommy ruff (18.7%), garfish (10.9%) and Australian salmon (7.7%). Data were not obtained on the size of fish taken. However, estimates of fish size were obtained from a survey conducted by Jones (1983). This survey was undertaken in March, and thus corresponded to the mid point of the current survey. The average weights for King George whiting, garfish, Australian salmon and tommy ruff were 240g, 66g, 250g and 100g, respectively. These data were used to estimate the total weight of fish caught, which is also provided in Table 13.

Table 13. Total Catch - Major Species - January to June 1990

	CATCH (No. of Fish)	%	CATCH WEIGHT (kgs)
King George whiting	46293	53.7	11110
Salmon	6615	7.7	1654
Garfish	9416	10.9	621
Tommy ruff	16163	18.7	1616
Other	7716	9.0	na
	86203	100.0	15002

The monthly variation in catch of the main species is provided in Table 14. King George whiting catches peaked in March at 11345 fish, before declining to 1249 in June. The main factor contributing to the decline in catch from March to June was the reduction in fishing effort (Table 3) rather than the reduction in catch rate (Table 5). Garfish catches peaked in March and April and catches of tommy ruff were highest in January.

Table 14. Number of Fish Caught by Species by Month - January to June 1990

	KING GEORGE WHITING	AUSTRALIAN SALMON	GARFISH	TOMMY RUFF	OTHER	TOTAL
January	8596	1392	1233	5587	3732	20540
February	7771	1023	1615	2128	770	13307
March	11345	783	2602	3729	1462	19921
April	8506	1896	2897	3612	649	17560
May	8826	1114	976	1007	924	12847
June	1249	407	93	100	179	2028
TOTAL	46293	6615	9416	16163	7716	86203

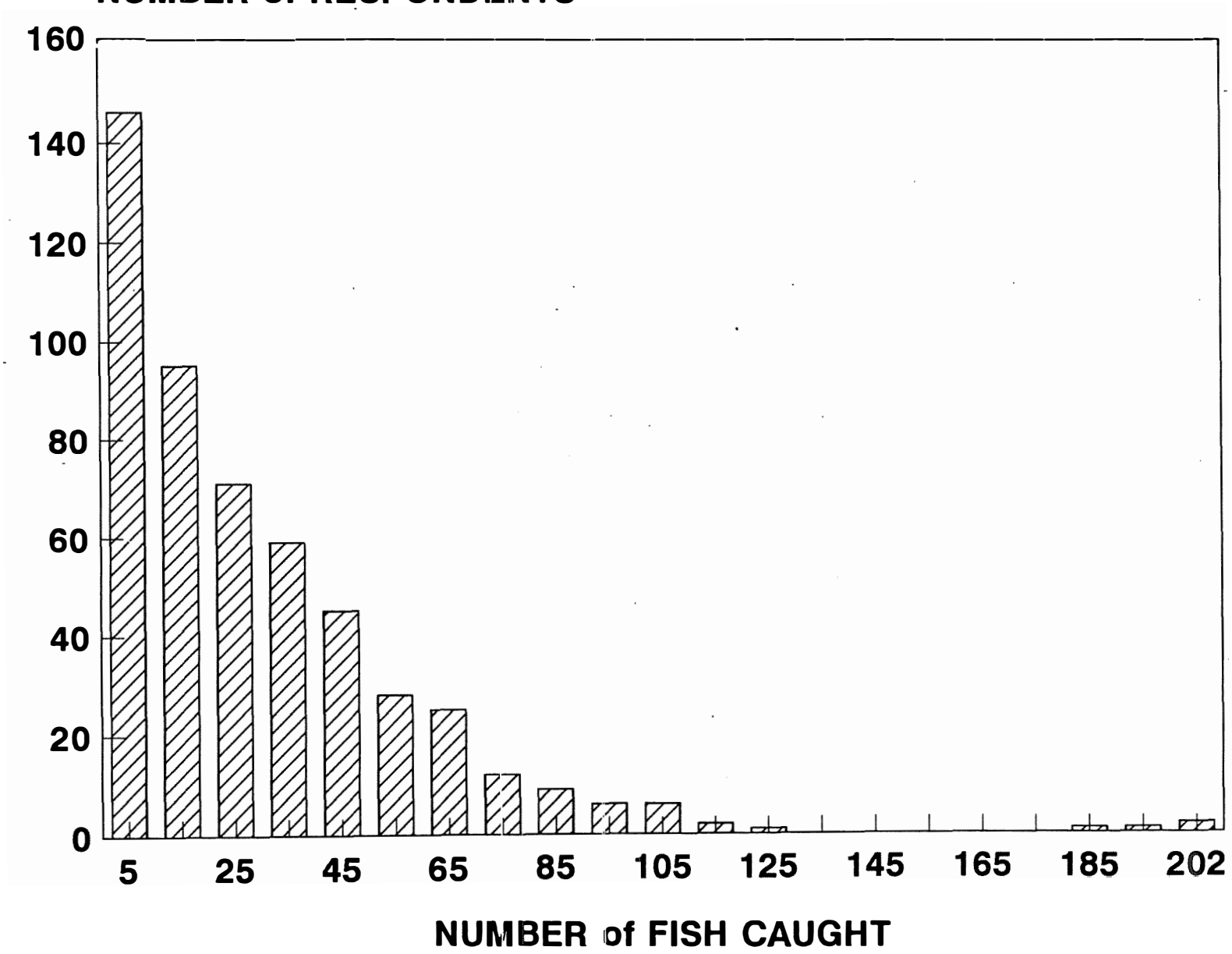

Fig. 2. Frequency distribution of fish caught.

The average catch of finfish per boat was 28.5 fish. In accord with the data on catch rates, the average catch varied significantly between months and survey period (Table 15). Catches increased from 20.8 fish in January to 41.2 fish in May. Average boat catches on weekdays were always higher than those on weekends. The distribution of catches in the survey sample is provided in Figure 2. A large proportion of boat anglers caught small numbers of fish; 241 respondents (47.3% of the sample) caught less than 20 fish. Large catches (greater than 60 fish) were taken by a small proportion of respondents (65 fishers or 12.7% of the sample).

Table 15. Finfish Catch Per Boat - January to June 1990

	PERIOD	CATCH RATE	STANDARD DEVIATION
JANUARY	School Holidays	20.79	21.84
	Average	20.79	21.84
FEBRUARY	Weekdays	30.19	25.66
	Weekends	16.61	20.64
	Average	26.18	24.19
MARCH	Weekdays	38.17	24.66
	Weekends	26.22	20.68
	Average	31.73	23.27
APRIL	Weekdays	36.60	29.52
	Weekends	31.00	25.77
	School Holidays	24.05	20.88
	Average	28.42	24.49
MAY	Weekdays	47.15	55.74
	Weekends	39.63	44.04
	Public Holidays	26.73	24.85
	Average	41.19	47.90
JUNE	Weekdays	51.33	30.27
	Weekends	3.00	0.00
	Public Holidays	25.65	23.73
	Average	30.52	27.11
AVERAGE		28.52	28.60

F Value

Month	3.05	P<0.01
Period	6.30	P<0.001
Interaction	0.48	n.s.

The species most frequently targeted by respondents in all months was King George whiting (Table 16). In March, 73.5% of respondents targeted King George whiting. The proportion of respondents targeting King George whiting was lowest in January (44.0%). During this month, 22% of respondents were targeting scallops. There was also a large proportion of respondents who were not targeting any particular species (ranging from 22.5% in March to 37.7% in February).

Table 16. Species Targeted by Recreational Fishers - January to June 1990

TARGET	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE		TOTAL SPECIES	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
King George Whiting	62	44.0	30	49.2	75	73.5	68	61.8	43	63.2	16	59.3	294	57.8
Garfish	2	1.4	1	1.6	2	2.0	6	5.5	1	1.5	1	3.7	13	2.6
Australian Salmon	1	0.7	1	1.6	0	0.0	1	0.9	1	1.5	0	0.0	4	0.8
Scallops	31	22.0	6	9.8	2	2.0	1	0.9	2	2.9	2	7.4	44	8.6
Other Species	3	2.1	0	0.0	0	0.0	4	3.6	0	0.0	0	0.0	7	1.4
No Target	42	29.8	23	37.7	23	22.5	30	27.3	21	30.9	8	29.6	147	28.9
TOTAL	141	100.0	61	100.0	102	100.0	110	100.0	68	100.0	27	100.0	509	100.0

Fishing Area

The Coffin Bay waters were divided into 4 subregions (Figure 1) and respondents were asked to nominate the region in which they had been fishing (Table 17). Most respondents fished in the inner and outer Coffin Bay regions (54.2% and 19.3% respectively).

Table 17. Area Fished by Recreational Fishers - January to June 1990

	KELLIDIE BAY		DUTTON BAY		INNER COFFIN BAY		OUTER COFFIN BAY		ALL AREAS	
	No.	%	No.	%	No.	%	No.	%	No. (a)	%
JANUARY	31	4.9	1	0.2	87	13.9	35	5.6	173	27.6
FEBRUARY	7	1.1	1	0.2	44	7.0	17	2.7	77	12.3
MARCH	8	1.3	3	0.5	76	12.1	20	3.2	121	19.3
APRIL	18	2.9	13	2.1	78	12.4	18	2.9	144	23.0
MAY	10	1.6	2	0.3	38	6.1	20	3.2	78	12.4
JUNE	2	0.3	1	0.2	17	2.7	11	1.8	34	5.4
TOTAL	76	12.1	21	3.3	340	54.2	121	19.3	628	100

(a) Sum for all areas may exceed total number of respondents as some fishers fished more than one area.

Fishing Method

The fishing method most frequently used by boat anglers was the rod or handline (87.7%, Table 18). Diving was the next most frequently used method (9.8%).

Table 18. Fishing Method used by Recreational Fishers - January to June 1990

	(a) NUMBER OF RESPONDENTS	%
Line	465	87.7
Net	2	0.4
Dab Net	0	0.0
Hoop Net	3	0.6
Troll Line	4	0.8
Diving	52	9.8
Other	4	0.8
TOTAL	530	100

(a) Sum may exceed total number of respondents as some fishers used more than 1 fishing method.

The average length of each boat trip was 4.8 hours (Table 19). This did not vary significantly between months. The average amount of time spent fishing by each respondent was 3.5 hours (72.7% of the time spent out in the boat).

Table 19. Time Spent Fishing by Recreational Fishers - January to June 1990

	AVERAGE BOAT HOURS	AVERAGE GEAR HOURS	AVE % OF TIME SPENT FISHING	NO. OF RESPONDENTS
January	4.6	3.2	70.2	139
February	4.9	3.5	72.6	61
March	5.1	3.7	72.1	102
April	4.7	3.6	75.9	109
May	4.9	3.6	72.9	68
June	4.7	3.5	74.2	28
TOTAL	4.8	3.5	72.7	507

Employment Status

Most boat anglers were employed full-time (68.4%). Retired persons accounted for 26.1% of the sample (Table 20). The proportion of retired persons was low in the school holiday period in January (6.4%).

Table 20. Employment Status of Recreational Fishers - January to June 1990

	FULL-TIME		PART-TIME		RETIRED		HOME MANAGER		STUDENT		UNEMPLOYED		TOTAL	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
January	126	89.4	3	2.1	9	6.4	0	0.0	2	1.4	1	0.7	141	100.0
February	43	70.5	2	3.3	15	24.6	0	0.0	1	1.6	0	0.0	61	100.0
March	63	61.8	3	2.9	34	33.3	2	2.0	0	0.0	0	0.0	102	100.0
April	60	54.5	7	6.4	40	36.4	1	0.9	2	1.8	0	0.0	110	100.0
May	36	52.9	2	2.9	29	42.6	1	1.5	0	0.0	0	0.0	68	100.0
June	20	74.1	1	3.7	6	22.2	0	0.0	0	0.0	0	0.0	27	100.0
TOTAL	348	68.4	18	3.5	133	26.1	4	0.8	5	1.0	1	0.2	509	100.0

Multiple Sampling

Many anglers fished in the Coffin Bay area regularly, or were staying for an extended period, and were interviewed on more than one occasion. During the survey period, 213 interviews (41.8% of the total) were conducted with people who had been previously interviewed (Table 21).

Table 21. Recreational Fishers Previously Interviewed - January to June 1990

	INTERVIEWED PREVIOUSLY					
	YES		NO		FISHERS	
	No	%	No	%	No	%
January	42	29.8	99	70.2	141	100.0
February	28	45.9	33	54.1	61	100.0
March	44	43.1	58	56.9	102	100.0
April	53	48.2	57	51.8	110	100.0
May	38	55.9	30	44.1	68	100.0
June	8	29.6	19	70.4	27	100.0
TOTAL	213	41.8	296	58.2	509	100.0

Average Expenditure

The average daily expenditure by recreational fishers was $16.56c, with the three major costs being boat fuel ($12.01c), car fuel ($2.92c), and bait and ice ($1.50c, Table 22). All expenditure showed little variation over the six month period.

Minimal fishing tackle was purchased on the day unless fishing gear was in disrepair.

Car fuel averaged $1 per day for fishers staying in Coffin Bay. Fishers not staying in Coffin Bay incurred higher fuel costs averaging $10 for the round trip.

Bait costs were low due to the availability of cockles in several easily accessible local areas. Many fishers collected fresh cockles in the early morning or late evening.

Table 22. Average Expenditure by Recreational Fishers - January to June 1990

	JAN	FEB	MARCH	APRIL	MAY	JUNE	AVERAGE
Boat Fuel & Oil	12.16	14.48	12.25	10.75	11.07	12.22	12.01
Boat Rental	0.00	0.16	0.00	0.00	0.00	0.00	0.02
Car Fuel	2.22	2.90	3.01	2.82	3.68	4.81	2.92
Fishing Tackle	0.03	0.00	0.00	0.15	0.13	0.00	0.06
Bait & Ice	1.48	1.90	1.24	1.53	0.88	3.15	1.50
TOTAL	16.07	19.44	16.50	15.25	15.76	20.19	16.56

Staying Overnight

Most fishers interviewed (70.5%) obtained overnight accommodation at Coffin Bay (Table 23). A smaller proportion of respondents made day trips to Coffin Bay (18.3%) or were residents of Coffin Bay (11.2%).

The proportion of fishers obtaining accommodation in Coffin Bay was higher in the warmer months of January (78%), February (70.5%), March (76.5%) and April (70.0%). The proportion of fishers travelling to Coffin Bay for the day increased in May (27.9%) and further increased in June (40.7%).

Table 23. Recreational Fishers Staying Overnight at Coffin Bay - January to June 1990

	STAYING OVERNIGHT		DAY TRIPS		COFFIN BAY RESIDENT		TOTAL FISHERS	
	No.	%	No.	%	No.	%	No.	%
January	110	78.0	19	13.5	12	8.5	141	100.0
February	43	70.5	9	14.8	9	14.8	61	100.0
March	78	76.5	17	16.7	7	6.9	102	100.0
April	77	70.0	18	16.4	15	13.6	110	100.0
May	37	54.4	19	27.9	12	17.6	68	100.0
June	14	51.9	11	40.7	2	7.4	27	100.0
TOTAL	359	70.5	93	18.3	57.0	11.2	509	100.0

Accommodation

The most popular accommodation type used by survey respondents was a rented house/cabin (39.9%), their own seasonal house (32.4%) and the caravan park (22.6%). Use of the motel was negligible (.3%, Table 24).

The percentage of fishers staying with friends was low and steady at an average of 4.5% for the period.

Other types of accommodation were insignificant.

An average of 15.7 nights was spent away from home, for all respondents. This average was higher for the proportion of respondents using their own seasonal house (19.7 nights) and lower for the proportion of respondents staying with friends (11.8 nights).

Table 24. Types of Accommodation Used by Recreational Fishers - January to June 1990

	HOTEL/MOTEL			CARAVAN PARK			RENTED HOUSE/CAB			OWN SEASONAL HOUSE		
	No.	%	Nights stayed	No.	%	Nights stayed	No.	%	Nights stayed	No.	%	Nights stayed
January	1	0.9	7	32	29.1	456	31	28.2	502	41	37.3	775
February	0	0.0	0	5	11.6	32	27	62.8	357	10	23.3	257
March	0	0.0	0	17	21.8	305	40	51.3	512	18	23.1	281
April	0	0.0	0	20	26.3	447	25	32.9	315	27	35.1	648
May	0	0.0	0	3	8.1	12	13	35.1	156	18	48.6	278
June	0	0.0	0	4	28.6	14	7	50.0	40.0	3	21.4	45
TOTAL	1	0.3	7	81	22.6	1266	143	39.9	1882	116	32.4	2283

	WITH FRIENDS			OTHER			TOTAL		
	No.	%	Nights stayed	No.	%	Nights stayed	No.	%	Nights stayed
January	4	3.6	41	1	0.9	16	110	100.0	1797
February	1	2.3	1	0	0.0	0	43	100.0	647
March	3	3.8	29	0	0.0	0	78	100.0	1127
April	5	6.6	52	0	0.0	0	77	100.0	1461
May	3	8.1	50	0	0.0	0	37	100.0	496
June	0	0.0	0	0	0.0	0	14	100.0	99
TOTAL	16	4.5	173	1	0.3	16	359	100.0	5627

The Recreational Value of Fish Caught in Coffin Bay

A measure of the total economic value of fish to recreational fishers is the maximum they are prepared to pay for fish in lieu of spending the same amount of money on other goods and services which satisfy personal needs and wants (Edwards 1990).

Information on the maximum amount recreational fishers were prepared to pay for each fishing trip at Coffin Bay during the survey period (termed "willingness to pay") was collected in the survey (Question 12, Appendix 1). The willingness to pay data were recorded as coded data. The coded data were converted to dollar values by setting each nominated category to the mid-point of the range.

These data refer to the total value of the recreational fishing experience. Bishop and Samples (1980) noted that the value of the recreational fishing experience includes the value placed on the opportunity to be outside, relax and enjoy the scenery etc., as well as the value placed on the fish caught. To separate the value attributed by recreational fishers to fish from the total value placed on the recreational fishing experience, it is necessary to determine the extent that the willingness to pay data are influenced by changes in the number of fish caught, taking into account other factors affecting the value of the fishing experience. This was done by estimating a willingness to pay function that relates willingness to pay to its determinants, using regression analysis (e.g. Hammack and Brown 1974, McConnell 1977, Dwyer and Bowes 1978).

The data on willingness to pay (total economic value of the recreational fishing experience) was defined as the dependent variable. Independent variables were hypothesised to be:

1. Total catch - Catch was defined as the total number of King George whiting, garfish, salmon, tommy ruff and other finfish caught during the fishing trip. A positive regression coefficient was expected, implying that as catch increased, willingness to pay would also increase.

2. Weather and sea conditions - Respondents were asked to rank weather and sea conditions on a scale from one (being poor) to five (being excellent). It was hypothesised that improved willingness to pay for the fishing trip would increase as weather and sea conditions improved.

3 Quality of fishing - A favoured target species of recreational fishers in Coffin Bay is King George whiting. It was hypothesised that as the proportion of King George whiting in the catch increased, the quality of fishing also increased, implying that the willingness to pay would increase.

4. Income - From economic theory, willingness to pay is expected to increase with increases in income. Income data were collected in a pilot questionnaire used in the Coffin Bay study. However, respondents often refused to provide the data or provided it reluctantly. The question was eventually removed from the questionnaire used in the study. Hence income was not included as an independent variable in the regression model. Difficulties in obtaining income data in willingness to pay studies have been reported by Cameron and James (1986).

5. Fishing days - Respondents were asked to estimate the number of days they had spent fishing in the last 12 months. It was hypothesised that as the number of fishing days increased, the willingness to pay for the recreational fishing experience would decline (i.e. the regression coefficient would be negative).

6. Dummy variables - Dummy variables were included as intercept shifters in the regression model to evaluate the impact of month, survey period, type of accommodation and employment status on willingness to pay. Most were statistically insignificant and were thus excluded from the model reported. The dummy variables retained were those for the month of January, accommodation in a rented house and accommodation staying with friends.

The preferred regression model is reported in Table 25, and was estimated with the willingness to pay, catch, quality, weather and fishing day variables transformed to natural logarithms. The proportion of variation explained by the model is low ($\bar{R}^2$ is 0.24). However, this is comparable with results obtained in similar studies e.g. the $\bar{R}^2$ obtained by Hammack and Brown (1974) and McConnell (1977) were 0.22 and 0.29 respectively. The regression model reported was estimated using ordinary least squares (OLS). Tests for heteroskedasticity were inconclusive, implying that an OLS estimator was appropriate.

The estimated coefficients for catch, quality of fishing and weather and sea conditions were highly significant ($P < .001$) and had the expected signs. From these results, it is concluded that these variables are significant determinants of the value placed by recreational fishers on the fishing trip. The coefficient for fishing days was negative as expected and significant at the 5% level, supporting the hypothesis that willingness to pay decreased as the number of fishing days increased.

The three dummy variables had positive coefficients, implying that persons visiting Coffin Bay in January or those staying with friends or in a rented house demonstrated a higher willingness to pay than others in the sample.

Table 25. Estimated Regression Model of the Willingness to Pay Function - January to June 1990

VARIABLE[a]	COEFFICIENT	STANDARD ERROR
Catch	0.30 (***)	0.05
Quality	0.18 (***)	0.05
Weather	0.40 (***)	0.11
Fishing Days	-0.07 (*)	0.04
January	0.52 (***)	0.10
Rented House	0.21 (**)	0.09
Friends	0.87 (*)	0.25
Constant	1.99 (***)	0.23
$\bar{R}^2$	0.24	

[a] The variables Willingness to Pay, Catch, Quality, Weather and Fishing Days were transformed to natural logarithms.

*** P<0.001
** P<0.01
* P<0.05

The positive coefficient for January may be due to the large number of people on holidays during this month. Survey respondents during January often gave the impression that they had come to Coffin Bay to fish and that cost factors had little influence on their decision to go out fishing for the day. The positive coefficient may also reflect an income effect. As discussed above, an income variable was omitted from the estimated willingness to pay function. During January, there was a greater proportion of fishers reporting full-time employment relative to the other months (Table 20), implying that the average income of respondents may have been high during January relative to the other months during the survey period.

An inverse Hicksian demand function, relating the marginal value of fish to the number of fish caught, was obtained by partially differentiating the willingness to pay function reported in Table 25 with respect to catch. A simplified model, obtained by substituting all other variables in the model at their mean values, is:

$$\partial WTP/\partial FISH = 3.073FISH^{-0.70297}.$$

where WTP denotes willingness to pay and FISH denotes the number of fish caught per boat trip.

Setting the number of fish caught per boat trip at the mean of 28.52 (Table 15), the marginal value of an additional fish to recreational fishers is estimated to be 29.2 cents per fish. It should be noted that this value is significantly less than the average willingness to pay per fish caught ($1.28) or the average daily trip costs per fish caught (58.1c, Table 26). The estimated marginal value is similar to the estimate of 36.5C per fish obtained by Collins (1991), who used the Cameron and James (1986) method to determine the value of King George whiting to recreational anglers in South Australia.

The marginal value of fish is the appropriate measure of value that should be used to compare the benefits from using fish in competing uses (e.g. commercial and recreational fishing, Bishop and Samples 1980). The variation in the alternative measures of "value" listed in Table 26 illustrates the extent to which estimates of the value of recreational fishing may be biased if inappropriate measures of value are used. It also reinforces the point that fish contribute only a portion of the value placed by fishers on the recreational fishing experience.

Table 26. Comparison of Marginal Value with the Average Willingness to Pay and Daily Trip Cost

	c/fish
Marginal Value	29.2
Average Willingness to Pay	127.7
Average Daily Trip Costs	58.1

The catch variable used in the regression model is the sum of all finfish species caught. Thus the estimated value refers to a composite fish corresponding to the composition of species caught (Table 13). The weight of this composite fish was estimated to be 175g, obtained by multiplying the percentage of catch of each species by the average weight of the species and summing. Using this estimate, the marginal value of fish to recreational fishers is estimated to be $1.67/kg[1].

An estimate of the value of the composite fish to the commercial fishery is obtained by multiplying the percentage of catch of each species taken by recreationalists (Table 13) by the market price that was obtained by commercial fishers for that species in 1989/90 (data on the price of fish in the region were obtained from the Department of Fisheries catch and effort data base). The estimated marginal value to commercial fishers is $3.86/kg.

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[1] 1000/175 * .292 = $1.67

Comparing these two estimates, it is apparent that the marginal value of fish in the commercial fishery is over twice as great as the value of the same fish in the recreational fishery. This result indicates that it may be beneficial to increase the proportion of fish taken by commercial fishers and reduce that taken by recreational fishers. However, the estimated value of **$1.67** per kg is a gross value, excluding the cost of catching fish. In the following section, a model to estimate the benefits to commercial and recreational fishers from reallocating fish that takes into account costs is developed.

Allocation of Fish Between Commercial and Recreational Fishers

A Theoretical Model

Principles for allocating fish between commercial and recreational fishers are discussed by Edwards (1990).

Consider Figure 3 which depicts supply and demand curves for the average recreational fisher and the commercial fishery. In Figure 3a, the WTP function is the Hicksian demand curve derived above, depicting the relationship between marginal willingness to pay and the quantity of fish caught per boat trip. The curve is downward sloping, implying that the marginal value of fish to recreational fishers decreases as catch increases. The costs incurred by recreational fishers are represented by the supply curve. These costs include direct costs such as fuel and bait expenses and also the opportunity cost of the fishers' time. The curve is upward sloping indicating that higher catches require increased time by fishers and increased direct costs. (It is assumed that all fishers are equally skilled). Assuming equilibrium, the supply curve for the recreational fisher will intersect the WTP function in Figure 3a at the point where marginal willingness to pay is equal to WTP_0 and catch is R_0 kgs. At this point, the marginal benefit from fishing is just equal to the marginal cost. The remainder of the supply curve is drawn as a linear function passing through the origin. A reduction in the recreational catch from R_0 to R_1 will reduce benefits to each recreational fisher by the area under the demand curve between R_0 and R_1 (area R_1BAR_0). Costs will similarly be reduced by area R_1CAR_0. The net effect (benefits minus costs) is a reduction of area ABC.

The equilibrium position for the commercial fishery is depicted in Figure 3b. The demand curve for fish is assumed to be perfectly elastic at price P, implying that increases in the quantity of fish taken from Coffin Bay have no effect on the overall price of fish. The supply curve is assumed to be linear, passing through the origin and intersecting the demand curve at equilibrium price P and catch Q.

A reduction in the recreational catch will increase the quantity of fish that can be profitably taken by commercial fishers. Thus the supply curve will pivot around the origin to the right from S_0 to S_1. It is assumed that catch increases from Q to Q^*. The increase in economic benefits (producer surplus) accruing to the commercial sector is area OYZ. Note that in this model, consumers do not benefit from the increase in commercial catch due to the assumption of perfectly elastic demand (consumer surplus is zero). If demand for Coffin Bay fish was less than perfectly elastic, benefits would also accrue to non-fish-catching consumers.

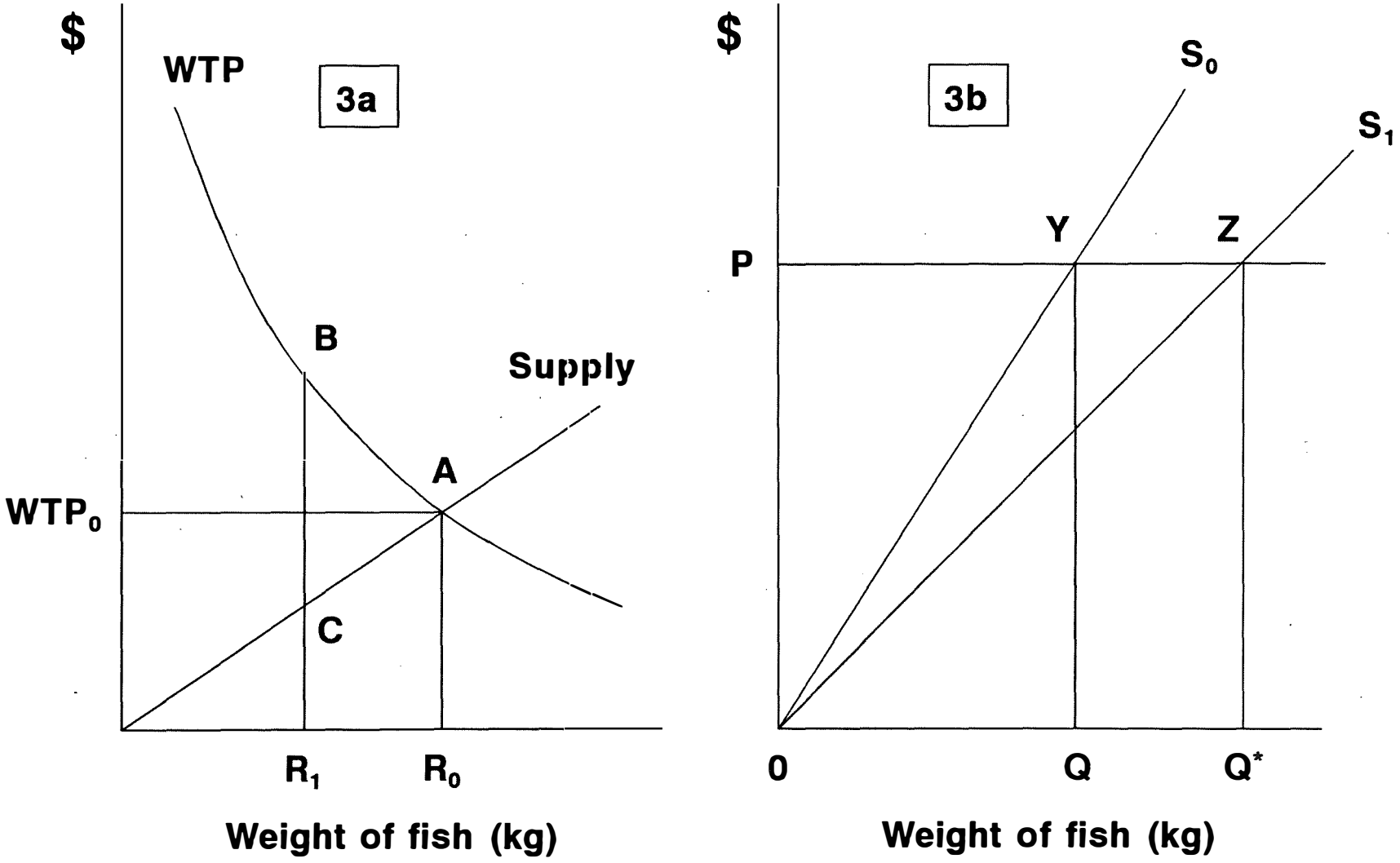


Fig. 3. A conceptual model for analysing recreational and commercial fishing in Coffin Bay.

An Empirical Model

The Hicksian demand curve for recreational fishing by individual fishers was estimated above and is of the form

$$WTP = aF^b$$

where WTP denotes marginal willingness to pay, F denotes the number of fish taken per boat trip, b is the price flexibility of demand for fish for an individual fisher and **a** is a model parameter.

The supply curve is defined as

$$MC = cF$$

where MC denoted marginal costs, F denotes the number of fish caught per boat trip and **c** is a model parameter.

Assuming equilibrium in the recreational fishery, marginal WTP is equal to MC. Thus estimates of marginal willingness to pay and fish caught can be used to calculate **c**:

$$c = MC/F.$$

The reduction in total benefits (RB) to an average recreational fisher per boat trip (area R_1 B A R_0 in Figure 3a) is calculated by evaluating the integral of the Hicksian demand curve between R_1 and R_0.

$$RB = a/(b+1) [R_1^{b+1} - R_0^{b+1}].$$

The reduction in costs (RC) to a recreational fisher per boat trip (area R_1 A C R_0 in Fig. 3a) is similarly calculated by integrating the supply function.

$$RC = c/2 [R_1^2 - R_0^2]$$

The net reduction in benefits per boat trip to a recreational fisher (NRB) is obtained by subtracting the change in costs from the change in benefits,

$$NRB = RB - RC.$$

The total reduction in net benefits to recreational fishers following a reduction in catch from R_0 to R_1 is calculated by multiplying the reductions in benefits per boat trip by the number of fishing trips made by recreational fishers (N)

$$RECBEN = NRB * N.$$

A reduction in the recreational catch will increase the commercial catch. The new commercial catch (Q^*), expressed in kilograms, is

$$Q^* = Q + (R_0 - R_1).\ W.N.L.$$

where Q denotes the current catch, W denotes the average weight of fish caught in kilograms, N denotes the number of recreational fishing boat trips made and L denotes the percentage of fish previously caught by recreational fishers that are recaptured by commercial fishers.

The net benefit accruing to commercial fishers (CB) from the increased catch (area OYZ in Figure 3b) is

$$CB = 0.5\ P\ (Q^* - Q)$$

The overall effect of the reallocation of fish from recreational to commercial fishers on economic benefits is assessed by calculating the net economic impact (NEI)

$$NEI = CB - (RB - RC)$$

(net benefits accruing to commercial fishers minus the reduction in net benefits to recreational fishers following a reduction in the recreational catch per boat trip from R_0 to R_1).

A positive NEI implies that the reallocation of fish will increase economic benefits generated from the fishery, and is thus economically desirable.

Model Inputs

Parameters of the willingness to pay function are obtained from Table 25. The equilibrium catch per recreational fishing trip is 28 fish (Table 15). The marginal value of fish to recreational fishers is 29.2 cents per fish or $1.67 per kg. (Table 26). The average weight of each fish is assumed to be 150 grams. The number of recreational fishing trips made is estimated to be 3155, obtained by dividing the recreational boat hours (Table 2) by the average length of each trip (Table 19).

The price of fish to commercial fishers is $3.86 per kilogram (see above). The equilibrium commercial catch (Q) is estimated by scaling up the recreational catch (Table 13) according to data on the distribution of King George whiting between commercial and recreational fishers in Coffin Bay. Jones et al (1990, p.78) estimated that recreational fishers took 34.2% of total catch in Coffin Bay. Applying this factor to the total recreational catch (15 002 kg, Table 13), commercial catch is estimated to be 28 865 kg.

There are no data available to estimate the proportion of fish that are recaptured by commercial fishers following a reduction in recreational catch. However, it is considered that not all of the fish would be recaptured. Some of the species caught by recreational fishers would not be targeted by commercial fishers. Professional fishers frequently target King George whiting, which accounted for approximately half of the recreational catch (Table 13). It is initially assumed that 50% of the fish currently taken by recreational fishers are recaptured. Sensitivity analysis is used to determine the sensitivity of the results to variation in the proportion of fish that are recaptured by commercial fishers.

Results

The model was used to calculate the increase in benefits to professional fishers and the reduction in benefits to recreational fishers for varying recreational catches (Figure 4). As the average recreational catch per boat trip declines from 28 fish (the sample average), benefits to professional fishers increase and those to recreational fishers are reduced. The recreational catch that maximises economic benefits is approximately 15 fish per boat trip. The curves drawn in Figure 4 intersect at this point, implying that the loss in benefits to the recreational fishery is just offset by the increase in benefits to the commercial fishery.

The position of the curves and the point where they intersect depends on the assumptions made in relation to the model inputs. As further work is required to verify these, detailed sensitivity analysis of the results is not undertaken. However, to illustrate the potential impact that changes in model inputs could have, an analysis of the impact of varying the proportion of fish recaptured by professional fishers on the optimum recreational catch per boat trip is provided in Table 27. If professional fishers recapture 70% of the catch foregone by recreational fishers (rather than 50%), the recreational catch that maximises economic benefits reduces from 15 to 10 fish per boat trip. The data in Table 27 imply that net benefits from reducing recreational catch are very sensitive to the proportion of fish that are recaptured by commercial fishers.

Table 27. Effect of Changes in % of Fish Recaptured by Commercial Fishers on the Optimal Recreational Boat Catch

% of Fish Recaptured	Optimal Recreational Catch (No. of fish caught per boat trip)
30	20
50	15
70	10
90	7

Further research is required to evaluate and verify the assumptions used in the model. Changes to policy cannot be recommended until this work is undertaken. However, to illustrate how the results obtained from the model could be used, the following interpretation of Figure 4 is provided.

1. The curves drawn in Figure 4 intersect, implying that both commercial and recreational fishing are necessary to maximise economic benefits from the Coffin Bay fishery.

2. The evidence obtained on the marginal value of fish in commercial and recreational fishing and from the simple economic model applied above, indicates that the current allocation of fish between the competing users is not maximising economic benefits from the fishery. The results imply that the recreational catch should be reduced and reallocated to the commercial fishery.

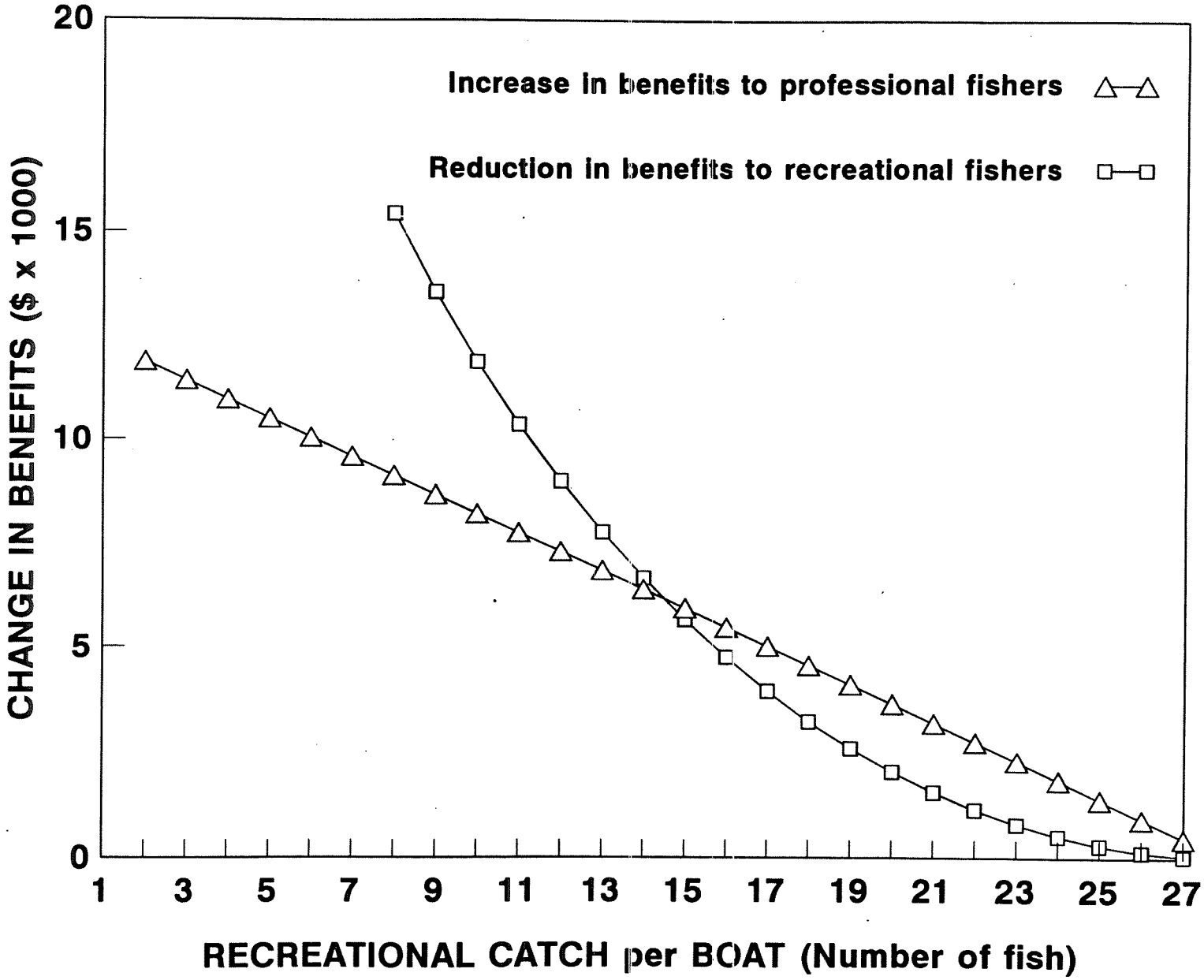


Fig. 4. Impact of a reduction in the recreational catch on commercial and recreational fishers.

According to the numerical results obtained from the model, economic benefits are maximised when the recreational catch per boat is approximately 15 fish. For catches below this level, benefits from using fish for recreational purposes exceed those that could be obtained by using the fish for commercial purposes. When catch per boat is greater than 15 fish, benefits could be increased by allocating more fish to commercial fishing.

3. The optimal recreational catch per boat trip is very sensitive to the assumption made on the proportion of fish foregone by recreational fishers that are recaptured by commercial fishers. More research is required to accurately quantify this parameter.

DISCUSSION

Comparison of Results with Previous Studies

The survey results obtained in this study are in accord with those from previous studies e.g. Hill (1986) and Jones and Retallick (1990). They show that recreational fishing is an important activity in the region. Fishing was the primary purpose of the boat trip for the majority (83%) of recreational boat owners using the Coffin Bay boat ramp. The fish species most frequently targeted by recreational fishers was King George whiting (57.8% of fishers reported that they were targeting King George whiting). The recorded catch rate of King George whiting per angler hour at Coffin Bay (1.25 fish) is comparable with the estimate of Jones and Retallick (1990) in Franklin Harbour (1.2) and Hill (1986) at Port Hughes (up to 1.16). Persons fishing during the week obtained higher catch rates than those fishing on weekends or in school holidays. These people often lived locally in the area or had detailed local knowledge. This is consistent with Hill's (1986) results. Fishing in Coffin Bay is seasonal, with species composition and catch rates varying during the survey period.

Impact of Commercial Netting on the Recreational Fishery

Commercial netting in Coffin Bay is prohibited from the beginning of November to the end of April. During this period, few commercial boats were launched from the boat ramp. The incidence of commercial boats launching from the boat ramp increased markedly in May and June.

Many recreational fishers interviewed asserted that commercial netting had a negative impact on catch rates in the recreational fishery. However, the data obtained indicate that the catch rates in the recreational fishery in May and June (when commercial netting was permitted) were comparable with those in March and April and exceeded those recorded in January and February. Total catch taken by recreational fishers declined in May and June. However, this was due mainly to a reduction in recreational boat fishing effort, perhaps due to other factors such as deteriorating weather conditions.

Allocation of Fish Between Commercial and Recreational Fishers

A key objective of this study was to develop a method to estimate the benefits to commercial and recreational fishers from policies implemented to change the share of catch between the two sectors. A model was successfully developed and applied to the Coffin Bay fishery. The model and data require further refinement before the results can be used to assist in policy formulation. More specifically, the model and the results obtained represent a first

attempt to value fish to recreational fishers in South Australia. The analytical techniques used are simple and the method used to elicit data on willingness to pay is susceptible to various biases (see Mitchell and Carson 1989). There is scope to use more advanced analytical methods in undertaking further research. Research into the stability of the parameters of the willingness to pay function, the performance of the survey instrument and the the extent to which results can be generalised is essential before the results can be used for policy purposes.

The analysis used in this paper models the decision to go fishing on a given day, by examining the benefits and cost of the fishing trip. However, it does not take into account the decision to visit Coffin Bay. Most of the fishers interviewed (70.5%) stayed in temporary accommodation overnight. The extent to which the opportunity to fish influenced the decision to stay overnight in Coffin Bay or its adjacent areas is not known. Failure to incorporate this decision into the analysis may have caused the estimated marginal value of recreationally caught fish to be understated. Future research should attempt to integrate the decision to visit Coffin Bay and the decision to go fishing on a given day.

The study was restricted in its geographical coverage to Coffin Bay. Coffin Bay has unique attributes as a recreational fishing site. Also the restrictions applying to commercial netting are specific to the area. Additional research is required to determine if the results obtained for Coffin Bay are applicable in other areas before implementing policy changes.

The model developed in this paper does not contain a biological model describing the response of the fish stock to variations in commercial and recreational fishing effort. Consequently the results only relate to the conditions applying in the year in which the survey was undertaken (1990). An implicit assumption of the analysis is that the total commercial and recreational catch is sustainable. It is also assumed that a specified proportion of fish removed from the recreational fishery will be caught by commercial fishers. It is possible that variations in recreational fishing activity will not affect commercial catch rates. Under these conditions, a variation in the level of recreational fishing effort may not affect the cost curves and total catches of commercial fishers. More work is required to quantify the biological interactions between competing user groups in fisheries. Also the lack of a biological model precludes analysis of intertemporal effects, dependent on recruitment patterns and growth rates.

OBSERVATION DATA

TO BE COMPLETED WITHOUT ASKING QUESTIONS

BOAT FISHERS

Survey No: ☐

Location: Coffin Bay

Date: ☐

Time: ☐

Type of Fishing: Boat ☐ B

Gender: Male ☐ 1

Female ☐ 2

Commercial Netting:

Allowed ☐ 1

Prohibited ☐ 2

Commercial Fisher:

Yes ☐ 1 **(Do not interview Commercial Fishers)**

No ☐ 2

<u>Introduction</u>

Introduce yourself as representing the Research Branch of the Department of Fisheries.

WE ARE CONDUCTING A SURVEY OF RECREATIONAL FISHING IN COFFIN BAY. THE RESULTS OF THIS SURVEY WILL BE USED TO PROVIDE VALUABLE INFORMATION ON FISHING ACTIVITIES IN THE AREA.

WE WOULD LIKE YOU TO ASSIST US IN THIS RESEARCH BY ANSWERING SOME QUESTIONS. THE ANSWERS YOU PROVIDE WILL BE USED FOR RESEARCH PURPOSES ONLY AND WILL BE TREATED CONFIDENTIALLY. NO FORM OF IDENTIFICATION WILL BE RECORDED ON THE QUESTIONNAIRE.

THE FIRST PART OF THE QUESTIONNAIRE CONTAINS QUESTIONS ON YOUR FISHING ACTIVITIES TODAY.

1. Was recreational fishing the primary purpose of your boat trip today?

Yes ☐ 1

No ☐ 2

1(a) If no, what percent of your time did you actually spend fishing?

(If zero, discontinue interview) [ ] %

2. During the time you fished today, were you targeting on just one kind of fish?

No ☐ Yes ☐

2a. If yes, what kind (species) of fish was your primary target today? (Tick the square of just one species)

King George whiting ☐ 1

Garfish ☐ 2

Salmon ☐ 3

Scallop ☐ 4

Others (please specify be ow)

_____

_____

_____

3a. How many hours were you out in your boat today?

[ ] hrs

3b. How many hours did you have fishing gear in the water today (record number of hours to the nearest half hour)?

[ ] hrs

4. Of your total fishing time today, what percent of it was spent on

line fishing		%	L
net fishing		%	N
dabbing		%	B
hoop nets		%	H
diving		%	D
other (specify)		%	O
other (specify)		%	O
	100%		

5. Of your total time so far today, what percent of it was spent within each of the areas shown on the map? [Hand respondent area map].

Kellidie Bay		%	1
Mt Dutton Bay		%	2
Inner Coffin Bay		%	3
Outside Coffin Bay		%	4
	100%		

6. Have you completed your fishing for today?

Yes ☐ 1 No ☐ 2

6a. If no, how much additional time do you expect to have gear in the water for today?

☐ Hours (Record number of hours to nearest half hour).

7. How much time did it take for you to drive from your permanent home to this location? (Record number of hours to the nearest half hour)

hrs

8. What is the post code of your permanent home?

9. Are you staying away from home overnight on this fishing trip?

No ☐ 1 Yes ☐ 2

9a. If yes, how many nights and where will you be staying away from your permanent home on this trip?

Hotel or motel		H
Caravan Park		C
Rented house or cabin		R
Own seasonal house (shack)		H
With friends		F

Other, specify ———————— O

10. How many people in your boat/group were actually fishing today?

Total number ☐

10a. Of the people fishing today, how many were under 16 years of age?

☐

11. What did today's fishing outing cost your boat/group for the following items?

11a. Boat fuel & oil $ ☐

11b. Rental boat fees $ ☐

11c. Car fuel $ ☐

11d. Fishing tackle $ ☐

11e. Bait and ice $ ☐

11. TOTAL $ ☐

12. You estimated that your total costs today were:

$ ☐ (from Q 11)

Imagine that the cost of fishing in Coffin Bay increased. By how much would total costs have to increase to stop you from going fishing today. Use scale card A to choose an appropriate cost.

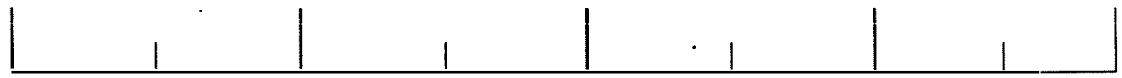
13. How many fish of the following species did your boat/group catch today?

Australian salmon		SAM
King George whiting		KGW
Garfish		GAR
Snapper		SNA
Tommy ruff		RUF
Scallops		SCA
Crabs		CRA
Other		OTH

14. How many King George whiting did your group catch and return to the water today (eg undersize)?

15. How enjoyable was today's fishing trip. Use the scale card to give a general idea about your feelings.

Not enjoyable — Very enjoyable

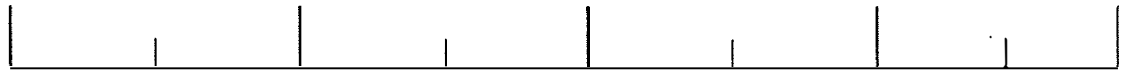


16. What were weather and sea conditions like during your fishing trip today? Use the scale to indicate conditions.

Poor — Excellent

16a. What did you expect weather and sea conditions to be like during your trip before you left to go fishing today? Use the scale card to indicate condition.

Poor — Excellent



17. On about how many different days did you go fishing at any location during the last year?

days

17a. How many different days did you fish at Coffin Bay during the last year.

	days

18. What is your employment status?

Full-time		F
Part-time		P
Retired		R
Home maker		H
Student		S
Unemployed		U
Other		O

19. Did you notice any commercial fishing activity today?

Yes ☐ 1 No ☐ 2

20. Have you previously been interviewed for this survey?

Yes ☐ 1 No ☐ 2

RECREATIONAL FISHING SURVEY EFFORT

LOCATION: Coffin Bay

DATE: / /

APPROXIMATE TEMPERATURE:

BOAT RAMP		WEATHER					WIND			SWELL		
TIME	TRAILERS	< 50% OVERCAST	> 50% OVERCAST	DRIZZLE	MODERATE RAIN	HEAVY RAIN	CALM	MODERATE	STRONG	CALM	MODERATE	ROUGH

APPENDIX 2

Appendix 3

AVERAGE NUMBER OF BOAT TRAILERS RECORDED AT EACH COUNT TIME
BY MONTH BY SURVEY PERIOD
Coffin Bay - January to June 1990

MONTH	JANUARY	FEBRUARY		MARCH		APRIL		MAY			JUNE		
SURVEY PERIOD	S	W	E	W	E	W	E	S	W	E	P	W	E	P
Time														
700	3.00	1.00	1.00	2.00	2.00	0.00	2.00	2.00	1.00	0.67	0.50	0.00	0.00	0.00
800	14.00	2.00	3.00	5.00	6.00	1.00	4.00	1.00	1.40	1.00	2.00	0.75	0.00	0.00
900	11.75	5.39	6.00	10.00	11.00	8.00	10.50	10.00	3.50	3.33	3.50	0.00	0.00	2.50
1000	13.75	10.30	11.00	11.50	10.00	13.00	7.00	19.00	4.67	8.00	6.00	0.00	0.00	4.50
1100	16.00	12.26	13.00	14.25	11.00	14.50	10.00	20.67	5.75	10.00	9.00	0.00	1.00	3.00
1200	19.50	15.40	9.50	12.60	16.40	15.50	10.50	22.75	7.29	12.67	9.00	1.80	1.00	9.00
1300	19.63	13.20	9.00	12.40	19.20	13.00	11.50	20.80	7.13	12.67	8.67	1.60	1.00	10.00
1400	17.73	11.80	11.00	10.60	18.40	13.33	12.50	20.20	7.00	11.33	9.33	2.20	2.00	9.00
1500	19.00	12.00	10.50	9.40	16.25	11.50	11.50	14.60	6.00	10.67	8.33	2.40	2.00	8.67
1600	18.86	7.00	7.00	6.40	13.60	8.00	7.50	12.20	4.13	6.33	6.67	1.00	1.00	5.33
1700	14.00	4.00	6.00	4.20	10.40	5.50	5.50	8.00	2.75	3.33	3.33	0.40	1.00	3.67
1800	11.57	1.67	1.00	2.00	5.40	3.00	2.00	3.00	2.00	2.00	0.67	0.60	1.00	0.67
TOTAL	178.78	96.02	88.00	100.35	139.65	106.33	94.50	154.22	52.60	82.00	67.00	10.75	10.00	56.33

S = School Holidays
W = Week days
E = Week ends
P = Public holidays

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