A survey of daytime recreational fishing during the annual period, March 1999 to February 2000, in Lake Macquarie, New South Wales

Aldo S. Steffe and Douglas J. Chapman

NSW Fisheries
P.O. Box 21, Cronulla, NSW, 2230
Australia

August 2003

NSW Fisheries Final Report Series
Report No. 52

ISSN 1440-3544

A survey of daytime recreational fishing during the annual period, March 1999 to February 2000, in Lake Macquarie, New South Wales

Aldo S. Steffe and Douglas J. Chapman

NSW Fisheries
P.O. Box 21, Cronulla, NSW, 2230
Australia

August 2003

NSW Fisheries Final Report Series
Report No. 52

ISSN 1440-3544

A survey of daytime recreational fishing during the annual period, March 1999 to February 2000, in Lake Macquarie, New South Wales

August 2003

Author: Aldo S. Steffe and Douglas J. Chapman

Published By: NSW Fisheries

Postal Address: PO Box 21, Cronulla NSW 2230

Internet: www.fisheries.nsw.gov.au

ISSN 1440-3544

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ACKNOWLEDGEMENTS

We would like to thank the following organisations and persons:

The Natural Heritage Trust and NSW Fisheries for providing funds for this project.

The many members of the Lake Macquarie Concerned Anglers Group: Steve Anderson; Tom Archbold; Col Austin; Liz Bailey; Winstone Buffrey; Frank Druery; Bill Gray; Patricia Hall; Richard Hall; Graham Halley; Ron Hemsley; Craig Jones; Lionel Jones; Alan Keft; John Lightfoot; Jan McLeod; John McLeod; Dennis Morgan; Col Munro; Gary Pearce; Allen Rae; Noel Stoops; Kevin Turner; Noel Vidler; Ray Ward and Sam Wilson.

The many members of the Australian Volunteer Coast Guard Association based at Swansea: Larry Baker; Nola Ellis; Norm Ellis; Allan Ferrier; John Green; Mike Hawkins; Garry Horgan; Tony Mackay; John Margarie; Craig Mason; T. Milton; Bruce Oliver; John Rains; Kay Rains; Bill Rogan; Barry Shoesmith; Peter Skinner; Bob Suttie; Jan Suttie; Richard Taubman; Alan Thomas; Jack Ward and Doug Young.

The independent group of field staff: Jason Bennett; Brett Corbett; Dave Harris; Chris Hird; Ian Hobden; Aaron Kinghorn; Tim McGowan; Ben Minors; Brad Minors; Linda Minors; Norma Minors; Steve Minors and Ryan Spong.

Pam and John Doniger provided us with warm hospitality and lively debates on current issues during our field trips to Lake Macquarie.

Dr. Steve Kennelly and Geoff Gordon provided valuable comments on the draft manuscript that greatly improved the final report.

Tracey McVea formatted the final report.

Finally, we would like to thank all of the fishers that participated in the survey. The successful completion of this work was made possible by their continual co-operation and support.

EXECUTIVE SUMMARY

Resource sharing and the allocation of fisheries resources between recreational and commercial user groups has long been a contentious management issue in NSW. Over the past 100 years, the ecosystem of Lake Macquarie has been placed under increasing stress by the combined effects of heavy industry, coal mining, the construction and operation of power stations, commercial and recreational fishing, tourism, non-extractive recreational usage, and a variety of agricultural and urban land uses within the catchment system of the Lake. These stresses have had negative impacts on the Lake Macquarie ecosystem and on the amenity and quality of the recreational and commercial fisheries. Thus, there was a need to collect quantitative information to describe the recreational fishery of Lake Macquarie and to compare the relative size of commercial and recreational harvests. These data are essential for assessing the status of the fisheries resources and the quality of the recreational fishery in Lake Macquarie.

Recreational fishing surveys of sound statistical design are essential for the collection of statistically unbiased information. We used stratified random sampling procedures as the basis of the survey design and integrated many data quality checks into the survey. The use of complemented survey methods to estimate the effort, harvest rates and harvest of the boat-based and shore-based fisheries separately in Lake Macquarie recognised that important differences exist between these two fisheries. The successful planning, organisation and execution of a large on-site survey of recreational fishing is a demanding and costly task and the limited financial resources available led us to develop an innovative community-based approach to the survey work. This novel approach relied heavily on the support and involvement of local interest groups during all phases of the survey and proved highly successful.

The recreational fishing survey was done during the annual period, March 1999 to February 2000. We found that the recreational fishing population of Lake Macquarie was male-dominated - over 82% of the boat-based fishers and over 83% of the shore-based fishers interviewed were male. We found that the great majority of fishers interviewed were of local origin, ranging from about 75% from the local area in the shore-based fishery to about 80% in the boat-based fishery.

We recorded a large amount of daytime recreational fishing effort (about 970,400 fisher hours) in Lake Macquarie and Swansea Channel during the survey year. This amount of fishing effort is relatively large when compared to other estuarine studies. This indicates that the Lake Macquarie fishery is an extremely important and popular recreational fishery. We estimated that the daytime recreational harvest from the Lake Macquarie fishery was about 295 tonnes (± 27 tonnes - approximate SE) consisting of about 913,500 fish, crabs and squid (± 65,700 individuals - approximate SE) from 60 taxa. The bulk of this harvest was made up of blue swimmer crab (≈108.9 tonnes), luderick (≈35.4 tonnes), yellowfin bream (≈32.5 tonnes), dusky flathead (≈21.4 tonnes), common squid (≈17.9 tonnes), sand mullet (≈13.8 tonnes), trumpeter whiting (≈12.4 tonnes), yellow-finned leatherjacket (≈10.2 tonnes), snapper (≈8.7 tonnes) and tailor (≈7.4 tonnes). These ten taxa, by weight, accounted for about 91% of the daytime recreational harvest during the annual survey period, indicating that the recreational harvest was very selective. This relatively large recreational harvest was achieved even though a large proportion of fishing parties were unsuccessful and did not retain any fish, crabs or cephalopods. The proportion of unsuccessful boat-based fishing parties was about 42% overall (ranging from about 32% to 49% on a seasonal basis), and the proportion of unsuccessful shore-based fishing parties was about 61% overall (ranging from about 54% to 68% on a seasonal basis).

We found inferential evidence in the form of harvest rate data for luderick, blue swimmer crabs and common squid, that the thermal plumes generated by the two power stations in the southern part of the Lake may have had a beneficial effect on the boat-based and shore-based recreational fisheries in that part of the Lake.

Reliable indicators of recreational fishing quality need to be developed for estuarine fisheries so that they can be used to provide a cost-effective means of monitoring the quality of important recreational fisheries. We discussed three indicators: the proportion of unsuccessful fishing parties, non-directed harvest rates for the boat-based and shore-based fisheries, and size-frequency distributions for some important taxa harvested by the recreational sector. We recommend that further analyses be done on the survey data collected in this study to provide additional indicators which could be used to assess future changes in the Lake Macquarie fishery.

We urge caution when comparing estimates of recreational harvest and declared commercial production data. There is a level of uncertainty associated with the estimation of recreational harvest (see standard errors) and the declared commercial production data are self-reported and the size and identification of these commercial catches have not been verified by independent observation.

We estimated that the daytime recreational harvest from the Lake Macquarie estuary during the survey period was about 295 tonnes and that the declared commercial production for the same period was about 274 tonnes (excluding prawns, pipis and cockles). This represents a harvest ratio of 1.077 which indicates that the daytime recreational harvest was about 8% larger than the declared commercial harvest. The recreational harvest of finfish was estimated at about 163 tonnes (± 12 tonnes - approximate SE) in the current study and the declared commercial catch of finfish was about 252 tonnes. This represents a harvest ratio of 0.647 for finfish during the survey period, which indicates that the total daytime recreational harvest of finfish from the Lake Macquarie estuary was about 35% smaller than the declared commercial finfish catch. Virgona (1983) reported an estimated recreational finfish harvest of about 98 tonnes during 1980/81 and a commercial finfish catch of about 415 tonnes in Lake Macquarie which represented a harvest ratio of 0.236 during that period. However, the estimates of recreational harvest made for 1980/81 are likely to be inaccurate because of statistical bias resulting from methodological errors in the survey design. Even so, these figures suggest that there may have been a major shift in the relative share of these fisheries resources between the recreational and commercial sectors with proportionally more finfish being taken by recreational fishers.

The recreational harvest of crabs and cephalopods was estimated at about 132 tonnes (± 24 tonnes - approximate SE) and the declared commercial catch of crabs and cephalopods was about 22 tonnes. This represents a harvest ratio of 6.0 for crabs and cephalopods during the survey period, which indicates that the total daytime recreational harvest of crabs and cephalopods from the Lake Macquarie estuary was about 500% larger than the declared commercial catch of crabs and cephalopods. A similar comparison for the combined harvests of crabs and cephalopods is not possible for 1980/81 because these taxa were not included in the previous survey (see Virgona 1983).

The recreational sector was the largest user-group for 17 taxa, blue-swimmer crab, luderick, bream, dusky flathead, squid, leatherjackets, sand mullet, trumpeter whiting, snapper, flat-tail mullet, flounder, mud crab, tarwhine, eastern blue-spotted flathead, sea garfish, school whiting and southern herring. There were two taxa for which there was little difference between the two sectors, tailor and silver trevally. The commercial sector was the largest user-group for 16 taxa, sea mullet, silver biddy, fan-tail mullet, striped seapike, yellowtail, butterfish, sand whiting, river garfish, mulloway, dolphin fish, salmon, freshwater eels, catfish, unidentified sharks, pilchard and hairtail. These harvest ratios showed that the recreational sector was a large and important user-group, having a considerable direct impact on fisheries resources in the Lake Macquarie fishery.

This recreational fishing survey provides evidence of a recreational fishery that is productive and providing good quality recreational fishing opportunities in Lake Macquarie and Swansea Channel. A summary of the evidence is that: (a) the levels of daytime recreational fishing effort were high; (b) the success rates (harvest rates) recorded were similar to those reported for other estuarine recreational fisheries, (c) the size-frequency distributions of important recreational species showed that large individuals were in the recreational harvest; (d) the proportions of under-sized fish in the recreational harvest were comparable to rates measured in other NSW estuarine fisheries; and (e) the daytime recreational harvest of many important recreational species was greater than that taken by the commercial sector. In contrast, there is some evidence to suggest that there may have been a decline in the tailor population within Lake Macquarie. A previous study had documented large catches of tailor in the vicinity of the Eraring hotwater outlet during Winter, yet we found evidence only of a small tailor fishery during the period of our survey but this result could be due to interannual fluctuations in tailor abundances.

1. INTRODUCTION

Australia's fisheries resources, though diverse, are not as abundant or productive as those in many other parts of the world (Kailola et al. 1993). Many fisheries resources are regarded as being fully fished, which suggests that current catches are sustainable and close to optimal levels (Kailola et al. 1993, NSW Fisheries 2000). Commercial production information is routinely collected by Australian fisheries agencies to monitor trends in commercial catches but comparable recreational statistics are usually not available and this is a problem faced by all fisheries agencies in Australia (Australian National Recreational Fisheries Working Group 1994, Dovers 1994, Kearney 1995, Steffe et al. 1996a). Recreational catch and effort data are more difficult and expensive to collect routinely because of the large number of participants and the diffuse access these fishers have to most fisheries. The paucity of quantitative information available for most recreational fisheries weakens stock assessments and increases the risk of making incorrect or inappropriate management decisions.

Resource sharing and the allocation of fisheries resources between recreational and commercial user groups has long been a contentious management issue in NSW (e.g. NSW Parliament - Fisheries Inquiry Commission 1880). Since the Fisheries Inquiry of 1880, the recreational sector has continued to grow and this has led to increased conflict with the commercial sector as both groups strive to maximise their share of limited fisheries resources. An extensive investigation into the hydrology, geology and ecology of Lake Macquarie was initiated in 1955 as a result of emphatic allegations that the fish stocks in Lake Macquarie had been depleted by commercial over-exploitation (see Baas Becking 1959; Baas Becking et al. 1959; Davis 1959; MacIntyre 1959; Spencer 1959; Thomson 1959a, 1959b, 1959c, 1959d, & 1959e; Wood 1959a & 1959b). Similar allocation disputes within NSW have been concentrated in other estuarine fisheries near large metropolitan areas such as Botany Bay and Sydney Harbour (Ruello and Henry 1977, State Pollution Control Commission (SPCC) 1981, Henry 1984).

Over the past 100 years, the ecosystem of Lake Macquarie has been placed under increasing stress by the combined effects of heavy industry, coal mining, the construction and operation of power stations, commercial and recreational fishing, tourism, non-extractive recreational usage and a variety of agricultural and urban land uses within the catchment system of the Lake (SPCC 1983, Lake Macquarie Taskforce 1999). These stresses have had negative impacts on the Lake Macquarie ecosystem and on the amenity and quality of the recreational and commercial fisheries of Lake Macquarie (Lake Macquarie Taskforce 1999). In response to public concerns about these issues, the NSW government established a taskforce in 1998 to address the issues affecting the health of Lake Macquarie. The Lake Macquarie Taskforce (1999) report provided a comprehensive assessment and integrated plan for improving the conditions of Lake Macquarie and its catchment. The report documented the conflicting views of local commercial and recreational fishing groups about the status of the fisheries resources within the Lake and their preferred management options (Lake Macquarie Taskforce 1999). Thus, there was a need to collect quantitative information to describe the recreational fishery of Lake Macquarie and to compare the relative size of commercial and recreational harvests. These data are essential for assessing the status of the fisheries resources and the quality of the recreational fishery in Lake Macquarie.

1.1. Site description

Lake Macquarie ($33^0$03'S $151^0$36'E) is a large coastal lagoon situated to the south of the industrial city of Newcastle, the second largest coastal centre in New South Wales (NSW) on the east coast of Australia (Fig. 1). Lake Macquarie has a surface area of about 110 km^2, a total catchment area of about 605 km^2 and an average depth of about 6 to 7 meters (Baas Becking et al. 1959, Lake Macquarie Task Force 1999). The Lake is a marine-dominated body of water which is connected to the ocean by a permanently-open channel at Swansea. The Swansea channel is a relatively narrow, shallow area that is characterised by strong tidal currents. The relatively small size of the Swansea channel in comparison to Lake Macquarie makes it a barrier that restricts tidal exchange between the Lake and the ocean to about 1% of the Lake volume each tidal cycle (Spencer 1959). The semi-diurnal tidal range in NSW coastal waters is about 2.0 meters but within the Lake itself the tidal range averages only 6 millimeters (SPCC 1983).

1.1.1. Access for recreational fishers during the survey period

The fisheries resources within Lake Macquarie and the Swansea channel were readily accessed by recreational fishers from boats and from the shore (Fig. 1). Boat-based fishers were able to access the recreational fishery from a great number of access points (Fig.1). During the survey period, there were 38 public boat ramps (see Appendix 1 for details), about 2160 boat moorings (Phil Howe pers. comm. - Waterways Authority of NSW), a multitude of private homes located on the edge of the Lake from which small boats could be launched and 9 caravan parks located near the Lake (some of these had their own boat ramps). Shoreline access to the recreational fishery was diffuse, even though there were large areas of shoreline which were not very accessible because of the vegetation, topography or restrictions to public access. There were 31 public wharves and jetties (Lake Macquarie Taskforce 1999) and there were about 1060 private jetties in 1998 (Central Mapping Authority - Department of Land and Water Conservation) throughout the Lake (Fig.1). There were two recognised camping grounds and all 9 caravan parks around the Lake provided access to the shoreline. The two outlets which discharge heated water from the power stations and adjacent areas within the thermal plumes were popular recreational fishing areas and were accessible to shore-based anglers. Most of Swansea channel was easily accessed by shore-based anglers. The channel has long areas of breakwall and some public jetties that were all frequently used as fishing platforms by anglers. The activities and catches of recreational anglers were regulated by bag and size limits.

1.1.2. Access for commercial fishers during the survey period

There were many restrictions imposed on commercial fishing activities in Lake Macquarie during the survey period. This meant that different sections of the Lake were subject to different levels of commercial fishing pressure. Commercial fishing was mainly done using gillnets (mesh nets) and seine nets (haul nets). There was a weekend closure to all commercial netting throughout the Lake and Swansea Channel. No commercial trapping, with the exception of small bait traps, was permitted within the Lake and Swansea Channel. The large northern area of the Lake (Fig. 1) was commercially fished by gill netting. Fish hauling was not permitted in the northern area of the Lake, although some sections within the Northern Lake were open to prawn hauling. The Swansea Channel area (Fig. 1) was closed to all fish hauling and gill netting. The large southern area of the Lake (Fig. 1) was commercially fished by means of hauling and gill netting and received most of the commercial fishing effort during the survey period.

1.2. Aims

The principal aims of this project were:
1. To estimate the level of daytime recreational fishing effort in Lake Macquarie during the annual period, March 1999 to February 2000 inclusive.
2. To estimate daytime recreational harvest rates in Lake Macquarie.
3. To estimate the daytime recreational harvest in Lake Macquarie.
4. To assess the relative direct impacts of the recreational and commercial user groups in Lake Macquarie by comparing the size of their harvests.
5. To examine claims of resource depletion in Lake Macquarie.

2. METHODS

2.1. General

We seek to communicate the findings of this work to a very diverse audience which includes recreational and commercial fishers, scientists, managers and interested members of the general public. The published texts describing the many different types of survey designs and methods, their relative strengths and limitations, and their statistical treatment, all contain a considerable quantity of technical terms. Unfortunately, it is not possible to eliminate the use of this technical language without compromising the scientific meaning of the report. We provide a glossary of the technical terms used in this report (see Appendix 2) to assist any layperson in his/her attempt to read and understand the findings of this work. Wherever possible, we also try to define terms in the text when they are used for the first time. The term "catch" is used to refer to the number or weight of fish caught (kept and released), whilst the term "harvest" refers to that part of the catch that is retained, usually measured as the number or weight of fish kept.

Accurate and precise information which describes and quantifies the fishing effort, harvests, and harvest rates of recreational fishers is needed to understand changes in recreational fisheries throughout time. Recreational fishing surveys that have multiple objectives usually involve complex survey designs and these types of surveys can be very costly (Pollock et al. 1994). The choice of survey design is constrained by practical considerations which are often site-specific, and by the limited finances available to the project. Thus, when decisions on sample sizes are made at the start of a survey, they are always influenced by the trade-off between desired levels of precision and the limited resources allocated to the survey. A statistically sound survey design based on the principles of stratified random sampling is essential to enable the cost-efficient collection of reliable survey data.

2.2. Survey design

We follow the terminology of Pollock et al. (1994) to describe the survey designs and estimation methods used to calculate harvest rates, estimates of total fishing effort and total harvest. We used on-site survey methods (surveys conducted at the fishing sites) because most of the information collected on-site can be verified by field staff. In contrast, off-site methods (surveys conducted away from fishing sites), such as telephone or diary surveys, depend largely on self-reported information which cannot be verified (Pollock et al. 1994). Another major advantage of on-site surveys is that the non-response or refusal rates recorded are usually much lower than the non-response rates recorded during off-site surveys (Pollock et al. 1994).

A complemented survey combines two or more contact methods for collecting effort and catch information from fishers (Pollock et al. 1994). Complemented survey methods were used to assess separately the shore-based recreational fishery and the boat-based recreational fishery. The shore-based fishery was assessed by using a roving(effort)-roving(harvest) design combination. The boat-based fishery was assessed by using a roving(effort)-access(harvest) design combination.

The sampling frame is a complete list of possible sampling units in the whole population and a clear and unambiguous definition of the sampling frame is needed to determine the scope of a survey (Cochran 1953, Yates 1965, Pollock et al. 1994). The sample frame can be divided into non-overlapping strata and a random sampling protocol is usually applied to select a sample from each stratum (Cochran 1953, Yates 1965, Pollock et al. 1994). This survey work is based on the principles of stratified random sampling. Pollock et al. (1994) summarised the advantages of stratification as:

(a) improving the overall precision of population estimates. An increase in precision (i.e. a reduction in variance) will occur when a relatively heterogeneous population is divided into non-overlapping strata of known size, that are relatively more homogeneous than the whole population;
(b) making the administration of the survey work easier because strata can be used to partition large frames that are difficult to sample into multiple, smaller units that can each be sampled more easily; and
(c) providing greater information yield. The creation of strata allows us to calculate population estimates for each separate stratum, thereby providing important information at a smaller scale, as well as providing overall estimates of population parameters for the entire population by combining the separate stratum totals and their associated variances.

2.3. Spatial sampling frame and stratification

The spatial sampling frame (geographical boundary) of this survey is illustrated in Figure 1. All excluded areas shown in Figure 1 are regarded as being outside the spatial sampling frame. Lake Macquarie (Fig. 1) was stratified into three distinct areas: (a) the Swansea Channel area; (b) the Northern Lake area; and (c) the Southern Lake area. These spatial strata were selected to reflect major differences in fish habitats, commercial fishing practices during the survey period and perceived differences in recreational fishing quality among the three areas.

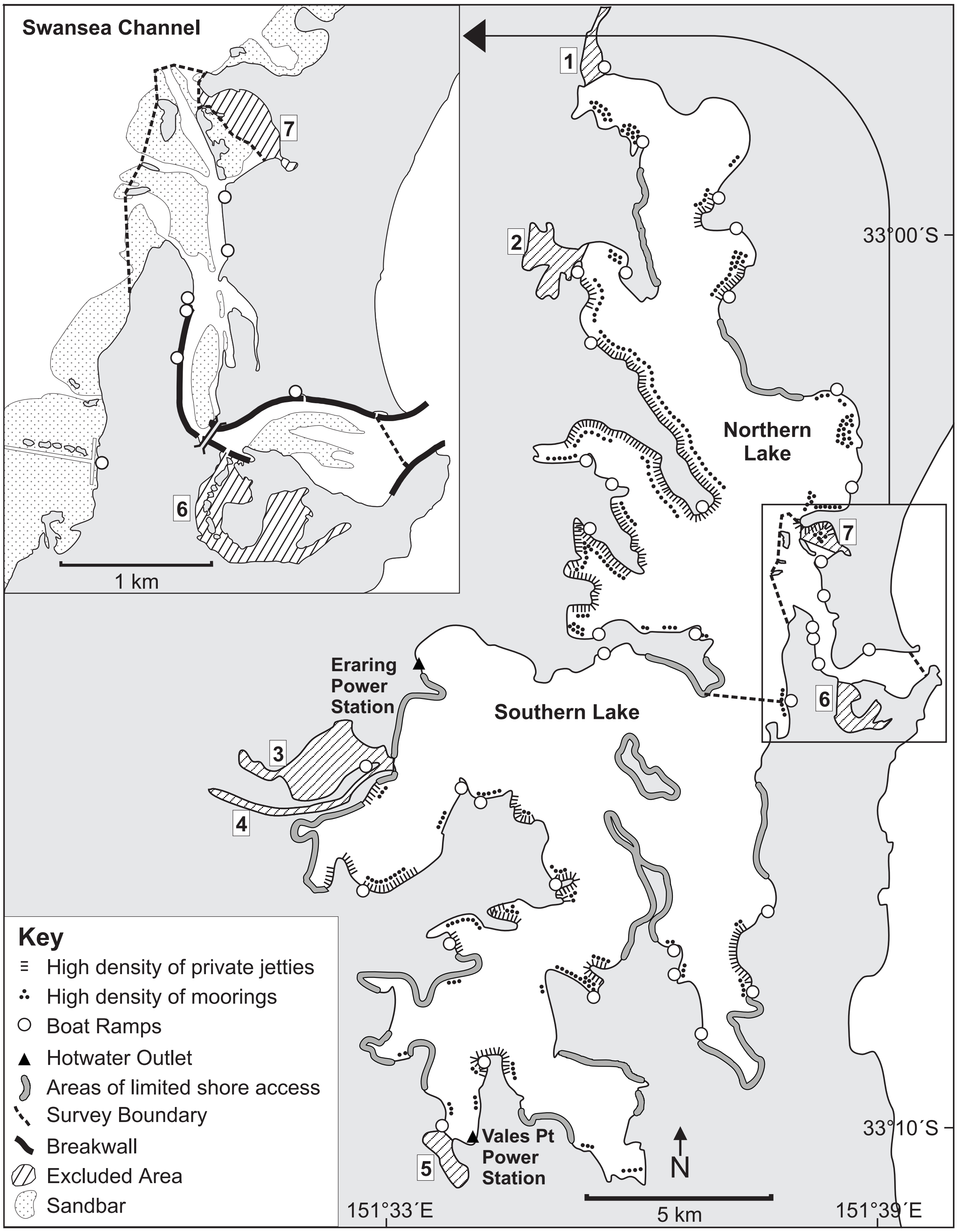


Figure 1. Map of Lake Macquarie showing the spatial extent of the survey and the boundaries used to divide the fishery into the Northern Lake, Southern Lake and Swansea Channel areas. The location of public boat ramps, high densities of private jetties and moorings, breakwalls, power station hotwater outlets, and areas of limited shore access have been marked. The areas excluded from the survey were: (1) Cockle Creek; (2) Fennell Bay; (3) Lake Eraring; (4) Dora Creek; (5) Mannering Bay; (6) Black Neds Bay; and (7) Swan Bay. For details of recognised boat ramps in Lake Macquarie see Appendix 1.

2.3.1. Swansea Channel area

The eastern extremity of the Swansea Channel area (Fig. 1) was defined as being a line drawn from Lucys Wall on the southern bank directly across to a large gap in the breakwall on the northern bank. The western extremity of Swansea Channel (Fig. 1) was defined as a line drawn between the two navigation markers at the western end of the Channel. Black Neds Bay and Swan Bay were excluded from the Swansea Channel sampling area.

2.3.2. Northern Lake area

The southern boundary of this area was a line extending from the southernmost tip of Wangi Wangi Point across to, and in line with, a long dredged navigation channel which ends on the opposite shore near “The Esplanade” boat ramp (see Fig. 1, Appendix 1). The two navigation markers at the western end of Swansea channel marked the boundary between the Northern Lake area and the Swansea Channel area. All waters west of the Fennel Bay Bridge and north of the Cockle Creek entrance were excluded from the Northern Lake area (Fig. 1).

2.3.3. Southern Lake area

The northern boundary of this area was a line extending from the southernmost tip of Wangi Wangi Point across to, and in line with, a long dredged navigation channel which ends on the opposite shore near “The Esplanade” boat ramp (see Fig. 1, Appendix 1). The shallow waters of Mannering Bay located at the southern extremity of Wyee Bay, and Lake Eraring situated near Dora Creek on the western side of Lake Macquarie were excluded from the Southern Lake area. Dora Creek was also excluded from the Southern Lake area (Fig. 1).

2.4. Temporal sampling frame and stratification

The temporal sampling frame of the survey spanned a one year period, commencing in March 1999 and concluding at the end of February 2000. Previous angler surveys in NSW waters had shown that fishing effort and harvest varied greatly among years, seasons and day-types (West and Gordon 1994, Steffe et al. 1996a & 1996b). Thus, we stratified the one year survey period into seasons (Autumn, Winter, Spring and Summer), and day-types within each season (Weekdays and Weekend days). Public holidays were classified as weekend days. Days were regarded as the primary sampling unit for all strata. By definition, a survey day started at sunrise and ended at sunset. We chose to restrict the coverage of the recreational fishing survey to the daylight hours because of the limited resources available to us and the logistic difficulties associated with counting and interviewing fishers at night. This definition of the survey day allows any variance associated with seasonal changes in daylength to be incorporated into the seasonal estimates of effort and harvest.

Basic sampling theory dictates that the accuracy and precision of overall population estimates can be improved by allocating more sampling units to a stratum that contains a large part of the recreational fishing effort and/or harvest (see Cochran 1953, Pollock et al. 1994). It has long been known that surveys will usually be most efficient (have least variance) when the distribution of sampling effort coincides with the distribution of fishing effort (Best and Boles 1956, Pollock et al. 1994). If effort and harvest are strongly correlated then it follows that by weighting sampling effort in proportion to the fishing effort there will also be an improvement in the precision of harvest estimates. We already knew from previous angler surveys that most of the recreational fishing effort occurs on weekend days (see West and Gordon 1994, Steffe et al. 1996a & 1996b) thus it was logical to allocate proportionally more sampling units to the weekend day-type stratum than to the weekday day-type stratum.

2.5. Collecting data for the boat-based and shore-based recreational fisheries

Two independent datasets were collected and used to estimate recreational fishing effort and harvest rates. These datasets consisted of: (1) progressive counts of recreational fishing effort; and (2) interviews with recreational fishing parties. These two datasets were used to obtain estimates of boat-based and shore-based recreational harvest.

2.5.1. Progressive counts of recreational fishing effort

Estimates of recreational fishing effort for the boat-based fishery and the shore-based fishery were made with progressive counts on randomly selected survey days. Progressive counts were made separately of all boats and all shore-based persons that were observed to be involved in some type of recreational fishing activity. These recreational fishing activities included all forms of angling and the setting, checking and retrieval of crab nets, but excluded activities such as spearfishing, bait collecting and prawning. We specifically excluded boats traveling across the Lake and anglers moving along the shore from the counts (even when recreational fishing gear was visible) when it was not possible to determine their destination nor their intent to engage in any recreational fishing activity. In contrast, we included boats in the counts when they were engaged in drift fishing and they were observed traveling to start another “drift” upstream. Drift fishing was common in the Swansea Channel.

We divided the survey area into two logistically convenient circuits for making progressive counts by boat: (a) the Northern Lake area and Swansea channel; and (b) the Southern Lake area (see Figure 1). We determined the time needed to complete progressive counts in each of the two circuits during a pilot study. This allowed us to schedule starting times for the progressive counts by picking one of a set of discrete possible starting times as recommended by Hoenig et al. (1993). The starting location and direction of travel were randomly selected for each scheduled progressive count within each circuit. This progressive count method will, under very general conditions, provide unbiased estimates of fishing effort during the day (Hoenig et al. 1993). The collection of recreational effort data by means of these progressive counts was, in a statistical sense, independent of the collection of recreational harvest data. The number of replicate progressive counts done for each area of the Lake, and for each day-type stratum within each season, is summarised in Table 1. The level of daily replication achieved represents annual sampling fractions of about 20% for the weekend day-type stratum and about 9% for the weekday stratum (Table 1).

Most of the progressive counts of recreational effort were contracted to two independent local groups: (a) the Australian Volunteer Coast Guard Association (Swansea base); and (b) B & L Fishing and Cruises Pty. Ltd., a company which specialised in charter fishing boat operations. These groups were selected for their boating experience and local knowledge of the Lake. Additional progressive counts were done in each season of the survey by NSW Fisheries staff.

Table 1. Sample sizes (number of days spent interviewing and the number of replicate progressive counts of effort for each lake area), number of interviews, number of refusals and refusal rates for the boat and shore recreational fisheries in Lake Macquarie during the annual survey period.

					BOAT FISHERY			SHORE FISHERY		
Season/Year	Day-Type	No. Days in Stratum	Effort Counts	Interview Days	Number of Interviews	Number of Refusals	Refusal Rate (%)	Number of Interviews	Number of Refusals	Refusal Rate (%)
Autumn 1999	Weekday	63	5	4	132	5	3.8	154	4	2.6
	Weekend	29	5	4	263	7	2.7	201	3	1.5
	Total	**92**	**10**	**8**	**395**	**12**	3.0	**355**	**7**	2.0
Winter 1999	Weekday	65	6	4	34	0	0	122	4	3.3
	Weekend	27	6	4	108	2	1.9	161	0	0
	Total	**92**	**12**	**8**	**142**	**2**	1.4	**283**	**4**	1.4
Spring 1999	Weekday	64	6	6	68	0	0	149	1	0.7
	Weekend	27	6	6	240	6	2.5	262	1	0.4
	Total	**91**	**12**	**12**	**308**	**6**	1.9	**411**	**2**	0.5
Summer 99/2000	Weekday	60	6	†7	179	2	1.1	205	2	1.0
	Weekend	31	6	6	253	5	2.0	208	4	1.9
	Total	**91**	**12**	**13**	**432**	**7**	1.6	**413**	**6**	1.5
Yearly Total	Weekday	252	23	21	413	7	1.7	630	11	1.7
	Weekend	114	23	20	864	20	2.3	832	8	1.0
	Total	**366**	**46**	**41**	**1,277**	**27**	2.1	**1,462**	**19**	1.3

† An extra day of interviewing was done in this stratum.

2.5.2. *Interviews with recreational fishing parties*

All interviews were done between 09:00 hours and sunset. We chose to restrict the interview coverage because data from a previous study had showed that less than 4% of recreational fishing trips were completed between sunrise and 09:00 hours making it cost-effective to start interviewing after 09:00 hours (Steffe et al. 1996a). It is important to note that most recreational fishing trips that begin in the period between sunrise and 09:00 hours are completed later in the day and would be covered by this sampling regime. Machine-readable interview forms were used to collect information from boat-based and shore-based fishing parties. Fishing parties were approached and asked to participate in the survey by providing information about their fishing trip and their harvest. Attempts were made to interview all recreational fishing parties encountered (shore-based and boat-based), however, during periods of high recreational activity it was necessary to subsample systematically every second or third fishing party (depending on the number of fishing parties available for interview). Refusals to provide information, or to show the fish retained, were recorded. We asked co-operative recreational fishers about their targeting preferences during their current fishing trip, the time they started fishing and their fishing locations in the Lake and Swansea channel. We also recorded the number of fishers in the fishing party (non-fishers were not included as part of a fishing party), the sexes of all fishing party members, and the home postcodes of all persons (fishers and non-fishers). The retained catch was identified by field staff and, whenever possible, measurements of all fish (fork length), crabs (carapace length) and squid (mantle length) were taken to the nearest whole centimetre. When fishers were in a hurry to leave the ramp and it was not possible to measure all fish, crabs and squid, the survey personnel were instructed to record counts of the identified harvest and attempt to measure a sub-sample of the harvest.

We used the local knowledge of the many field staff to determine the relative usage of boat ramps throughout the fishery and found that the Lake Macquarie area contained many ramps which were rarely used by recreational fishers. Some of these boat ramps were small and in poor repair, whilst some larger boat ramps were mainly used by ski-boat enthusiasts and by organised sailing clubs which caused most recreational fishers to avoid them. Sampling effort was concentrated at the main boat ramps used by recreational fishers throughout the fishery and visits to minor ramps were scheduled regularly. This approach was adopted to maximise the number of interviews with boat-based fishing parties. The use of a bus-route method in this fishery was considered but proved to be impractical (see Robson and Jones 1989 for a description of this method).

Boat-based fishing parties were approached at boat ramps when they returned from their fishing trip. The harvest rate information collected during these access point interviews is based on completed trips (Malvestuto 1983, Hayne 1991, Pollock et al. 1994, Pollock et al. 1997). The access point survey method works best when there are few, well-defined, access sites (Pollock et al. 1994) but there are many private jetties and moorings in Lake Macquarie that could be used as access points to the recreational fishery (Fig. 1). We collected some limited interview data from private-access points during the course of the survey. A graphical comparison of the two datasets (private-access against public-access interviews) did not show any major differences between them, however, there were insufficient numbers of private-access point interviews to allow a meaningful statistical comparison with interview data derived from public-access points. That is, the non-significant result obtained could also have been interpreted as a lack of statistical power (see Cohen 1988). Therefore, we had to assume that the fishing activities of recreational fishers using the public boat ramps were representative of recreational fishing parties that used other private access points to enter and leave the fishery. Although we could not afford to test this important assumption, we have no reason to expect that anglers using private access points in the Lake would have behaved differently to those fishers that used public boat ramps because these populations of fishers (regardless of where they access the fishery) use the same methods to target the same species in the same fishing areas within the Lake. Appendix 1 provides information describing the location of all recognised public boat ramps in Lake Macquarie and the Swansea channel. The seasonal coverage of these boat ramps during the survey is given in Appendix 3.

The diffuse access to the fishery in Lake Macquarie and Swansea channel across large stretches of shoreline compelled us to use roving survey methods to assess the shore-based fishery. The shore-based fishery was divided into sub-areas of manageable size which were searched entirely at least once during each survey day by an interviewer, thus providing coverage of the entire shore-based fishery on each survey day. Some sub-areas of the shore-based fishery received consistently high levels of fishing effort and accordingly sampling effort was concentrated in these areas to maximise the number of interviews. Shore-based fishing parties were approached during their fishing trips by field staff. Therefore, the harvest rate information collected during these interviews was based on incomplete trips which documented only part of the total effort and harvest for these fishing trips (Robson 1961 & 1991, Pollock et al. 1994). The use of a roving survey design introduced a sampling bias because the probability of interviewing a group is proportional to the duration of their fishing trip. That is, parties that fish for longer time periods are more likely to be encountered by field staff moving through the fishery, termed the "length-of-stay" bias (Robson 1991, Pollock et al. 1994, Pollock et al. 1997, Hoenig et al. 1997), which means that harvest rates derived from roving survey methods tend to be based on samples that contain an over-representative number of longer trips and an under-representative number of short trips. Roving survey methods require the following assumptions be made: (a) the harvest rate for the portion of fishing trip documented is the same as the harvest rate for the entire trip; and (b) the harvest rate of interviewed fishing parties is representative of the whole fishing population, which is the expected outcome for estimates derived from randomly selected samples (Malvestuto 1983, Phippen and Bergersen 1991, Pollock et al. 1994, Hoenig et al. 1997). Appendix 3 provides information describing the seasonal coverage of the shore-based fishery during the survey period.

Most interviews were done by the members of two local groups: (a) the Lake Macquarie Concerned Anglers Group (CAG), a large lobby group for the recreational sector (1166 interviews - about 42.6% of the total interviews); and (b) B & L Fishing and Cruises Pty. Ltd., a company which specialised in charter fishing operations (1566 interviews – about 57.2% of the total interviews). The Lake Macquarie Concerned Anglers Group provided many volunteers to assist in interviewing recreational fishing parties. The involvement of CAG was particularly valuable because their members were able to do many interviews around the Lake, thereby improving the spatial coverage of the survey. A group of people independent of the Concerned Anglers Group and affiliated to the charter boat company were contracted to do interviews in all survey areas. This independent group of interview staff was employed specifically to be a control group for validating the interviews generated by CAG members. We examined the interviews done by the members of the two groups and found the datasets to be very similar in terms of: (a) species composition of harvest; (b) numbers of individuals harvested; and (c) reported sizes of fish, squid and crabs. This validation was necessary to establish the credibility of the survey data and to refute concerns that the survey results may have been biased in some way by the involvement of CAG members. Staff from NSW Fisheries also collected some interview data (7 interviews – less than 0.3% of total interviews).

2.6. Estimation methods

We follow the general equations used by Pollock et al. (1994) for estimating total recreational fishing effort, recreational harvest rates, and total recreational harvest for the boat-based and shore-based fisheries and refer the reader to this book for worked examples. More detailed explanations of the statistical procedures used can be found in Cochran (1953), Robson (1960, 1961 & 1991), Yates (1965), Malvestuto (1983), Hayne (1991), Hoenig et al. (1993 & 1997) and Pollock et al. (1997).

2.6.1. Basic notation

j denotes the stratum being considered $(j = 1,...,J)$;

J denotes the total number of strata;

i denotes the sample day unit within the stratum $(i = 1,....,N_j)$;

N_j is the total population size (all possible sampling days) in stratum j;

n_j is the sample size in stratum j;

x_{ij} denotes the value of the i th unit of stratum j;

$\bar{x}_j$ is the sample mean for stratum j;

$s_j^2 = \dfrac{\left[\sum_{i=1}^{n_j}(x_{ij} - \bar{x}_j)^2\right]}{(n_j - 1)}$ is the sample variance for stratum j

2.6.2. Effort estimation for the boat-based and shore-based recreational fisheries

Estimation of total effort was done separately for the boat-based fishery (units of boat hours) and the shore-based fishery (units of fisher hours). The base level of effort estimation was a day-type stratum within a season for each of the three areas in the Lake (Northern Lake, Southern Lake, and Swansea Channel). Effort estimates for the weekday and weekend day strata were combined to give seasonal totals. Annual totals were obtained by adding the seasonal totals. Finally, the effort totals for each Lake area were combined to give seasonal and annual totals for the whole Lake. A description of the equations used for estimating stratum totals, variances and standard errors are provided below.

Step 1 - The progressive counts of recreational fishing boats and shore-based fishers were expanded separately to estimate the daily effort for each fishing day that was sampled.

$\hat{e}_i = P_i \times T$ (Equation 1)

where:
$\hat{e}_i$ is the estimate of fishing effort for the i th sample day.
P_i is the progressive count for the i th sample day. The number of boats counted is used for the boat-based fishery. The number of shore fishers counted is used for the shore-based fishery.
T is the length of the fishing day. We used the mean daylength period (units are hours) for each season.

Step 2 - These daily effort estimates were then expanded for each day-type stratum within each season. This was done by multiplying the number of possible sample days in each base level stratum with the the mean of the daily estimates of effort.

$\bar{e}_j = \dfrac{\sum \hat{e}_{ij}}{n_j}$ (Equation 2)

where:
$\overline{e}_j$ is the estimated mean daily fishing effort for the j th day-type stratum within a season, in units of boats per day for the boat fishery and fishers per day for the shore fishery.
$\hat{e}_{ij}$ is the estimate of fishing effort for the i th sample day in the j th day-type stratum within a season.
n_j is the number of days sampled in the j th day-type stratum within a season.

$$\hat{E}_j = N_j \times \overline{e}_j \quad \text{(Equation 3)}$$

where:
$\hat{E}_j$ is the estimate of total effort for the j th day-type stratum within a season. In the boat fishery the units are boat hours and for the shore fishery the units are fisher hours.
See Equations 1 and 2 for definitions of the other terms.

Step 3 - Calculate the precision of the effort estimates. This is done for each fishery by estimating variances and standard errors for each stratum.

$$Var(\overline{e}_j) = \frac{s_j^2}{n_j} \quad \text{(Equation 4)}$$

where:
$Var(\overline{e}_j)$ is the estimated variance of the mean daily fishing effort for the j th day-type stratum within a season. This is calculated separately for each fishery.
s_j^2 is the sample variance of the daily estimates of fishing effort for the j th day-type stratum within a season.
n_j is the sample size as described in Equation 2.

$$SE(\overline{e}_j) = \sqrt{Var(\overline{e}_j)} \quad \text{(Equation 5)}$$

where:
$SE(\overline{e}_j)$ is the estimated standard error of the mean daily fishing effort.
$Var(\overline{e}_j)$ is the estimated variance of the mean daily fishing effort as described in Equation 4.

$$Var(\hat{E}_j) = N_j^2 \times Var(\overline{e}_j) \quad \text{(Equation 6)}$$

where:
$Var(\hat{E}_j)$ is the estimated variance of total effort for a stratum, and is calculated separately for each day-type within each season for each fishery.
See Equations 1 and 4 for definitions of the other terms.

$$SE(\hat{E}_j) = \sqrt{Var(\hat{E}_j)} \quad \text{(Equation 7)}$$

where:

$SE\left(\hat{E}_j\right)$ is the estimated standard error of total effort for a stratum.
$Var\left(\hat{E}_j\right)$ is the estimated variance of total effort for a stratum as described in Equation 5.

Step 4 - Calculate total fishing effort separately for the boat-based and shore-based fisheries. This was done by adding the effort estimates of the strata together to obtain seasonal totals, then by adding seasonal totals to obtain annual totals.

$$\hat{E}_{Tot} = \sum_{j=1}^{J} \hat{E}_j \quad \text{(Equation 8)}$$

where:
$\hat{E}_{Tot}$ is the total effort calculated by combining the effort estimates for each stratum. Thus, the term $\hat{E}_{Tot}$ refers to seasonal effort totals when adding day-type strata, and to the annual effort total when seasonal totals are combined.
$\hat{E}_j$ is the estimate of total effort for the j th stratum as defined in Equation 3.

Step 5 - Calculate the precision of effort estimates obtained by adding stratum totals. This is done by simply adding the estimated variances for each stratum and calculating a standard error for the estimates of seasonal and annual effort totals.

$$Var\left(\hat{E}_{Tot}\right) = \sum_{j=1}^{J} Var\left(\hat{E}_j\right) \quad \text{(Equation 9)}$$

where:
$Var\left(\hat{E}_{Tot}\right)$ is the estimated total variance calculated by combining the estimated effort variances for each stratum. Thus, the term $Var\left(\hat{E}_{Tot}\right)$ refers to seasonal variance totals when adding variances from day-type strata, and to the annual variance total when seasonal variances are combined, as the calculations are based on the general form of the same equation.

$$SE\left(\hat{E}_{Tot}\right) = \sqrt{Var\left(\hat{E}_{Tot}\right)} \quad \text{(Equation 10)}$$

where:
$SE\left(\hat{E}_{Tot}\right)$ is the estimated standard error for seasonal effort totals when adding day-type strata, and is the estimated standard error for the annual effort when seasonal totals are combined.
$Var\left(\hat{E}_{Tot}\right)$ is the estimated total variance as described in Equation 9.

Step 6 - Calculate total fishing effort (boat-based plus shore-based) for Lake Macquarie and Swansea Channel. The initial step in these calculations was to convert the effort estimates for the boat-based fishery into units of fisher hours. As before, the base level of effort estimation was for a day-type stratum within a season for each of the three Lake areas (Northern Lake, Southern Lake, and Swansea Channel).

Please note: to simplify the notation in the following equations we have stopped adding the suffix j (which denotes the j th stratum) to all terms in the general equations even though these terms still refer implicitly to the j th stratum.

$\hat{E}_{new} = \hat{E}_{old} \times \bar{f}$ (Equation 11)

where:
$\hat{E}_{new}$ is the new estimate of effort for the boat-based fishery in units of fisher hours.
$\hat{E}_{old}$ is the old estimate of effort for the boat-based fishery in units of boat hours.
$\bar{f}$ is the mean number of fishers per boat in that stratum.

Step 7 - Calculate the variance and standard error of the new estimate of effort for the boat-based fishery.

$Var(\hat{E}_{new}) = \left[\hat{E}_{old}^2 \times Var(\bar{f})\right] + \left[\bar{f}^2 \times Var(\hat{E}_{old})\right] - \left[Var(\bar{f}) \times Var(\hat{E}_{old})\right]$ (Equation 12)

where:
$Var(\hat{E}_{new})$ is the estimated variance of the new estimate of effort for the boat-based fishery.
$Var(\bar{f})$ has been calculated by using the general form of Equation 4.
$Var(\hat{E}_{old})$ has been calculated by using the general form of Equation 6.
The terms $\hat{E}_{old}$ and $\bar{f}$ are described in Equation 11.

$SE(\hat{E}_{new}) = \sqrt{Var(\hat{E}_{new})}$ (Equation 13)

where:
$SE(\hat{E}_{new})$ is the estimated standard error of the new estimate of effort for the boat-based fishery.
$Var(\hat{E}_{new})$ is described in Equation 12.

Step 8 - When estimates of effort totals for the boat-based fishery had been converted into the same units as those in the shore-based fishery, it was possible to combine stratum totals for the boat and shore fisheries to give estimates of seasonal and annual effort totals. Seasonal and annual effort estimates for the three spatial strata (north Lake, south Lake and Swansea Channel) were then combined to give effort estimates for the whole Lake. This procedure of adding stratum estimates has already been described and calculations are done using the general form of Equation 8.

Step 9 - Calculate seasonal and annual estimates of variance and standard errors for the total fishery. This procedure has already been described and calculations are done using the general form of Equations 9 and 10.

2.6.3. Harvest rate estimator for the boat-based fishery

When the objective is to estimate total harvest, and the interview data are based on completed trips, the correct harvest rate estimator to use is the "ratio of means" (Jones et al. 1995, Pollock et al. 1997). This estimator is essentially the ratio of mean harvest to mean effort on a given day. The "ratio of means" was used for estimating the harvest of the boat-based fishery. Pollock et al. (1997) have shown that this estimator has a statistical expectation that is equal to total harvest divided by total effort for the population of fishers when it is applied to completed trip interviews taken at access points to the fishery.

$$\hat{R}_1 = \frac{\sum_{k=1}^{n} H_k}{\sum_{k=1}^{n} L_k} \quad \text{(Equation 14)}$$

where:

$\hat{R}_1$ is the "ratio of means" an estimated daily harvest rate based on complete trips. The units used to estimate recreational harvest for the boat-based fishery were the number of fish per boat hour (see Appendices 4.1 to 4.18), and the weight of fish per boat hour (which are not presented). We also converted harvest rates for the boat-based fishery to numbers of fish per fisher hour so that comparisons could be made with the shore-based fishery.

H_k is the complete harvest for the k th fishing unit. These fishing units can be boats, fishing parties, or fishers.

L_k is the complete trip length for the k th fishing unit.

n is the number of fishing units in the daily sample.

We calculated mean daily harvest rates $\overline{R}_1$ for each day-type stratum within a season and this was done separately for each of the three areas in the Lake (Northern Lake, Southern Lake, and Swansea Channel). The estimated variances of the mean daily harvest rates $Var(\overline{R}_1)$ were calculated by using the general form of Equation 4, and the estimated standard errors of the mean daily harvest rates $SE(\overline{R}_1)$ were calculated using the general form of Equation 5.

2.6.4. Harvest rate estimator for the shore-based fishery

When the objective is to estimate total harvest, and the interviews are based on incomplete trips, the correct harvest rate estimator to use is the "mean of ratios" (Jones et al. 1995, Pollock et al. 1997, Hoenig et al. 1997). This estimator is essentially the mean of the individual harvest rates for all fishers interviewed on a given day. The "mean of ratios" was used for estimating the harvest of the shore-based fishery. Hoenig et al (1997) used simulation procedures to show that the "mean of ratios" estimator has a large variance caused by the inclusion of high harvest rates resulting from very short, incomplete trips that have harvested some fish already. These authors found that the truncation (exclusion) of all short incomplete trips reduced the variance greatly without inducing an appreciable bias. Hoenig et al. (1997) recommended the truncation of short trips less than 20-30 minutes but noted that there was a trade-off between the level of truncation used and the number of interviews that were discarded. We examined the relationship between the harvest rate and the duration of the fishing trip for shore-based interviews to determine the most appropriate level of truncation. We found that by discarding all incomplete trips that had been in progress for less than 30 fisher minutes, we were able to remove the four interviews with the most extreme harvest rates and hence minimise the variance of the harvest rate estimator. The adoption of this truncation criterion resulted in the loss of 104 shore-based interviews (about 7.2% of the useable shore-based interviews) from harvest calculations. We had routinely asked shore-based fishing parties about the intended finishing time for their current trip. We retained and used four other shore-based interviews with fishing parties that had completed their trips but had fished for less than 30 fisher minutes. We believe it is logical to keep and use the data from these complete short trips, regardless of the small amount of time fished or the amount of harvest taken, because it is these short trips that are under-represented in roving surveys due to "length-of-stay" bias.

Hoenig et al. (1997) showed that the mean of ratios estimator has an approximate statistical expectation of total harvest divided by total effort for the population of fishing units when it is applied to incomplete trip interviews with a truncation of short trips, taken by roving through the fishery. Thus, the mean of ratios estimator $(\hat{R}_2)$ used on incomplete trips with a truncation of short trips, provides an equivalent measure of fishing success to the ratio of means estimator $(\hat{R}_1)$ used on complete trips (Pollock et al. 1997, Hoenig et al. 1997).

$$\hat{R}_2 = \frac{1}{n}\sum_{k=1}^{n}\frac{H_k}{L_k} \quad \text{(Equation 15)}$$

where:
$\hat{R}_2$ is the "mean of ratios" an estimated daily harvest rate with truncation of short incomplete trips. The units used to estimate recreational harvest for the shore-based fishery were the number of fish per fisher hour, and the weight of fish per fisher hour.
H_k is the incomplete harvest (the harvest recorded at the time of interview for the incomplete trip) for the k th fishing unit. These fishing units can be boats, fishing parties, or fishers.
L_k is the incomplete trip length (the length of the incomplete trip at the time of interview) for the k th fishing unit.
n is the number of fishing units in the daily sample.

We calculated mean daily harvest rates $\overline{R}_2$ for each day-type stratum within a season and this was done separately for each of the three areas in the Lake (Northern Lake, Southern Lake, and Swansea Channel). The estimated variances of the mean daily harvest rates $Var(\overline{R}_2)$ were calculated by using the general form of Equation 4, and the estimated standard errors of the mean daily harvest rates $SE(\overline{R}_2)$ were calculated using the general form of Equation 5.

2.6.5. Seasonal harvest rate estimation for boat and shore fisheries

The calculation of seasonal harvest rate estimates for each of the three Lake areas (Northern Lake, Southern Lake, and Swansea Channel) was done by combining the mean daily harvest rates obtained for each day-type stratum within a season. The contribution of each day-type stratum to the estimated seasonal harvest rate was weighted by the relative size of each day-type stratum within the season (Pollock et al. 1994). This means that a greater weighting was given to the weekday stratum because there are more weekdays in a season than there are weekend days in a season.

$$\overline{R}_{Season} = \left(\frac{N_{wd}}{N_{Season}} \times \overline{r}_{wd}\right) + \left(\frac{N_{we}}{N_{Season}} \times \overline{r}_{we}\right) \quad \text{(Equation 16)}$$

where:
$\overline{R}_{Season}$ is a stratified mean daily harvest rate for a season. The $\hat{R}_1$ estimator described in Equation 14 should be used for the boat-based fishery, and the $\hat{R}_2$ estimator described in Equation 15 should be used for the shore-based fishery. The units are the number of fish per fisher hour for the boat and shore fisheries.
N_{wd} is the number of weekdays in the season.
N_{we} is the number of weekend days (includes public holidays) in the season.
N_{Season} is the total number of days in the season (weekdays N_{wd} plus weekend days N_{we}).

$\bar{r}_{wd}$ is the mean daily harvest rate for the weekday stratum. The $\hat{R}_1$ estimator described in Equation 14 should be used for the boat-based fishery, and the $\hat{R}_2$ estimator described in Equation 15 should be used for the shore-based fishery. The units are the number of fish per fisher hour for the boat and shore fisheries.
$\bar{r}_{we}$ is the mean daily harvest rate for the weekend day stratum. The $\hat{R}_1$ estimator described in Equation 14 should be used for the boat-based fishery, and the $\hat{R}_2$ estimator described in Equation 15 should be used for the shore-based fishery. The units are the number of fish per fisher hour for the boat and shore fisheries.

The estimates of variance for the stratified mean daily harvest rates for each season were calculated using the following equation:

$$Var\left(\overline{R}_{Season}\right) = \left[\left(\frac{N_{wd}}{N_{Season}}\right)^2 \times Var\left(\bar{r}_{wd}\right)\right] + \left[\left(\frac{N_{we}}{N_{Season}}\right)^2 \times Var\left(\bar{r}_{we}\right)\right] \text{ (Equation 17)}$$

where:
$Var\left(\overline{R}_{Season}\right)$ is the estimated variance for the stratified mean daily harvest rate for a season.
$Var\left(\bar{r}_{wd}\right)$ is the estimated variance for the mean daily harvest rates for the weekday stratum in a season. This variance of a mean can be calculated by using the general form of Equation 4.
$Var\left(\bar{r}_{we}\right)$ is the estimated variance for the mean daily harvest rates for the weekend day stratum in a season. This variance of a mean can be calculated by using the general form of Equation 4.
The other terms used have been described in Equation 16.

The estimates of standard errors for the stratified mean daily harvest rates for each season were calculated using the following equation:

$$SE\left(\overline{R}_{Season}\right) = \sqrt{Var\left(\overline{R}_{Season}\right)} \text{ (Equation 18)}$$

where:
$SE\left(\overline{R}_{Season}\right)$ is the standard error of the stratified mean daily harvest rate for a season.
$Var\left(\overline{R}_{Season}\right)$ is the variance of the stratified mean daily harvest rate for a season. This term has been described in Equation 17.

The seasonal trends and spatial patterns that were found when comparing Lake areas are vital in understanding the recreational fisheries of Lake Macquarie. Accordingly, the amalgamation of these harvest rate data into larger groupings (e.g. annual or total Lake harvest rates) were not done for any taxon because they mask the trends seen at smaller spatial and temporal scales and do not enhance the assessment of the recreational fisheries.

2.6.6. Harvest estimation for the boat-based and shore-based fisheries

The complemented survey designs used to assess the recreational fisheries in Lake Macquarie used different on-site, contact methods to estimate effort and harvest. Harvest estimation in the boat-based fishery used interviews of completed trips, whereas the shore-based fishery used interviews of incomplete trips. Total harvest was estimated for both these fisheries by multiplying an independent estimate of effort with an appropriate estimate of harvest rate (Pollock et al. 1994, Jones et al. 1995, Pollock et al. 1997, Hoenig et al. 1997).

$\hat{H}_{Boat} = \hat{E}_{Boat} \times \overline{R}_1$ (Equation 19)

where:

$\hat{H}_{Boat}$ is an estimate of harvest for the boat-based fishery. The base level of estimation was for each day-type stratum within a season and this was done separately for each of the three areas in the Lake (Northern Lake, Southern Lake, and Swansea Channel). Harvest units are either numbers of fish, or the weight of fish.

$\hat{E}_{Boat}$ is an estimate of effort for the boat-based fishery. Units are in boat hours.

$\overline{R}_1$ is an estimate of mean daily harvest rate as described in Equation 14. The units are either numbers of fish per boat hour, or the weight of fish per boat hour.

$\hat{H}_{Shore} = \hat{E}_{Shore} \times \overline{R}_2$ (Equation 20)

where:

$\hat{H}_{Shore}$ is an estimate of harvest for the shore-based fishery. The base level of estimation was for each day-type stratum within a season and this was done separately for each of the three areas in the Lake (Northern Lake, Southern Lake, and Swansea Channel). Harvest units are either numbers of fish, or the weight of fish.

$\hat{E}_{Shore}$ is an estimate of effort for the shore-based fishery. Units are in fisher hours.

$\overline{R}_2$ is an estimate of mean daily harvest rate as described in Equation 15. The units are either numbers of fish per fisher hour, or the weight of fish per fisher hour.

We did not attempt to make expanded estimates of harvest for any taxa that were considered to have been “rare” throughout the survey year - defined as any taxon that had been recorded from three or less interviews during a survey year, regardless of the number of individuals harvested in those trips. This definition of rarity was applied separately to the boat-based and shore-based fisheries. All taxa which did not meet the criterion for rarity were classified as common taxa and expanded estimates of harvest were made for these taxa.

Survey personnel had, where possible, measured all identified fish, crabs and squid that were seen during interviews with fishing parties. It was not always possible to obtain measurements, usually because fishers were in a hurry to leave the ramp. Thus, during many interviews, survey personnel were only able to collect measurements for a sub-sample of the entire harvest, or were only able to record counts of identified fish, crabs and squid.

We did not measure the weight of fish during interviews but converted the length measurements into weights using length to weight keys. This was done for all taxa for which we had suitable length to weight conversion keys (Appendix 5). The remaining unmeasured component of the harvest (i.e. those fish seen during interviews but only counted) were assigned the median weight for that taxon as calculated for the appropriate base level of estimation, for each day-type stratum within a season. We used a median weight rather than a mean weight (as is traditionally done in angler surveys) because many of the estimated weight frequency distributions were highly skewed, making the median a better estimate of the centre of the population (Sokal and Rohlf 1969). In many cases, the use of a mean would have resulted in higher estimates of harvest rate and hence higher estimates of harvest. Where possible we calculated medians separately for the boat-based and shore-based fisheries and within these fisheries for each of the three areas in the Lake. When no measurements had been made for a taxon in an area of the Lake for a particular fishery (e.g. the boat fishery), we used the available measurements from the same area of the Lake that had been collected for the other fishery (e.g. the shore fishery). In some cases, measurements were not available for some taxa in an area of the Lake for either fishery (boat or shore) even though these taxa had been recorded repeatedly in the recreational harvest. For these taxa, we pooled available measurements from the same Lake area across the entire survey year.

The estimates of variance for harvest in the boat-based fishery and the shore-based fishery were calculated using the following general equation. The base level of estimation was for a day-type stratum within a season for each of the three areas in the Lake (Northern Lake, Southern Lake, and Swansea Channel).

$$Var(\hat{H}) = \left[\hat{E}^2 \times Var(\overline{R})\right] + \left[\overline{R}^2 \times Var(\hat{E})\right] - \left[Var(\overline{R}) \times Var(\hat{E})\right] \text{ (Equation 21)}$$

where:
$Var(\hat{H})$ is the estimated variance of the boat-based fishery when using equivalent terms from Equation 19, and the estimated variance of the shore-based fishery when using equivalent terms from Equation 20.
$\overline{R}$ is an estimate of the mean daily harvest rate for a stratum. The $\hat{R}_1$ estimator described in Equation 14 was used for the boat-based fishery and the $\hat{R}_2$ estimator described in Equation 15 was used for the shore-based fishery.
$Var(\overline{R})$ is the estimated variance of the mean daily harvest rate for a stratum. This variance is calculated using the general form of Equation 4. The $\hat{R}_1$ estimator described in Equation 14 was used for the boat-based fishery, and the $\hat{R}_2$ estimator described in Equation 15 was used for the shore-based fishery.
$\hat{E}$ is the total effort for a stratum, and is described in Equation 3.
$Var(\hat{E})$ is the estimated variance of the total effort for a stratum, and is described in Equation 6.

$$SE(\hat{H}) = \sqrt{Var(\hat{H})} \text{ (Equation 22)}$$

where:
$SE(\hat{H})$ is the estimated standard error of the harvest of the boat-based fishery when using equivalent terms from Equation 19, and the estimated standard error of the harvest of the shore-based fishery when using equivalent terms from Equation 20.
$Var(\hat{H})$ is the estimated variance of the harvest, as described in Equation 21.

Harvest estimates for the weekday and weekend day strata were combined to give seasonal totals. Annual totals were obtained by adding the seasonal totals. Finally, the harvest totals for each Lake area were combined to give seasonal and annual totals for the whole Lake. A description of the equations used for estimating stratum totals, variances and standard errors is provided for effort estimation. The general form of the equations used in the estimation of effort and the associated variances and standard errors has been used for harvest estimation.

2.7. Harvest comparisons between the recreational and commercial fisheries

Recreational harvest estimates were obtained by the methods described in the previous section. The recreational harvest statistics (estimated weights) were available only for common taxa for which we had suitable length to weight conversion keys (Appendix 5). In contrast, commercial fishers are required by legislation to provide accurate catch statistics on a monthly basis to NSW Fisheries. We used the declared commercial statistics for estuarine catches taken from Lake

Macquarie to make comparisons with the recreational fishery. These comparisons were made by using the monthly commercial returns to construct tables of commercial harvest for the same annual period during which the recreational fishery was surveyed. We present these comparisons of the two sectors at the spatial scale of the whole Lake using harvest ratios which simply describe the relative sizes of the harvests. Harvest ratios were calculated for all common recreational taxa for which we had made expanded estimates of harvest, and for all taxa (except prawns, pipis and cockles which were outside the scope of the study) that were taken commercially in quantities greater than 100 kilograms. The harvest ratios were calculated simply as:

$$\hat{R}_3 = \frac{\hat{H}_{REC}}{H_{COM}} \quad \text{(Equation 23)}$$

where:

$\hat{R}_3$ is the harvest ratio for a given taxon.

$\hat{H}_{REC}$ is the estimate of total daytime recreational harvest for a given taxon (boat plus shore fisheries).

H_{COM} is the total declared commercial harvest for a given taxon (all methods combined).

When this harvest ratio is greater than one, it indicates that the estimated recreational harvest is greater than the declared commercial landings taken from Lake Macquarie. Conversely, when this ratio is less than one, it indicates that the declared commercial landings exceeded the size of the estimated recreational harvest from Lake Macquarie. When the ratio is equal to one the estimated recreational harvest is of equal size to the declared commercial landings.

2.8. Quality assurance

A survey can be useless if the data collected are of poor quality (Yates 1965, Pollock et al. 1994). We incorporated important quality assessment and control procedures into all phases of the survey so that the highest possible level of data quality and integrity could be attained. A brief description of these procedures are provided below.

2.8.1. Survey preparation phase

2.8.1.1. Design and pre-testing of survey forms

We had previously used similar data collection forms and interview procedures in other recreational fishing surveys. A feature of the previous surveys was the extensive field testing of survey forms that was done to ensure clearly worded, unambiguous questions and the development of a simple survey protocol. The forms used in this current survey were based on the previously used form designs. The old data collection forms were simplified to meet the needs of the current survey. We pre-tested the new data collection forms to confirm the logic of the questions and their functionality by conducting a series of mock interviews with persons having no involvement in this project. This pre-testing step was useful for further improving the form designs and was completed prior to the start of staff training.

2.8.1.2. Training of survey personnel

There were more than 60 people involved in data collection during this survey. NSW Fisheries staff provided comprehensive training to all persons involved in the survey, which included detailed documentation of survey protocols and procedures, fish identification and an on-site component to familiarise them with the survey work. All persons were provided with explanations of the aims of the survey and the importance of the information that was being collected.

All members of the groups that participated in the counts of fishing effort were provided with clear instructions describing the use of the survey forms for recording data; unambiguous definitions that described the data to be collected, work rosters which specified starting times, starting location and direction of travel; and hand-held tally counters to record any observed recreational fishing activity during their circuit of the fishery. Overall, there were 27 persons (including 23 members of the Swansea base of the Australian Volunteer Coast Guard Association) involved in the collection of recreational fishing effort data during the survey period.

All persons involved in interviewing recreational fishing parties were provided with clear instructions on standard interview procedures, protocols for recording data on the interview forms, and on the use of the fish identification kit. Additional training based on hypothetical examples likely to be encountered during the course of the survey was also provided to all interviewers. The importance of using a systematic sampling procedure to subsample recreational fishing parties during busy periods was stressed to all interviewers and strict instructions were given to them to not preferentially interview fishers known to them or parties that were known to be cooperative. Overall, there were 26 members of the Concerned Anglers Group, 13 members of the independent group (B & L Fishing and Cruises Pty. Ltd.) and two staff from NSW Fisheries involved in the interviewing of recreational fishers.

2.8.1.3. Field identification kit for fish, squid and crabs

We developed a detailed field identification kit for fish and invertebrates that were likely to be caught by recreational fishers during the survey. This kit was used to standardise the level of taxonomic precision among interviewers working at different sites in Lake Macquarie and Swansea Channel. In this way, we were certain that any differences among Lake areas that we detected were real and not just a reflection of the different skill levels in fish identification between individuals working at different sites. The use of the identification kit also facilitated the conduct of interviews and as such was an important part of the interview procedure.

2.8.1.4. Information leaflets

Prior to the survey, we distributed leaflets which announced the imminent start of the survey and stated the objectives of the study. These leaflets generated much local interest and the survey was the subject of several articles in local newspapers. The distribution of these information leaflets was a critical step for ensuring survey data integrity because it began the process of building a good working relationship between the survey personnel and the general recreational fishing community.

2.8.2. Survey operation phase

2.8.2.1. Supervision of survey personnel

Random checks of survey personnel were done during the survey period to provide a cost-effective way of ensuring data quality. We also maintained regular contact with nominated group leaders by telephone, and by organising regular meetings to keep the various groups informed of preliminary findings and the progress of the survey. In this way we were able to provide a regular flow of information to all volunteers and contracted personnel.

2.8.2.2. *Preliminary scrutiny of data collection forms*

Preliminary checks of progressive count data sheets and interview forms were made as they were received and we identified any missing or unusual data, such as, large numbers of fishing boats in particular areas of the Lake, very large harvests, fish having very small or very large sizes, and the occurrence of uncommon species. The individuals that had collected the unusual data were then contacted and asked to confirm or explain them. This scrutiny helped to maintain high levels of data integrity by identifying and correcting data problems at the earliest possible time.

2.8.2.3. *Maintaining the co-operation of the recreational fishing public*

We maintained the interest of recreational fishers by providing them with quarterly updates which described the seasonal catch composition and the relative numbers of each species recorded during survey days. The survey updates were given to recreational fishers when interviewed. This simple measure generated a great deal of rapport between the recreational fishers and the survey personnel and served greatly to maximise the co-operation of anglers and minimise the effects of survey fatigue on avid fishers that were interviewed frequently.

2.8.3. Data entry, checking and manipulation phase

2.8.3.1. *Data entry and data checking procedures*

Machine-readable data forms were designed and used during this project. After the initial vetting of the data forms, the sheets were scanned and the digital images of the forms were examined using Intelligent/Optical Character Recognition (ICR/OCR) software (Teleform Elite Version V - Cardiff software). A trained operator checked and either verified or corrected all data that were queried by the ICR/OCR data entry process. Random checks of data subsets were then done to validate the effectiveness of the data entry system. Prior to any analyses, the data were subjected to a wide range of data outlier checks to identify any unusual data and detect any reading or logic errors which had been missed during the preliminary checks.

2.8.3.2. *Data manipulation procedures*

We verified the correctness of the computations used to derive the estimates of harvest rates, weights of fish, effort, harvest, and their associated measures of precision by undertaking random checks on some subsets of the data.

3. RESULTS

3.1. Recreational fishing effort

3.1.1. Whole fishery (boat and shore fisheries combined)

We estimated that about 970,400 fisher hours of daytime recreational effort was expended in Lake Macquarie and Swansea Channel during the survey year - March 1999 to February 2000 inclusive (Table 2). Most recreational fishing effort, about 421,900 fisher hours representing 43.5% of total annual effort, occurred in the Northern Lake area (Table 3). The Southern Lake area received about 346,600 fisher hours representing 35.7% of the total annual effort (Table 4), and about 202,000 fisher hours of effort representing 20.8% of total annual effort were recorded for the Swansea Channel (Table 5). The level of daytime recreational fishing effort showed a distinct seasonal pattern (Table 2). The highest level of effort was found in Summer (about 421,300 fisher hours representing 43.4% of the total annual effort), an intermediate level of effort was recorded in Autumn (about 255,800 fisher hours representing 26.4% of the total annual effort) and the lowest levels of effort were recorded in Spring (about 172,700 fisher hours representing 17.8% of the total annual effort), and Winter (about 120,800 fisher hours representing 12.4% of the total annual effort). Table 2 also provides estimates of daytime effort for each day-type stratum within a season.

Table 2. Estimates of daytime recreational fishing effort (fisher hours) for the Lake Macquarie and Swansea Channel areas combined. Data are presented for all temporal strata and for the boat-based and shore-based fisheries.

Season/Year	Day-Type	Boat Effort (fisher hrs)		SE	Shore Effort (fisher hrs)		SE	Total Effort (fisher hrs)		SE
Autumn 99	Weekday	89,719	±	8,373	49,166	±	6,872	138,885	±	10,832
	Weekend	82,620	±	8,566	34,276	±	3,851	116,896	±	9,391
	Total	**172,339**	±	**11,978**	**83,442**	±	**7,877**	**255,781**	±	**14,336**
Winter 99	Weekday	29,151	±	3,255	27,757	±	4,041	56,908	±	5,189
	Weekend	41,906	±	3,990	21,939	±	1,989	63,845	±	4,458
	Total	**71,057**	±	**5,150**	**49,696**	±	**4,504**	**120,753**	±	**6,841**
Spring 99	Weekday	68,087	±	7,975	19,743	±	3,197	87,830	±	8,591
	Weekend	55,531	±	6,848	29,326	±	3,789	84,857	±	7,827
	Total	**123,618**	±	**10,511**	**49,069**	±	**4,958**	**172,687**	±	**11,622**
Summer 99/00	Weekday	159,777	±	20,405	57,083	±	6,676	216,860	±	21,469
	Weekend	155,028	±	15,448	49,371	±	7,575	204,399	±	17,205
	Total	**314,805**	±	**25,592**	**106,454**	±	**10,097**	**421,259**	±	**27,512**
Yearly Total	Weekday	346,734	±	23,678	153,749	±	10,878	500,483	±	26,057
	Weekend	335,085	±	19,360	134,912	±	9,514	469,997	±	21,572
	Total	**681,819**	±	**30,585**	**288,661**	±	**14,452**	**970,480**	±	**33,828**

Table 3. Estimates of daytime recreational fishing effort (fisher hours) for the Northern Lake area. Data are presented for all temporal strata and for the boat-based and shore-based fisheries.

Season/Year	Day-Type	Boat Effort (fisher hrs)		SE	Shore Effort (fisher hrs)		SE	Total Effort (fisher hrs)		SE
Autumn 99	Weekday	40,255	±	4,811	24,583	±	5,139	64,838	±	7,040
	Weekend	34,853	±	6,560	13,947	±	2,232	48,800	±	6,929
	Total	**75,108**	±	**8,135**	**38,530**	±	**5,603**	**113,638**	±	**9,878**
Winter 99	Weekday	11,869	±	1,838	7,417	±	1,594	19,286	±	2,433
	Weekend	19,812	±	2,800	9,289	±	1,330	29,101	±	3,100
	Total	**31,681**	±	**3,350**	**16,706**	±	**2,076**	**48,387**	±	**3,941**
Spring 99	Weekday	30,995	±	4,647	12,614	±	2,603	43,609	±	5,327
	Weekend	27,108	±	5,519	12,957	±	2,384	40,065	±	6,012
	Total	**58,103**	±	**7,215**	**25,571**	±	**3,530**	**83,674**	±	**8,032**
Summer 99/00	Weekday	60,838	±	13,553	25,000	±	3,622	85,838	±	14,029
	Weekend	70,124	±	6,641	20,236	±	2,397	90,360	±	7,060
	Total	**130,962**	±	**15,093**	**45,236**	±	**4,343**	**176,198**	±	**15,705**
Yearly Total	Weekday	143,957	±	15,225	69,614	±	6,989	213,571	±	16,753
	Weekend	151,897	±	11,199	56,429	±	4,263	208,326	±	11,984
	Total	**295,854**	±	**18,901**	**126,043**	±	**8,187**	**421,897**	±	**20,598**

Table 4. Estimates of daytime recreational fishing effort (fisher hours) for the Southern Lake area. Data are presented for all temporal strata and for the boat-based and shore-based fisheries.

Season/Year	Day-Type	Boat Effort (fisher hrs)		SE	Shore Effort (fisher hrs)		SE	Total Effort (fisher hrs)		SE
Autumn 99	Weekday	35,519	±	5,575	7,432	±	1,759	42,951	±	5,846
	Weekend	37,342	±	4,829	12,434	±	2,560	49,776	±	5,466
	Total	**72,861**	±	**7,376**	**19,866**	±	**3,106**	**92,727**	±	**8,003**
Winter 99	Weekday	14,992	±	2,592	9,777	±	2,285	24,769	±	3,456
	Weekend	16,804	±	2,763	4,761	±	870	21,565	±	2,897
	Total	**31,796**	±	**3,789**	**14,538**	±	**2,445**	**46,334**	±	**4,509**
Spring 99	Weekday	27,692	±	5,342	3,153	±	847	30,845	±	5,409
	Weekend	18,554	±	2,976	6,478	±	1,174	25,032	±	3,199
	Total	**46,246**	±	**6,115**	**9,631**	±	**1,448**	**55,877**	±	**6,284**
Summer 99/00	Weekday	70,978	±	14,022	10,694	±	2,402	81,672	±	14,226
	Weekend	58,300	±	11,527	11,697	±	2,411	69,997	±	11,776
	Total	**129,278**	±	**18,151**	**22,391**	±	**3,403**	**151,669**	±	**18,468**
Yearly Total	Weekday	149,181	±	16,216	31,056	±	3,847	180,237	±	16,666
	Weekend	131,000	±	13,141	35,370	±	3,808	166,370	±	13,681
	Total	**280,181**	±	**20,872**	**66,426**	±	**5,413**	**346,607**	±	**21,562**

Table 5. Estimates of daytime recreational fishing effort (fisher hours) for the Swansea Channel area. Data are presented for all temporal strata and for the boat-based and shore-based fisheries.

Season/Year	Day-Type	Boat Effort (fisher hrs)		SE	Shore Effort (fisher hrs)		SE	Total Effort (fisher hrs)		SE
Autumn 99	Weekday	13,945	±	3,985	17,151	±	4,210	31,096	±	5,797
	Weekend	10,425	±	2,650	7,895	±	1,814	18,320	±	3,211
	Total	**24,370**	±	**4,786**	**25,046**	±	**4,584**	**49,416**	±	**6,627**
Winter 99	Weekday	2,290	±	703	10,563	±	2,927	12,853	±	3,010
	Weekend	5,290	±	670	7,889	±	1,196	13,179	±	1,371
	Total	**7,580**	±	**971**	**18,452**	±	**3,162**	**26,032**	±	**3,308**
Spring 99	Weekday	9,400	±	3,668	3,976	±	1,651	13,376	±	4,023
	Weekend	9,869	±	2,754	9,891	±	2,701	19,760	±	3,857
	Total	**19,269**	±	**4,587**	**13,867**	±	**3,166**	**33,136**	±	**5,573**
Summer 99/00	Weekday	27,961	±	6,005	21,389	±	5,067	49,350	±	7,857
	Weekend	26,604	±	7,852	17,438	±	6,769	44,042	±	10,367
	Total	**54,565**	±	**9,885**	**38,827**	±	**8,456**	**93,392**	±	**13,008**
Yearly Total	Weekday	53,596	±	8,117	53,079	±	7,395	106,675	±	10,981
	Weekend	52,188	±	8,758	43,113	±	7,605	95,301	±	11,600
	Total	**105,784**	±	**11,941**	**96,192**	±	**10,608**	**201,976**	±	**15,973**

3.1.2. Boat-based fishery

We estimated that about 681,800 fisher hours of daytime recreational boat-based effort was expended in Lake Macquarie and Swansea Channel during the survey year - March 1999 to February 2000 inclusive (Table 2). This represented 70.3% of the annual effort for the total fishery (boat and shore combined). Similar amounts of boat-based effort were recorded from the Northern Lake area (about 295,900 fisher hours representing 43.4% of the annual boat-based effort - Table 3) and the Southern Lake area (about 280,200 fisher hours representing 41.1% of the annual boat-based effort - Table 4). Swansea Channel received the lowest level of boat-based effort (about 105,800 fisher hours representing 20.8% of the annual boat-based effort - Table 5). The same seasonal pattern was evident in all three Lake areas (Tables 3 to 5). The highest level of boat-based effort occurred in Summer, an intermediate level of effort was found during Autumn, and the lowest effort levels were recorded in the Spring and Winter seasons. Tables 2 to 5 also provide estimates of daytime boat-based effort for each day-type stratum within a season. Supplementary daytime effort information for the boat-based fishery is provided in units of boat hours, the original units used in the calculations of boat-based effort and harvest (see Appendix 6).

3.1.3. Shore-based fishery

We estimated that about 288,700 fisher hours of daytime recreational shore-based effort was expended in Lake Macquarie and Swansea Channel during the survey year - March 1999 to February 2000 inclusive (Table 2). This represented 29.7% of the annual effort for the total fishery (boat and shore combined). The highest amount of shore-based effort was recorded from the Northern Lake area (about 126,000 fisher hours representing 43.7% of the annual shore-based effort - Table 3), an intermediate amount of effort was recorded from the Swansea Channel (about 96,200 fisher hours representing 33.3% of the annual shore-based effort - Table 5), and the lowest amount of shore-based effort was found in the Southern Lake area (about 66,400 fisher hours representing 23.0% of the annual shore-based effort - Table 4). The same seasonal pattern was found for the Southern Lake area and Swansea Channel (Tables 4 and 5). In these two Lake areas, the highest levels of daytime effort were in Summer, slightly lower levels of effort were recorded in the Autumn season, with a further decline evident during the Winter, and the lowest level of shore-based effort was recorded in the Spring season (Tables 4 and 5). The Northern Lake area had a slightly different pattern of effort to that found in the other two Lake areas (Table 3). In the Northern Lake area, the highest level of daytime shore-based effort was recorded during the Summer, with declining effort levels evident in the Autumn and Spring seasons, and the lowest effort level was recorded during the Winter season (Table 3). Tables 2 to 5 also provide estimates of daytime shore-based effort for each day-type stratum within a season.

3.2. Demography of the fishing population

The populations of boat-based and shore-based fishers were dominated by males (Table 6). Over the annual survey period, we found that 82.2% of the boat-based fishers that had been interviewed were males. Similarly, we found that 83.3% of the shore-based fishers that had been interviewed were males. There were no apparent seasonal trends in the sexes of participants in either fishery (Table 6). However, a consistent pattern was evident when comparing the sex-based composition of the fishing populations between day-type strata. A higher proportion of female fishers were observed in the fishing population on weekend days. This pattern was consistent within each of the four seasons and for both the boat-based and shore-based fisheries (Table 6).

Over the annual survey period, we found that the great majority of fishers were of local origin (Table 7 & Appendix 8). This was true for both the boat-based fishery (80.6% locals) and for the shore-based fishery (75.4% locals). The proportion of visiting fishers in the boat-based and shore-based fishing populations was highest on weekend days during the Autumn, Winter and Spring seasons (Table 7). In contrast, the proportion of visiting fishers in the boat-based and shore-based fisheries was higher during the weekdays in Summer (Table 7).

Table 6. Numbers and percentages of male and female fishers for the boat and shore recreational fisheries in Lake Macquarie during the annual survey period.

		BOAT FISHERY				SHORE FISHERY			
Season/Year	Day-Type	No. Male	% Male	No. Female	% Female	No. Male	% Male	No. Female	% Female
Autumn 1999	Weekday	205	84.4	38	15.6	220	89.8	25	10.2
	Weekend	493	79.3	129	20.7	310	77.5	90	22.5
	Total	**698**	**80.7**	**167**	**19.3**	**530**	**82.2**	**115**	**17.8**
Winter 1999	Weekday	52	82.5	11	17.5	186	86.5	29	13.5
	Weekend	189	78.7	51	21.3	276	83.9	53	16.1
	Total	**241**	**79.5**	**62**	**20.5**	**462**	**84.9**	**82**	**15.1**
Spring 1999	Weekday	111	88.1	15	11.9	221	91.7	20	8.3
	Weekend	440	80.6	106	19.4	403	84.7	73	15.3
	Total	**551**	**82.0**	**121**	**18.0**	**624**	**87.0**	**93**	**13.0**
Summer 99/2000	Weekday	346	87.4	50	12.6	318	83.0	65	17.0
	Weekend	479	82.7	100	17.3	333	77.3	98	22.7
	Total	**825**	**84.6**	**150**	**15.4**	**651**	**80.0**	**163**	**20.0**
Yearly Total	Weekday	714	86.2	114	13.8	945	87.2	139	12.8
	Weekend	1,601	80.6	386	19.4	1,322	80.8	314	19.2
	Total	**2,315**	**82.2**	**500**	**17.8**	**2,267**	**83.3**	**453**	**16.7**

Table 7. Numbers and percentages of local and visiting fishers for the boat and shore recreational fisheries in Lake Macquarie during the annual survey period.

		BOAT FISHERY				SHORE FISHERY			
Season/Year	Day-Type	No. Local	% Local	No. Visitors	% Visitors	No. Local	% Local	No. Visitors	% Visitors
Autumn 1999	Weekday	212	90.2	23	9.8	188	82.1	41	17.9
	Weekend	413	70.2	175	29.8	287	74.9	96	25.1
	Total	**625**	**75.9**	**198**	**24.1**	**475**	**77.6**	**137**	**22.4**
Winter 1999	Weekday	53	86.9	8	13.1	189	91.7	17	8.3
	Weekend	185	80.1	46	19.9	245	74.7	83	25.3
	Total	**238**	**81.5**	**54**	**18.5**	**434**	**81.3**	**100**	**18.7**
Spring 1999	Weekday	114	89.8	13	10.2	189	80.1	47	19.9
	Weekend	428	81.4	98	18.6	354	75.2	117	24.8
	Total	**542**	**83.0**	**111**	**17.0**	**543**	**76.8**	**164**	**23.2**
Summer 99/2000	Weekday	316	81.2	73	18.8	237	63.4	137	36.6
	Weekend	469	83.9	90	16.1	300	72.8	112	27.2
	Total	**785**	**82.8**	**163**	**17.2**	**537**	**68.3**	**249**	**31.7**
Yearly Total	Weekday	695	85.6	117	14.4	803	76.8	242	23.2
	Weekend	1,495	78.5	409	21.5	1,186	74.4	408	25.6
	Total	**2,190**	**80.6**	**526**	**19.4**	**1,989**	**75.4**	**650**	**24.6**

3.3. Targeting preferences

The main targeting preferences nominated by boat-based fishing parties over the annual survey period were grouped into 15 target categories (Table 8). Many boat-based fishing parties indicated that they did not have any specific target preference. Fishing parties nominating “anything” as their main target were ranked highest in each season during the annual survey period (Table 8). Bream, flathead, crab, squid and whiting were other popular main targets of boat-based fishing parties and these target groups were nominated consistently across all seasons. Fishing parties that had nominated any of these five main target categories, or the generalist category “anything” made up over 92% of the boat-based fishing population during the annual survey period (Table 8). Some seasonal differences in the targeting preferences of boat-based fishing parties were evident. For example, the proportion of generalist fishing parties that had targeted “anything” was highest during the Summer, with no apparent difference in the proportional representation of these generalists during the other seasons. Fishing parties targeting “bream” were present in higher proportions during Autumn, and a decline in their proportional representation in the boat-based fishing population was evident throughout Winter, Spring and Summer (Table 8). In contrast, the proportion of boat-based fishing parties targeting “crab” remained relatively stable throughout all seasons during the survey period (Table 8).

The main targeting preferences nominated by shore-based fishing parties over the annual survey period were grouped into 18 target categories (Table 9). A large proportion of shore-based fishing parties indicated that they did not have any specific target preference. Fishing parties nominating “anything” as their main target were ranked highest during the Summer and Autumn seasons, but were only ranked second in order of importance during the Winter and Spring seasons (Table 9). Luderick, bream, leatherjacket, squid and flathead were other popular main targets of shore-based fishing parties and these target groups were nominated consistently across all seasons. Fishing parties that had nominated any of these five main target categories, or the generalist category “anything” made up over 94% of the shore-based fishing population during the annual survey period (Table 9). Some seasonal differences in the targeting preferences of shore-based fishing parties was evident. For example, the proportion of generalist fishing parties that had targeted “anything” was highest in the Summer and Autumn seasons, with lower but still relatively large proportions present during the Winter and Spring seasons (Table 9). In contrast, fishing parties targeting “luderick” were present in higher proportions during the Winter and Spring seasons, with a notable decline in their proportional representation within the shore-based fishing population during the Autumn and Summer seasons (Table 9).

Table 8. Main target categories nominated by boat-based fishing parties in the Lake Macquarie fishery during the annual survey period.

Boat-Based	Autumn 1999		Winter 1999		Spring 1999		Summer 99/2000		Total	
Target Category	No.	%	No.	%	No.	%	No.	%	No.	%
Anything	134	34.6	52	37.1	111	36.6	206	48.5	503	40.1
Flathead	46	11.9	11	7.9	57	18.8	72	16.9	186	14.8
Bream	84	21.7	24	17.1	39	12.9	33	7.8	180	14.3
Crab	53	13.7	14	10.0	35	11.5	47	11.1	149	11.9
Squid	25	6.4	16	11.4	16	5.3	34	8.0	91	7.3
Whiting	14	3.6	4	2.9	22	7.3	13	3.1	53	4.2
Tailor	11	2.8	5	3.6	10	3.3	1	0.2	27	2.2
Leatherjacket	5	1.3	6	4.3	5	1.7	7	1.6	23	1.8
Luderick	4	1.0	3	2.1	4	1.3	3	0.7	14	1.1
Snapper	3	0.8	4	2.9	1	0.3	5	1.2	13	1.0
Mullet	6	1.6	1	0.7	-	-	1	0.2	8	0.6
Mulloway	1	0.3	-	-	2	0.7	2	0.5	5	0.4
Garfish	1	0.3	-	-	-	-	-	-	1	0.1
Kingfish	-	-	-	-	-	-	1	0.2	1	0.1
Octopus	-	-	-	-	1	0.3	-	-	1	0.1
Total	**387**		**140**		**303**		**425**		**1255**	

Table 9. Main target categories nominated by shore-based fishing parties in the Lake Macquarie fishery during the annual survey period.

Shore-Based	Autumn 1999		Winter 1999		Spring 1999		Summer 99/2000		Total	
Target Category	No.	%	No.	%	No.	%	No.	%	No.	%
Anything	152	43.6	91	32.6	143	35.0	243	59.9	629	43.5
Luderick	60	17.2	136	48.7	165	40.4	53	13.1	414	28.6
Bream	66	18.9	18	6.5	40	9.8	34	8.4	158	10.9
Leatherjacket	8	2.3	17	6.1	18	4.5	12	3.0	55	3.8
Squid	11	3.2	6	2.2	15	3.7	23	5.7	55	3.8
Flathead	23	6.5	-	-	15	3.7	14	3.4	52	3.6
Mullet	15	4.3	2	0.7	1	0.2	9	2.2	27	1.9
Tailor	1	0.3	4	1.4	2	0.5	4	1.0	11	0.8
Crab	7	2.0	-	-	1	0.2	2	0.5	10	0.7
Whiting	4	1.1	-	-	2	0.5	3	0.7	9	0.6
Black Trevally (Spinefoot)	-	-	3	1.1	1	0.2	3	0.7	7	0.5
Kingfish	-	-	2	0.7	3	0.7	2	0.5	7	0.5
Southern Herring	1	0.3	-	-	-	-	3	0.7	4	0.3
Rock Blackfish	-	-	-	-	1	0.2	-	-	1	0.1
Mulloway	1	0.3	-	-	-	-	-	-	1	0.1
Red Scorpioncod	-	-	-	-	-	-	1	0.2	1	0.1
Snapper	-	-	-	-	1	0.2	-	-	1	0.1
Yellowtail	-	-	-	-	1	0.2	-	-	1	0.1
Total	**349**		**279**		**409**		**406**		**1443**	

3.4. Indicators of recreational fishing quality

An assessment of a recreational fishery can be improved if reliable indicators of fishing quality are available. We present three indicators of recreational fishing quality for the boat-based and shore-based fisheries in Lake Macquarie. These are: (a) the proportion of unsuccessful fishing parties; (b) recreational harvest rates; and (c) the size-frequency distributions for some important taxa harvested by the recreational sector.

3.4.1. Proportion of unsuccessful fishing parties

We found that a high proportion of boat-based fishing parties were unsuccessful during their fishing trips. That is, these fishing parties failed to catch any fish, crab or squid that they regarded as being worthy of keeping. The proportion of unsuccessful boat-based fishing parties ranged from about 32% to 49% on a seasonal basis (Fig. 2). The proportion of unsuccessful boat-based fishing parties was about 42% over the entire annual survey period.

Shore-based fishing parties were less successful than boat-based parties. The proportion of unsuccessful shore-based fishing parties ranged from about 54% to 68% on a seasonal basis (Fig. 2). The proportion of unsuccessful shore-based fishing parties was about 61% over the entire annual survey period.

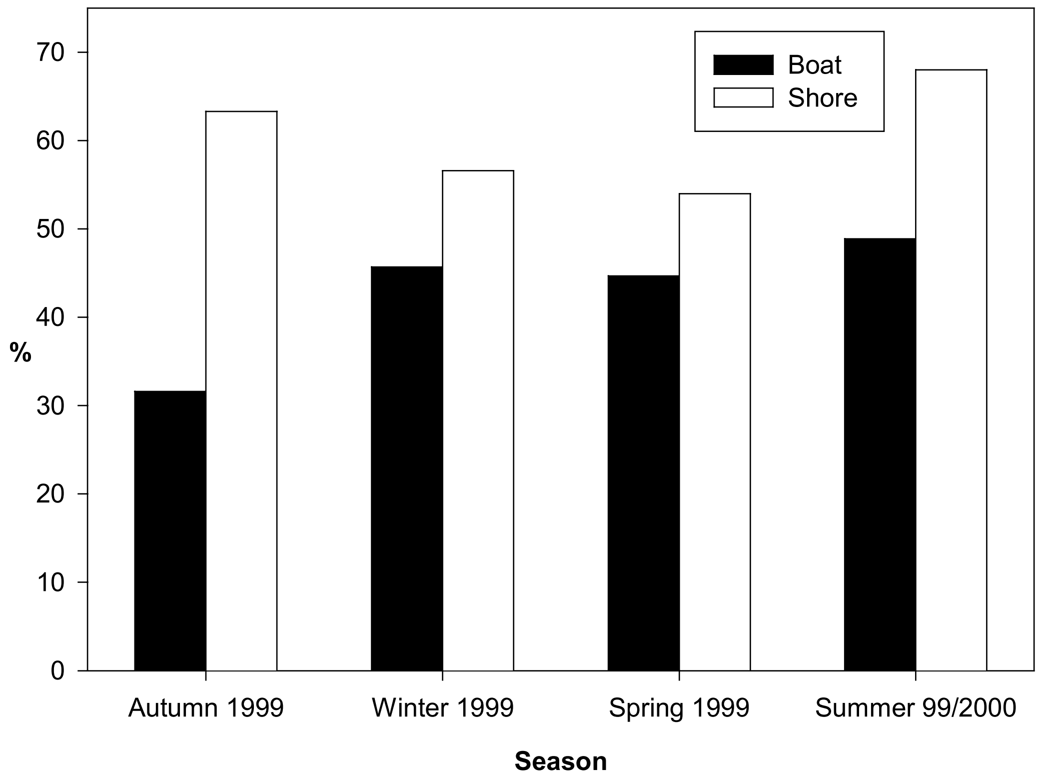


Figure 2. The proportion of unsuccessful boat-based and shore-based fishing parties for each season of the survey. Sample sizes are presented in Table 1.

3.4.2. Recreational harvest rates

The harvest rates reported in this document are based on calculations made using total fishing effort (non-directed effort) for a stratum. We present harvest rates for the boat-based and shore-based fisheries for each day-type stratum within each season, for seasons, and for each of the three Lake areas. In this way, temporal trends within the survey period and spatial patterns within the whole fishery can be examined. We now provide some contrasting examples of the trends and patterns evident in these harvest rate data. This approach is preferable to providing lengthy descriptions for each species. We urge the reader to examine the harvest rate data for particular species of interest (see Tables 10 to 27). We also provide supplementary harvest rate information for the boat-based fishery in units of number of fish per boat hour (see Appendices 4.1 to 4.18). These appendices report the harvest rates for the boat-based fishery in the original units that were used in the calculations of boat-based effort and harvest, and are useful for other workers that may want to make comparisons between boat-based fisheries from other locations and/or survey periods.

Table 10. Recreational harvest rate estimates (fish per fisher hour) and standard errors for Luderick (*Girella tricuspidata*) taken by (a) boat-based fishers, and (b) shore-based fishers, in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE
Autumn 1999	Weekday	0.012	±	0.011	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**0.008**	±	**0.008**	**-**		**-**	**-**		**-**
Winter 1999	Weekday	0.068	±	0.055	-		-	0.065	±	0.053
	Weekend	0.014	±	0.012	-		-	-		-
	Total	**0.052**	±	**0.039**	**-**		**-**	**0.046**	±	**0.037**
Spring 1999	Weekday	0.160	±	0.160	-		-	0.007	±	0.007
	Weekend	0.010	±	0.010	-		-	0.178	±	0.178
	Total	**0.115**	±	**0.113**	**-**		**-**	**0.058**	±	**0.053**
Summer 99/2000	Weekday	0.007	±	0.008	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**0.005**	±	**0.005**	**-**		**-**	**-**		**-**

b. SHORE FISHERY

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE
Autumn 1999	Weekday	-		-	0.042	±	0.021	0.031	±	0.028
	Weekend	0.035	±	0.023	0.120	±	0.062	0.052	±	0.018
	Total	**0.011**	±	**0.007**	**0.067**	±	**0.024**	**0.038**	±	**0.020**
Winter 1999	Weekday	-		-	0.788	±	0.147	0.164	±	0.054
	Weekend	-		-	0.446	±	0.157	0.041	±	0.024
	Total	**-**		**-**	**0.688**	±	**0.114**	**0.128**	±	**0.039**
Spring 1999	Weekday	-		-	0.813	±	0.158	0.177	±	0.085
	Weekend	0.056	±	0.056	0.554	±	0.119	0.201	±	0.048
	Total	**0.016**	±	**0.016**	**0.736**	±	**0.116**	**0.184**	±	**0.062**
Summer 99/2000	Weekday	0.017	±	0.013	0.317	±	0.185	0.050	±	0.042
	Weekend	0.017	±	0.017	0.093	±	0.014	0.060	±	0.033
	Total	**0.017**	±	**0.010**	**0.241**	±	**0.122**	**0.054**	±	**0.030**

Table 11. Recreational harvest rate estimates (crabs per fisher hour) and standard errors for Blue Swimmer Crab (*Portunus pelagicus*) taken by (a) boat-based fishers, and (b) shore-based fishers, in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (crabs/fisher hr)		SE	Harvest Rate (crabs/fisher hr)		SE	Harvest Rate (crabs/fisher hr)		SE
Autumn 1999	Weekday	0.260	±	0.074	0.368	±	0.112	-		-
	Weekend	0.090	±	0.030	0.161	±	0.053	0.001	±	0.001
	Total	**0.206**	±	**0.052**	**0.303**	±	**0.079**	**< 0.001**	±	**< 0.001**
Winter 1999	Weekday	-		-	0.834	±	0.606	-		-
	Weekend	0.041	±	0.033	0.093	±	0.054	-		-
	Total	**0.012**	±	**0.010**	**0.617**	±	**0.429**	**-**		**-**
Spring 1999	Weekday	0.035	±	0.024	0.098	±	0.077	0.002	±	0.002
	Weekend	0.076	±	0.039	0.599	±	0.502	0.005	±	0.003
	Total	**0.047**	±	**0.020**	**0.246**	±	**0.159**	**0.003**	±	**0.002**
Summer 99/2000	Weekday	0.097	±	0.071	0.272	±	0.068	0.002	±	0.002
	Weekend	0.072	±	0.043	0.581	±	0.487	0.002	±	0.002
	Total	**0.088**	±	**0.049**	**0.377**	±	**0.172**	**0.002**	±	**0.001**

b. SHORE FISHERY

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (crabs/fisher hr)		SE	Harvest Rate (crabs/fisher hr)		SE	Harvest Rate (crabs/fisher hr)		SE
Autumn 1999	Weekday	0.023	±	0.019	-		-	-		-
	Weekend	0.001	±	0.001	0.006	±	0.005	-		-
	Total	**0.016**	±	**0.013**	**0.002**	±	**0.002**	**-**		**-**
Winter 1999	Weekday	-		-	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**-**		**-**	**-**		**-**
Spring 1999	Weekday	-		-	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**-**		**-**	**-**		**-**
Summer 99/2000	Weekday	0.003	±	0.003	-		-	-		-
	Weekend	-		-	0.013	±	0.012	-		-
	Total	**0.002**	±	**0.002**	**0.004**	±	**0.004**	**-**		**-**

Table 12. Recreational harvest rate estimates (fish per fisher hour) and standard errors for Trumpeter Whiting (*Sillago maculata*) taken by (a) boat-based fishers, and (b) shore-based fishers, in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL	
Season/Year	Day-Type	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)	SE
Autumn 1999	Weekday	0.177	±	0.070	0.311	±	0.262	-	-
	Weekend	0.009	±	0.006	0.133	±	0.036	-	-
	Total	**0.124**	±	**0.048**	**0.255**	±	**0.179**	**-**	**-**
Winter 1999	Weekday	-		-	0.028	±	0.023	-	-
	Weekend	0.045	±	0.030	0.169	±	0.050	-	-
	Total	**0.013**	±	**0.009**	**0.070**	±	**0.022**	**-**	**-**
Spring 1999	Weekday	0.025	±	0.022	0.039	±	0.039	-	-
	Weekend	0.016	±	0.011	0.179	±	0.065	-	-
	Total	**0.023**	±	**0.016**	**0.081**	±	**0.034**	**-**	**-**
Summer 99/2000	Weekday	0.007	±	0.007	0.128	±	0.057	-	-
	Weekend	0.107	±	0.071	0.088	±	0.041	-	-
	Total	**0.041**	±	**0.025**	**0.115**	±	**0.040**	**-**	**-**

b. SHORE FISHERY

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL	
Season/Year	Day-Type	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)	SE
Autumn 1999	Weekday	-		-	0.023	±	0.012	-	-
	Weekend	0.016	±	0.010	0.013	±	0.012	-	-
	Total	**0.005**	±	**0.003**	**0.020**	±	**0.009**	**-**	**-**
Winter 1999	Weekday	-		-	-		-	-	-
	Weekend	-		-	-		-	-	-
	Total	**-**		**-**	**-**		**-**	**-**	**-**
Spring 1999	Weekday	-		-	-		-	-	-
	Weekend	-		-	-		-	-	-
	Total	**-**		**-**	**-**		**-**	**-**	**-**
Summer 99/2000	Weekday	-		-	-		-	-	-
	Weekend	0.040	±	0.040	-		-	-	-
	Total	**0.014**	±	**0.014**	**-**		**-**	**-**	**-**

Table 13. Recreational harvest rate estimates (fish per fisher hour) and standard errors for Yellowfin Bream (*Acanthopagrus australis*) taken by (a) boat-based fishers, and (b) shore-based fishers, in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE
Autumn 1999	Weekday	0.137	±	0.030	-		-	0.056	±	0.026
	Weekend	0.076	±	0.011	0.044	±	0.014	0.060	±	0.036
	Total	**0.118**	±	**0.021**	**0.014**	±	**0.004**	**0.057**	±	**0.021**
Winter 1999	Weekday	0.060	±	0.043	-		-	0.008	±	0.007
	Weekend	0.055	±	0.029	0.006	±	0.003	0.005	±	0.004
	Total	**0.058**	±	**0.032**	**0.002**	±	**0.001**	**0.007**	±	**0.005**
Spring 1999	Weekday	0.027	±	0.014	0.049	±	0.032	0.062	±	0.030
	Weekend	0.020	±	0.012	0.007	±	0.005	0.028	±	0.008
	Total	**0.025**	±	**0.011**	**0.036**	±	**0.022**	**0.052**	±	**0.021**
Summer 99/2000	Weekday	0.031	±	0.017	0.005	±	0.005	0.159	±	0.138
	Weekend	0.015	±	0.008	-		-	0.054	±	0.007
	Total	**0.025**	±	**0.012**	**0.003**	±	**0.003**	**0.123**	±	**0.091**

b. SHORE FISHERY

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE
Autumn 1999	Weekday	0.045	±	0.041	0.076	±	0.044	0.010	±	0.006
	Weekend	0.056	±	0.030	0.080	±	0.026	0.023	±	0.012
	Total	**0.049**	±	**0.029**	**0.077**	±	**0.032**	**0.014**	±	**0.005**
Winter 1999	Weekday	0.007	±	0.006	0.007	±	0.006	0.014	±	0.011
	Weekend	0.016	±	0.008	0.008	±	0.004	0.016	±	0.008
	Total	**0.010**	±	**0.005**	**0.007**	±	**0.004**	**0.014**	±	**0.008**
Spring 1999	Weekday	0.007	±	0.007	0.050	±	0.028	0.011	±	0.007
	Weekend	0.057	±	0.023	0.048	±	0.034	0.056	±	0.026
	Total	**0.022**	±	**0.008**	**0.050**	±	**0.022**	**0.024**	±	**0.009**
Summer 99/2000	Weekday	0.086	±	0.066	0.002	±	0.002	0.037	±	0.015
	Weekend	0.371	±	0.326	0.014	±	0.011	0.005	±	0.004
	Total	**0.183**	±	**0.119**	**0.006**	±	**0.004**	**0.026**	±	**0.010**

Table 14. Recreational harvest rate estimates (squid per fisher hour) and standard errors for Common Squid (*Photololigo spp.*) taken by (a) boat-based fishers, and (b) shore-based fishers, in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (squid/fisher hr)		SE	Harvest Rate (squid/fisher hr)		SE	Harvest Rate (squid/fisher hr)		SE
Autumn 1999	Weekday	0.056	±	0.050	0.208	±	0.113	0.776	±	0.621
	Weekend	0.095	±	0.044	0.298	±	0.040	0.112	±	0.059
	Total	**0.068**	±	**0.037**	**0.237**	±	**0.078**	**0.567**	±	**0.426**
Winter 1999	Weekday	0.063	±	0.052	0.021	±	0.017	0.021	±	0.017
	Weekend	0.037	±	0.026	0.389	±	0.060	0.021	±	0.017
	Total	**0.056**	±	**0.037**	**0.129**	±	**0.022**	**0.021**	±	**0.013**
Spring 1999	Weekday	0.003	±	0.003	0.017	±	0.017	0.066	±	0.066
	Weekend	0.004	±	0.002	0.051	±	0.024	0.145	±	0.094
	Total	**0.004**	±	**0.002**	**0.027**	±	**0.014**	**0.089**	±	**0.054**
Summer 99/2000	Weekday	-		-	0.052	±	0.042	0.400	±	0.187
	Weekend	0.003	±	0.003	0.049	±	0.025	0.187	±	0.078
	Total	**0.001**	±	**0.001**	**0.051**	±	**0.029**	**0.327**	±	**0.126**

b. SHORE FISHERY

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (squid/fisher hr)		SE	Harvest Rate (squid/fisher hr)		SE	Harvest Rate (squid/fisher hr)		SE
Autumn 1999	Weekday	0.003	±	0.003	0.038	±	0.032	-		-
	Weekend	-		-	-		-	-		-
	Total	**0.002**	±	**0.002**	**0.026**	±	**0.022**	**-**		**-**
Winter 1999	Weekday	-		-	0.086	±	0.028	-		-
	Weekend	-		-	0.008	±	0.006	-		-
	Total	**-**		**-**	**0.063**	±	**0.020**	**-**		**-**
Spring 1999	Weekday	-		-	0.017	±	0.017	0.037	±	0.037
	Weekend	-		-	0.002	±	0.002	0.024	±	0.021
	Total	**-**		**-**	**0.012**	±	**0.012**	**0.033**	±	**0.027**
Summer 99/2000	Weekday	-		-	-		-	0.124	±	0.069
	Weekend	-		-	-		-	0.049	±	0.038
	Total	**-**		**-**	**-**		**-**	**0.098**	±	**0.047**

Table 15. Recreational harvest rate estimates (fish per fisher hour) and standard errors for Dusky Flathead (*Platycephalus fuscus*) taken by (a) boat-based fishers, and (b) shore-based fishers, in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE
Autumn 1999	Weekday	0.050	±	0.015	0.054	±	0.041	0.009	±	0.005
	Weekend	0.038	±	0.017	0.022	±	0.009	0.018	±	0.013
	Total	**0.046**	**±**	**0.012**	**0.044**	**±**	**0.028**	**0.012**	**±**	**0.005**
Winter 1999	Weekday	-		-	-		-	-		-
	Weekend	0.021	±	0.007	0.005	±	0.003	-		-
	Total	**0.006**	**±**	**0.002**	**0.001**	**±**	**0.001**	**-**		**-**
Spring 1999	Weekday	0.005	±	0.004	0.027	±	0.021	0.036	±	0.023
	Weekend	0.059	±	0.036	0.012	±	0.010	0.019	±	0.015
	Total	**0.021**	**±**	**0.011**	**0.022**	**±**	**0.015**	**0.031**	**±**	**0.017**
Summer 99/2000	Weekday	0.021	±	0.012	0.016	±	0.008	0.047	±	0.035
	Weekend	0.024	±	0.009	0.012	±	0.007	0.043	±	0.015
	Total	**0.022**	**±**	**0.009**	**0.015**	**±**	**0.006**	**0.046**	**±**	**0.023**

b. SHORE FISHERY

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE
Autumn 1999	Weekday	0.003	±	0.003	0.024	±	0.013	-		-
	Weekend	0.005	±	0.003	-		-	0.002	±	0.002
	Total	**0.004**	**±**	**0.002**	**0.016**	**±**	**0.009**	**0.001**	**±**	**0.001**
Winter 1999	Weekday	0.015	±	0.012	-		-	-		-
	Weekend	-		-	0.001	±	0.001	-		-
	Total	**0.011**	**±**	**0.009**	**< 0.001**	**±**	**< 0.001**	**-**		**-**
Spring 1999	Weekday	-		-	-		-	0.001	±	0.001
	Weekend	-		-	-		-	0.007	±	0.005
	Total	**-**		**-**	**-**		**-**	**0.003**	**±**	**0.002**
Summer 99/2000	Weekday	-		-	0.016	±	0.016	0.005	±	0.004
	Weekend	0.005	±	0.005	-		-	0.012	±	0.011
	Total	**0.002**	**±**	**0.002**	**0.010**	**±**	**0.011**	**0.007**	**±**	**0.005**

Table 16. Recreational harvest rate estimates (fish per fisher hour) and standard errors for Flat-tail Mullet (*Liza argentea*) taken by (a) boat-based fishers, and (b) shore-based fishers, in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE
Autumn 1999	Weekday	0.012	±	0.010	-		-	-		-
	Weekend	0.073	±	0.040	0.020	±	0.018	-		-
	Total	**0.031**	±	**0.015**	**0.006**	±	**0.006**	**-**		**-**
Winter 1999	Weekday	0.027	±	0.022	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**0.019**	±	**0.016**	**-**		**-**	**-**		**-**
Spring 1999	Weekday	-		-	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**-**		**-**	**-**		**-**
Summer 99/2000	Weekday	0.006	±	0.007	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**0.004**	±	**0.005**	**-**		**-**	**-**		**-**

b. SHORE FISHERY

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE
Autumn 1999	Weekday	0.007	±	0.006	-		-	-		-
	Weekend	0.015	±	0.013	-		-	0.001	±	0.001
	Total	**0.010**	±	**0.006**	**-**		**-**	**< 0.001**	±	**< 0.001**
Winter 1999	Weekday	-		-	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**-**		**-**	**-**		**-**
Spring 1999	Weekday	-		-	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**-**		**-**	**-**		**-**
Summer 99/2000	Weekday	0.170	±	0.126	0.047	±	0.051	-		-
	Weekend	0.017	±	0.017	-		-	-		-
	Total	**0.118**	±	**0.083**	**0.031**	±	**0.034**	**-**		**-**

Table 17. Recreational harvest rate estimates (fish per fisher hour) and standard errors for Fan-bellied Leatherjacket (*Monacanthus chinensis*) taken by (a) boat-based fishers, and (b) shore-based fishers, in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE
Autumn 1999	Weekday	-		-	-		-	-		-
	Weekend	0.003	±	0.003	0.025	±	0.004	0.001	±	0.001
	Total	**0.001**	±	**0.001**	**0.008**	±	**0.001**	**< 0.001**	±	**< 0.001**
Winter 1999	Weekday	-		-	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**-**		**-**	**-**		**-**
Spring 1999	Weekday	-		-	0.004	±	0.004	-		-
	Weekend	0.002	±	0.001	0.006	±	0.004	-		-
	Total	**0.001**	±	**< 0.001**	**0.005**	±	**0.003**	**-**		**-**
Summer 99/2000	Weekday	0.012	±	0.009	0.014	±	0.013	-		-
	Weekend	0.005	±	0.005	0.005	±	0.003	0.002	±	0.002
	Total	**0.009**	±	**0.006**	**0.011**	±	**0.008**	**0.001**	±	**0.001**

b. SHORE FISHERY

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE
Autumn 1999	Weekday	0.016	±	0.014	-		-	-		-
	Weekend	0.023	±	0.015	-		-	0.001	±	0.001
	Total	**0.018**	±	**0.011**	**-**		**-**	**< 0.001**	±	**< 0.001**
Winter 1999	Weekday	-		-	-		-	0.012	±	0.006
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**-**		**-**	**0.008**	±	**0.004**
Spring 1999	Weekday	0.003	±	0.003	0.006	±	0.006	-		-
	Weekend	0.004	±	0.004	-		-	-		-
	Total	**0.003**	±	**0.002**	**0.004**	±	**0.004**	**-**		**-**
Summer 99/2000	Weekday	0.068	±	0.068	-		-	0.015	±	0.016
	Weekend	-		-	0.002	±	0.002	0.001	±	0.001
	Total	**0.045**	±	**0.045**	**0.001**	±	**0.001**	**0.010**	±	**0.011**

Table 18. Recreational harvest rate estimates (fish per fisher hour) and standard errors for Large-toothed Flounder (*Pseudorhombus arsius*) taken by (a) boat-based fishers, and (b) shore-based fishers, in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE
Autumn 1999	Weekday	0.005	±	0.003	0.004	±	0.004	-		-
	Weekend	0.006	±	0.003	0.011	±	0.007	0.001	±	0.001
	Total	**0.006**	±	**0.002**	**0.006**	±	**0.003**	**< 0.001**	±	**< 0.001**
Winter 1999	Weekday	-		-	-		-	-		-
	Weekend	0.004	±	0.003	0.008	±	0.007	-		-
	Total	**0.001**	±	**0.001**	**0.002**	±	**0.002**	**-**		**-**
Spring 1999	Weekday	0.002	±	0.002	0.018	±	0.013	-		-
	Weekend	0.010	±	0.008	0.004	±	0.003	-		-
	Total	**0.004**	±	**0.003**	**0.014**	±	**0.009**	**-**		**-**
Summer 99/2000	Weekday	0.012	±	0.006	0.012	±	0.008	-		-
	Weekend	0.011	±	0.011	0.009	±	0.004	-		-
	Total	**0.012**	±	**0.005**	**0.011**	±	**0.006**	**-**		**-**

b. SHORE FISHERY

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE
Autumn 1999	Weekday	0.011	±	0.010	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**0.007**	±	**0.007**	**-**		**-**	**-**		**-**
Winter 1999	Weekday	-		-	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**-**		**-**	**-**		**-**
Spring 1999	Weekday	-		-	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**-**		**-**	**-**		**-**
Summer 99/2000	Weekday	-		-	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**-**		**-**	**-**		**-**

Table 19. Recreational harvest rate estimates (fish per fisher hour) and standard errors for Six-spined Leatherjacket (*Meuschenia freycineti*) taken by (a) boat-based fishers, and (b) shore-based fishers, in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE
Autumn 1999	Weekday	0.001	±	0.001	-		-	-		-
	Weekend	0.001	±	0.001	-		-	-		-
	Total	**0.001**	±	**0.001**	**-**		**-**	**-**		**-**
Winter 1999	Weekday	0.011	±	0.009	-		-	0.377	±	0.226
	Weekend	-		-	-		-	-		-
	Total	**0.007**	±	**0.006**	**-**		**-**	**0.266**	±	**0.160**
Spring 1999	Weekday	-		-	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**-**		**-**	**-**		**-**
Summer 99/2000	Weekday	0.002	±	0.002	0.018	±	0.019	0.016	±	0.018
	Weekend	-		-	-		-	-		-
	Total	**0.001**	±	**0.001**	**0.012**	±	**0.013**	**0.011**	±	**0.012**

b. SHORE FISHERY

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE
Autumn 1999	Weekday	0.015	±	0.008	-		-	-		-
	Weekend	0.051	±	0.042	0.001	±	0.001	-		-
	Total	**0.026**	±	**0.014**	**< 0.001**	±	**< 0.001**	**-**		**-**
Winter 1999	Weekday	0.003	±	0.003	-		-	0.124	±	0.054
	Weekend	-		-	-		-	0.019	±	0.011
	Total	**0.002**	±	**0.002**	**-**		**-**	**0.093**	±	**0.038**
Spring 1999	Weekday	-		-	-		-	0.050	±	0.034
	Weekend	0.005	±	0.004	-		-	0.044	±	0.023
	Total	**0.001**	±	**0.001**	**-**		**-**	**0.048**	±	**0.025**
Summer 99/2000	Weekday	-		-	-		-	0.014	±	0.008
	Weekend	-		-	-		-	0.003	±	0.002
	Total	**-**		**-**	**-**		**-**	**0.010**	±	**0.005**

Table 20. Recreational harvest rate estimates (fish per fisher hour) and standard errors for Yellow-finned Leatherjacket (*Meuschenia trachylepis*) taken by (a) boat-based fishers, and (b) shore-based fishers, in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE
Autumn 1999	Weekday	-		-	0.002	±	0.002	-		-
	Weekend	0.048	±	0.041	0.001	±	0.001	0.004	±	0.002
	Total	**0.015**	±	**0.013**	**0.002**	±	**0.001**	**0.001**	±	**0.001**
Winter 1999	Weekday	-		-	0.033	±	0.020	0.010	±	0.008
	Weekend	0.002	±	0.002	-		-	-		-
	Total	**0.001**	±	**0.001**	**0.024**	±	**0.014**	**0.007**	±	**0.006**
Spring 1999	Weekday	0.020	±	0.020	0.040	±	0.040	-		-
	Weekend	0.022	±	0.013	0.001	±	0.001	0.054	±	0.034
	Total	**0.020**	±	**0.014**	**0.028**	±	**0.028**	**0.016**	±	**0.010**
Summer 99/2000	Weekday	0.053	±	0.031	0.008	±	0.005	0.006	±	0.007
	Weekend	0.028	±	0.020	0.007	±	0.006	0.001	±	0.001
	Total	**0.044**	±	**0.021**	**0.008**	±	**0.004**	**0.004**	±	**0.004**

b. SHORE FISHERY

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE
Autumn 1999	Weekday	0.286	±	0.256	-		-	0.010	±	0.009
	Weekend	0.150	±	0.077	-		-	0.045	±	0.040
	Total	**0.243**	±	**0.177**	**-**		**-**	**0.021**	±	**0.014**
Winter 1999	Weekday	-		-	-		-	-		-
	Weekend	-		-	-		-	0.004	±	0.003
	Total	**-**		**-**	**-**		**-**	**0.001**	±	**0.001**
Spring 1999	Weekday	0.067	±	0.067	0.005	±	0.005	0.002	±	0.002
	Weekend	0.024	±	0.012	-		-	0.001	±	0.001
	Total	**0.054**	±	**0.047**	**0.003**	±	**0.003**	**0.002**	±	**0.001**
Summer 99/2000	Weekday	0.153	±	0.079	0.004	±	0.004	0.006	±	0.006
	Weekend	0.026	±	0.022	-		-	0.016	±	0.016
	Total	**0.110**	±	**0.053**	**0.003**	±	**0.003**	**0.009**	±	**0.007**

Table 21. Recreational harvest rate estimates (fish per fisher hour) and standard errors for River Garfish (*Hyporhamphus regularis*) taken by (a) boat-based fishers in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE
Autumn 1999	Weekday	-		-	0.090	±	0.081	-		-
	Weekend	-		-	0.017	±	0.015	-		-
	Total	**-**		**-**	**0.067**	±	**0.056**	**-**		**-**
Winter 1999	Weekday	-		-	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**-**		**-**	**-**		**-**
Spring 1999	Weekday	-		-	0.035	±	0.035	-		-
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**0.024**	±	**0.024**	**-**		**-**
Summer 99/2000	Weekday	-		-	-		-	-		-
	Weekend	0.001	±	0.001	-		-	0.039	±	0.039
	Total	**< 0.001**	±	**< 0.001**	**-**		**-**	**0.013**	±	**0.013**

Table 22. Recreational harvest rate estimates (fish per fisher hour) and standard errors for Sand Whiting (*Sillago ciliata*) taken by (a) boat-based fishers, and (b) shore-based fishers, in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE
Autumn 1999	Weekday	0.005	±	0.005	-		-	-		-
	Weekend	0.015	±	0.006	-		-	0.041	±	0.028
	Total	**0.008**	±	**0.004**	**-**		**-**	**0.013**	±	**0.009**
Winter 1999	Weekday	-		-	-		-	-		-
	Weekend	-		-	0.002	±	0.001	-		-
	Total	**-**		**-**	**< 0.001**	±	**< 0.001**	**-**		**-**
Spring 1999	Weekday	-		-	-		-	0.030	±	0.019
	Weekend	0.008	±	0.004	0.002	±	0.002	0.022	±	0.010
	Total	**0.002**	±	**0.001**	**< 0.001**	±	**< 0.001**	**0.028**	±	**0.014**
Summer 99/2000	Weekday	0.010	±	0.009	-		-	0.084	±	0.082
	Weekend	0.001	±	0.001	-		-	0.005	±	0.005
	Total	**0.007**	±	**0.006**	**-**		**-**	**0.057**	±	**0.054**

b. SHORE FISHERY

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE
Autumn 1999	Weekday	-		-	-		-	-		-
	Weekend	0.001	±	0.001	0.002	±	0.002	-		-
	Total	**< 0.001**	±	**< 0.001**	**0.001**	±	**0.001**	**-**		**-**
Winter 1999	Weekday	-		-	-		-	0.002	±	0.001
	Weekend	0.011	±	0.009	-		-	-		-
	Total	**0.003**	±	**0.003**	**-**		**-**	**0.001**	±	**0.001**
Spring 1999	Weekday	-		-	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**-**		**-**	**-**		**-**
Summer 99/2000	Weekday	-		-	-		-	-		-
	Weekend	-		-	-		-	0.002	±	0.001
	Total	**-**		**-**	**-**		**-**	**0.001**	±	**< 0.001**

Table 23. Recreational harvest rate estimates (fish per fisher hour) and standard errors for Small-toothed Flounder (*Pseudorhombus jenynsii*) taken by (a) boat-based fishers, and (b) shore-based fishers, in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE
Autumn 1999	Weekday	0.010	±	0.006	-		-	-		-
	Weekend	0.017	±	0.009	0.009	±	0.006	-		-
	Total	**0.012**	±	**0.005**	**0.003**	±	**0.002**	**-**		**-**
Winter 1999	Weekday	-		-	-		-	-		-
	Weekend	0.006	±	0.003	0.014	±	0.008	0.005	±	0.004
	Total	**0.002**	±	**0.001**	**0.004**	±	**0.002**	**0.002**	±	**0.001**
Spring 1999	Weekday	0.007	±	0.007	0.004	±	0.004	-		-
	Weekend	0.001	±	0.001	0.014	±	0.006	0.002	±	0.002
	Total	**0.005**	±	**0.005**	**0.007**	±	**0.004**	**0.001**	±	**0.001**
Summer 99/2000	Weekday	0.004	±	0.004	0.007	±	0.005	0.006	±	0.006
	Weekend	0.004	±	0.002	0.004	±	0.003	0.002	±	0.002
	Total	**0.004**	±	**0.003**	**0.006**	±	**0.004**	**0.005**	±	**0.004**

b. SHORE FISHERY

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE
Autumn 1999	Weekday	0.002	±	0.002	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**0.001**	±	**0.001**	**-**		**-**	**-**		**-**
Winter 1999	Weekday	-		-	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**-**		**-**	**-**		**-**
Spring 1999	Weekday	-		-	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**-**		**-**	**-**		**-**
Summer 99/2000	Weekday	-		-	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**-**		**-**	**-**		**-**

Table 24. Recreational harvest rate estimates (fish per fisher hour) and standard errors for Sand Mullet (*Myxus elongatus*) taken by (a) boat-based fishers, and (b) shore-based fishers, in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE
Autumn 1999	Weekday	0.056	±	0.050	0.012	±	0.007	0.310	±	0.277
	Weekend	-		-	-		-	-		-
	Total	**0.038**	±	**0.034**	**0.009**	±	**0.005**	**0.212**	±	**0.190**
Winter 1999	Weekday	-		-	-		-	-		-
	Weekend	0.038	±	0.031	-		-	-		-
	Total	**0.011**	±	**0.009**	**-**		**-**	**-**		**-**
Spring 1999	Weekday	-		-	-		-	-		-
	Weekend	0.001	±	0.001	-		-	-		-
	Total	**< 0.001**	±	**< 0.001**	**-**		**-**	**-**		**-**
Summer 99/2000	Weekday	0.048	±	0.044	0.023	±	0.025	-		-
	Weekend	0.001	±	0.001	-		-	0.079	±	0.079
	Total	**0.032**	±	**0.029**	**0.015**	±	**0.017**	**0.027**	±	**0.027**

b. SHORE FISHERY

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE
Autumn 1999	Weekday	0.113	±	0.062	0.015	±	0.013	-		-
	Weekend	0.062	±	0.032	-		-	-		-
	Total	**0.097**	±	**0.044**	**0.010**	±	**0.009**	**-**		**-**
Winter 1999	Weekday	-		-	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**-**		**-**	**-**		**-**
Spring 1999	Weekday	0.467	±	0.333	-		-	-		-
	Weekend	0.079	±	0.073	-		-	-		-
	Total	**0.352**	±	**0.235**	**-**		**-**	**-**		**-**
Summer 99/2000	Weekday	0.109	±	0.064	-		-	0.001	±	0.002
	Weekend	0.070	±	0.070	-		-	0.015	±	0.015
	Total	**0.096**	±	**0.049**	**-**		**-**	**0.006**	±	**0.005**

Table 25. Recreational harvest rate estimates (fish per fisher hour) and standard errors for Snapper (*Pagrus auratus*) taken by (a) boat-based fishers, and (b) shore-based fishers, in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE
Autumn 1999	Weekday	0.034	±	0.008	-		-	-		-
	Weekend	0.022	±	0.007	0.007	±	0.003	-		-
	Total	**0.030**	±	**0.006**	**0.002**	±	**0.001**	**-**		**-**
Winter 1999	Weekday	0.032	±	0.021	-		-	-		-
	Weekend	0.057	±	0.013	-		-	-		-
	Total	**0.040**	±	**0.015**	**-**		**-**	**-**		**-**
Spring 1999	Weekday	0.006	±	0.006	0.007	±	0.007	-		-
	Weekend	0.003	±	0.002	-		-	0.001	±	0.001
	Total	**0.005**	±	**0.004**	**0.005**	±	**0.005**	**< 0.001**	±	**< 0.001**
Summer 99/2000	Weekday	0.025	±	0.013	0.010	±	0.011	-		-
	Weekend	0.003	±	0.002	-		-	0.001	±	0.001
	Total	**0.017**	±	**0.009**	**0.006**	±	**0.007**	**< 0.001**	±	**< 0.001**

b. SHORE FISHERY

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE
Autumn 1999	Weekday	0.005	±	0.005	-		-	-		-
	Weekend	-		-	0.001	±	0.001	0.001	±	0.001
	Total	**0.004**	±	**0.003**	**< 0.001**	±	**< 0.001**	**< 0.001**	±	**< 0.001**
Winter 1999	Weekday	-		-	-		-	-		-
	Weekend	-		-	-		-	0.001	±	0.001
	Total	**-**		**-**	**-**		**-**	**< 0.001**	±	**< 0.001**
Spring 1999	Weekday	-		-	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**-**		**-**	**-**		**-**
Summer 99/2000	Weekday	-		-	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**-**		**-**	**-**		**-**

Table 26. Recreational harvest rate estimates (fish per fisher hour) and standard errors for Tailor (*Pomatomus saltatrix*) taken by (a) boat-based fishers, and (b) shore-based fishers, in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE
Autumn 1999	Weekday	0.013	±	0.004	-		-	-		-
	Weekend	0.052	±	0.019	0.010	±	0.005	0.003	±	0.002
	Total	**0.025**	±	**0.007**	**0.003**	±	**0.002**	**0.001**	±	**0.001**
Winter 1999	Weekday	0.123	±	0.059	-		-	-		-
	Weekend	0.010	±	0.008	-		-	-		-
	Total	**0.090**	±	**0.042**	**-**		**-**	**-**		**-**
Spring 1999	Weekday	0.051	±	0.041	0.004	±	0.004	-		-
	Weekend	0.054	±	0.046	0.001	±	0.001	-		-
	Total	**0.052**	±	**0.032**	**0.003**	±	**0.003**	**-**		**-**
Summer 99/2000	Weekday	0.014	±	0.011	0.002	±	0.002	0.004	±	0.004
	Weekend	0.004	±	0.003	-		-	0.012	±	0.012
	Total	**0.011**	±	**0.007**	**0.001**	±	**0.001**	**0.007**	±	**0.005**

b. SHORE FISHERY

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE
Autumn 1999	Weekday	0.062	±	0.047	0.001	±	0.001	-		-
	Weekend	0.001	±	0.001	0.003	±	0.003	-		-
	Total	**0.043**	±	**0.032**	**0.002**	±	**0.001**	**-**		**-**
Winter 1999	Weekday	-		-	0.006	±	0.005	-		-
	Weekend	0.025	±	0.020	-		-	-		-
	Total	**0.007**	±	**0.006**	**0.004**	±	**0.003**	**-**		**-**
Spring 1999	Weekday	0.010	±	0.010	0.010	±	0.010	-		-
	Weekend	0.024	±	0.017	0.003	±	0.003	-		-
	Total	**0.014**	±	**0.009**	**0.008**	±	**0.007**	**-**		**-**
Summer 99/2000	Weekday	-		-	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**-**		**-**	**-**		**-**

Table 27. Recreational harvest rate estimates (fish per fisher hour) and standard errors for Tarwhine (*Rhabdosargus sarba*) taken by (a) boat-based fishers, and (b) shore-based fishers, in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE
Autumn 1999	Weekday	-		-	-		-	-		-
	Weekend	0.005	±	0.004	-		-	-		-
	Total	**0.002**	±	**0.001**	**-**		**-**	**-**		**-**
Winter 1999	Weekday	-		-	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**-**		**-**	**-**		**-**
Spring 1999	Weekday	-		-	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**-**		**-**	**-**		**-**
Summer 99/2000	Weekday	-		-	-		-	0.001	±	0.002
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**-**		**-**	**0.001**	±	**0.001**

b. SHORE FISHERY

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE	Harvest Rate (fish/fisher hr)		SE
Autumn 1999	Weekday	-		-	0.033	±	0.022	-		-
	Weekend	-		-	0.111	±	0.096	-		-
	Total	**-**		**-**	**0.058**	±	**0.034**	**-**		**-**
Winter 1999	Weekday	-		-	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**-**		**-**	**-**		**-**
Spring 1999	Weekday	-		-	0.004	±	0.004	-		-
	Weekend	0.002	±	0.002	0.046	±	0.035	0.041	±	0.032
	Total	**0.001**	±	**0.001**	**0.017**	±	**0.011**	**0.012**	±	**0.009**
Summer 99/2000	Weekday	-		-	0.020	±	0.016	0.034	±	0.029
	Weekend	-		-	0.019	±	0.012	0.001	±	0.001
	Total	**-**		**-**	**0.020**	±	**0.011**	**0.022**	±	**0.019**

3.4.2.1. Example 1 - Luderick

The highest harvest rates for luderick were achieved by shore-based fishing parties in the Southern Lake area (Table 10). The peak seasons for shore-based luderick fishing success were the Winter and Spring (Table 10). This was true for both the Southern Lake and Swansea Channel areas. Shore-based harvest rates of luderick in the Northern Lake area were relatively low throughout the annual survey period (Table 10).

The harvest rates of luderick taken by boat-based fishing parties were relatively low when compared to the harvest rates recorded by shore-based fishing parties. The peak seasons for boat-based luderick fishing success in the Northern Lake and Swansea Channel areas were the Winter and Spring seasons (Table 10). Interestingly, we did not record any luderick in the harvest of boat-based fishing parties that had fished in the Southern Lake area (Table 10).

3.4.2.2. Example 2 - Blue-swimmer crab

Blue swimmer crabs were mainly harvested by boat-based fishing parties in the Southern and Northern Lake areas (Table 11). The relatively low harvest rates of crabs taken by boat-based fishing parties in the Swansea Channel indicate that these crabs may have been an incidental harvest of fishing within the Channel area. The seasonal harvest rates achieved by boat-based fishing parties in the Southern Lake area were always higher than those recorded by fishing parties in the Northern Lake area (Table 11).

The harvest rates of blue swimmer crabs taken by shore-based fishing parties were relatively low and were recorded in the Autumn and Summer seasons in the Northern and Southern Lake areas only (Table 11). We did not record any blue swimmer crabs in the harvest of shore-based fishing parties that had fished in the Swansea Channel during the entire annual survey period, nor during the Winter and Spring seasons in the Northern and Southern Lake areas (Table 11).

3.4.2.3. Example 3 - Trumpeter whiting

Trumpeter whiting were mainly harvested by boat-based fishing parties in the Southern and Northern Lake areas (Table 12). The seasonal harvest rates achieved by boat-based fishing parties in the Southern Lake area were always higher than those recorded by fishing parties in the Northern Lake area (Table 12). Trumpeter whiting harvest rates for boat-based fishing parties were greatest during the Autumn season in both the Southern and Northern Lake areas (Table 12). We did not record any trumpeter whiting in the harvests of either boat-based or shore-based fishing parties that had fished in the Swansea Channel during the entire annual survey period (Table 12). Trumpeter whiting were not an important part of shore-based harvests, hence the relatively low harvest rates recorded for shore-based fishing parties in the Northern and Southern Lake areas throughout the annual survey period (Table 12).

3.4.2.4. Example 4 - Bream

Bream were an important component of the harvest for both boat-based and shore-based fishing parties. The harvest rates of boat-based fishers were highly variable and this variability was evident in all areas of the Lake and across all seasons (Table 13). In Autumn and Winter the highest harvest rates were recorded from the Northern Lake area, in Spring the bream harvest rates were relatively similar in all three Lake areas, and in Summer the highest harvest rate was achieved by boat-based fishers in Swansea Channel (Table 13).

The shore-based harvest rates for bream were similar throughout all three Lake areas and across seasons, with the exception of one relatively high harvest rate recorded during the Summer season in the Northern Lake area (Table 13). Overall, these relatively similar harvest rates indicate that bream were being taken consistently by shore-based fishers throughout the Lake (Table 13).

3.4.2.5. Example 5 - Common squid

Common squid were mainly harvested by boat-based fishers. In the Autumn and Summer seasons the highest harvest rates for common squid were achieved by boat-based fishers in the Swansea Channel (Table 14). This pattern changed during the Winter season, when the highest harvest rate for common squid was recorded from the Southern Lake area (Table 14). Relatively low harvest rates for common squid were recorded during Spring throughout all of the Lake areas (Table 14). The harvest rates of shore-based fishers were relatively low and sporadic when compared to the boat-based harvest rates. Even so, the highest harvest rate for shore-based fishers during the Winter season was recorded in the Southern Lake area, and the highest harvest rate for common squid taken by shore-based fishers during Summer was achieved in the Swansea Channel (Table 14). This pattern is consistent with the observations made for the boat-based fishery.

3.4.3. Size-frequency distributions

Appendix 7 contains descriptive statistics of all measurements taken for each taxon by boat-based and shore-based fishers during the survey period. Here, we present length frequency distributions for 13 taxa that were commonly observed in the harvest taken by recreational fishers, aggregated for the whole fishery (boat and shore combined). The size-frequency distributions presented here are important baseline indicators which can be used to monitor future changes (if any) in the size structure of many species in the fishery. There are several noteworthy features evident in these size-frequency distributions (Figures 3 to 5). Firstly, large, highly-prized individuals were present in the recreational harvests indicating that the quality of recreational fishing opportunities were quite good. Secondly, the proportions of under-sized blue swimmer crab and luderick in the recreational harvest were extremely low indicating good compliance with fisheries regulations. Thirdly, the proportions of under-sized snapper, sand whiting and tailor were relatively high indicating a compliance problem exists for at least part of the recreational fishing population. The proportions of under-sized bream and dusky flathead in the recreational harvest were less than 10% which is comparable to compliance rates measured in other NSW estuarine fisheries (see Table 35).

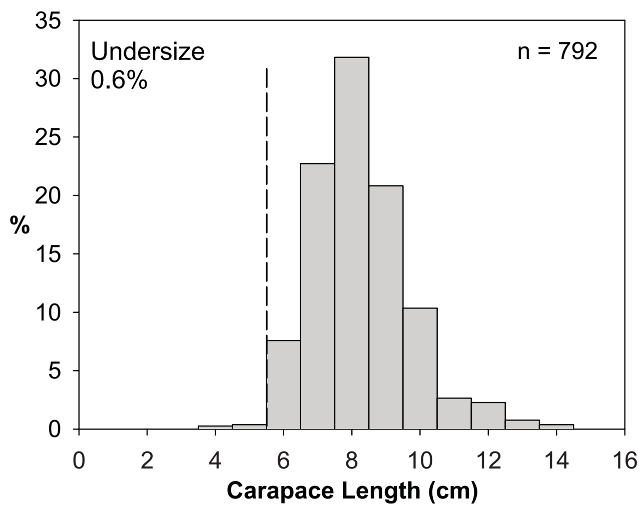


Figure 3. Length frequency distribution for Blue Swimmer Crab (*Portunus pelagicus*) taken by recreational fishers in the Lake Macquarie fishery during the annual survey period. The length frequency data have been pooled across the three Lake areas and for the boat and shore fisheries. The dashed line indicates the minimum legal carapace length.

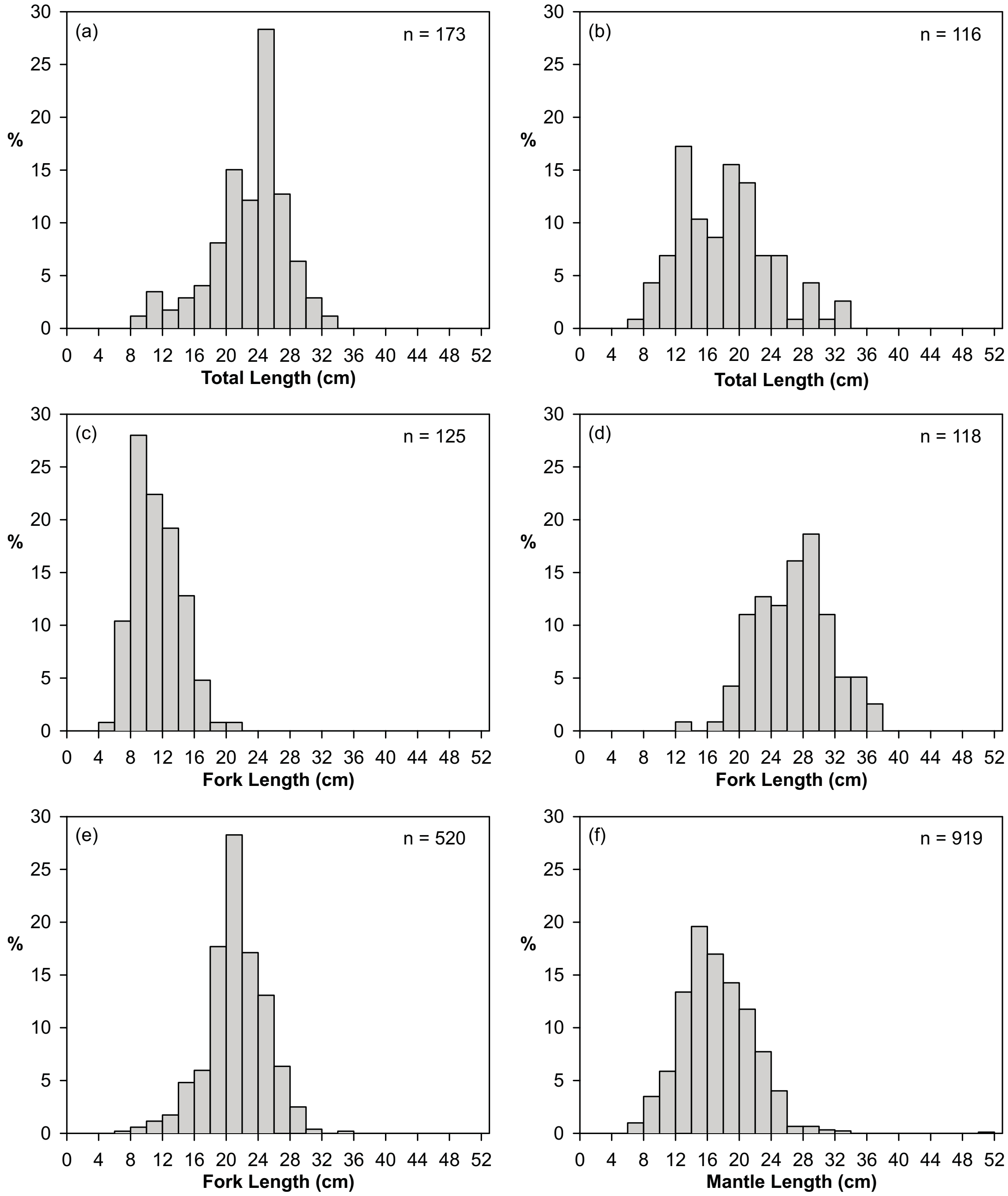


Figure 4. Length frequency distributions for (a) Yellow-finned Leatherjacket (*Meuschenia trachylepis*); (b) Six-spined Leatherjacket (*Meuschenia freycineti*); (c) Southern Herring (*Herklotsichthys castelnaui*); (d) Sand Mullet (*Myxus elongatus*); (e) Trumpeter Whiting (*Sillago maculata*); and (f) Common Squid (*Photololigo spp.*); taken by recreational fishers in the Lake Macquarie fishery during the annual survey period. The length frequency data have been pooled across the three Lake areas and for the boat and shore fisheries. These taxa do not have minimum legal lengths.

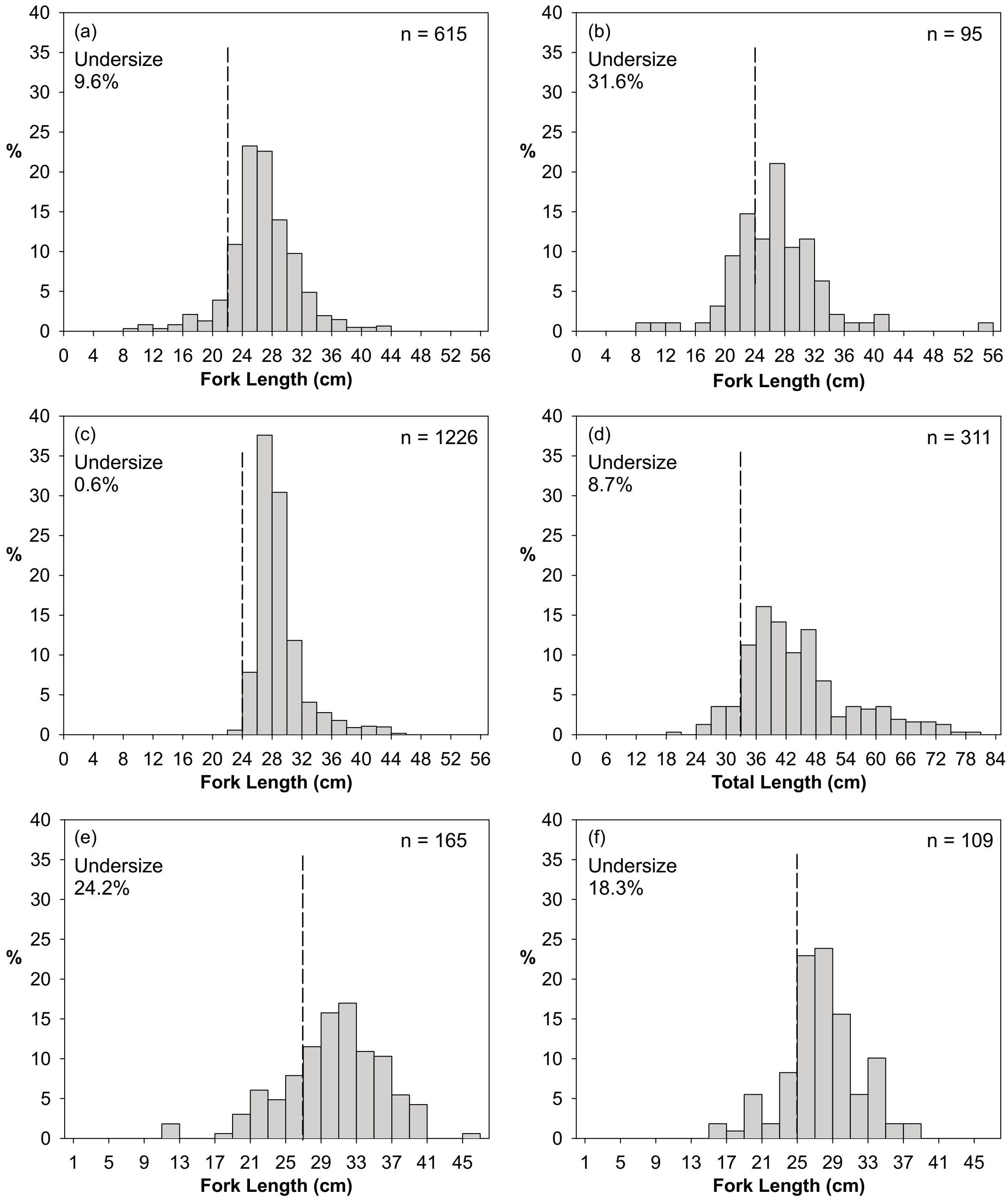


Figure 5. Length frequency distributions for (a) Yellowfin Bream (*Acanthopagrus australis*); (b) Snapper (*Pagrus auratus*); (c) Luderick (*Girella tricuspidata*); (d) Dusky Flathead (*Platycephalus fuscus*); (e) Tailor (*Pomatomus saltatrix*); and (f) Sand Whiting (*Sillago ciliata*); taken by recreational fishers in the Lake Macquarie fishery during the annual survey period. The length frequency data have been pooled across the three Lake areas and for the boat and shore fisheries. The dashed line indicates the minimum legal length.

3.5. Recreational harvest

3.5.1. Whole fishery

We recorded 60 taxa in the retained catch of recreational fishers accessing the Lake Macquarie fishery by boat and from the shore during the annual survey period (Table 28). We estimated that about 913,500 fish, crabs and cephalopods (± 65,700 individuals - approximate SE) were harvested by daytime recreational fishers from Lake Macquarie and Swansea Channel during the survey year (Table 28), and that this recreational harvest consisted of about 546,100 finfish (± 47,600 individuals - approximate SE) and about 367,400 crabs and cephalopods (± 45,400 individuals - approximate SE). The ten most commonly harvested taxa, by number (Table 28), during the survey period were blue swimmer crab (≈235,100 - 25.7%), trumpeter whiting (≈132,400 - 14.5%), common squid (≈125,000 - 13.7%), yellowfin bream (≈74,200 - 8.1%), luderick (≈66,800 - 7.3%), yellow-finned leatherjacket (≈53,200 - 5.8%), sand mullet (≈51,000 - 5.6%), dusky flathead (≈34,000 - 3.7%), tailor (≈21,800 - 2.4%) and flat-tail mullet (≈18,900 - 2.1%). These ten taxa, by number, accounted for 88.9% of the daytime recreational harvest during the annual survey period (Table 28).

We estimated that about 295 tonnes of fish, crabs and cephalopods (± 27 tonnes - approximate SE) were harvested by daytime recreational fishers from Lake Macquarie and Swansea Channel during the survey year (Table 29), and that this recreational harvest consisted of about 163 tonnes of finfish (± 12 tonnes - approximate SE) and about 132 tonnes of crabs and cephalopods (± 24 tonnes - approximate SE). The ten most commonly harvested taxa, by weight (Table 29), during the survey period were blue swimmer crab (≈108.9 tonnes - 36.9%), luderick (≈35.4 tonnes - 12.0%), yellowfin bream (≈32.5 tonnes - 11.0%), dusky flathead (≈21.4 tonnes - 7.3%), common squid (≈17.9 tonnes - 6.0%), sand mullet (≈13.8 tonnes - 4.7%), trumpeter whiting (≈12.4 tonnes - 4.2%), yellow-finned leatherjacket (≈10.2 tonnes - 3.5%), snapper (≈8.7 tonnes - 2.9%) and tailor (≈7.4 tonnes - 2.5%). These ten taxa, by weight, accounted for 91.0% of the daytime recreational harvest during the annual survey period (Table 29).

Table 28. Seasonal and annual harvest estimates (number of individuals) and standard errors for taxa taken by recreational fishers in the Lake Macquarie fishery. The daytime harvest data have been pooled across the three Lake areas and for the boat and shore fisheries.

	TOTAL HARVEST FOR WHOLE FISHERY										
	Autumn 1999		Winter 1999		Spring 1999		Summer 99/2000		Total		%
Taxon	No.	SE	No.	SE	No.	SE	No.	SE	No.	SE	total
Blue Swimmer Crab *Portunus pelagicus*	71,355	± 12,631	24,883	± 13,879	36,586	± 19,131	102,301	± 31,467	235,125	± 41,332	25.7
Trumpeter Whiting *Sillago maculata*	63,899	± 32,649	8,708	± 2,453	12,216	± 3,916	47,595	± 13,523	132,418	± 35,640	14.5
Common Squid *Photololigo spp.*	66,115	± 15,324	19,553	± 3,523	6,356	± 2,001	32,937	± 9,422	124,961	± 18,439	13.7
Yellowfin Bream *Acanthopagrus australis*	27,323	± 3,870	4,254	± 1,349	10,448	± 2,624	32,198	± 14,315	74,223	± 15,119	8.1
Luderick *Girella tricuspidata*	6,470	± 1,998	20,266	± 3,875	26,237	± 8,945	13,798	± 4,682	66,771	± 10,998	7.3
Yellow-finned Leatherjacket *Meuschenia trachylepis*	21,447	± 12,964	991	± 475	9,050	± 4,401	21,719	± 6,272	53,207	± 15,066	5.8
Sand Mullet *Myxus elongatus*	16,949	± 6,289	1,402	± 1,148	13,897	± 8,702	18,761	± 7,575	51,009	± 13,190	5.6
Dusky Flathead *Platycephalus fuscus*	13,514	± 4,024	1,171	± 332	5,891	± 2,225	13,389	± 2,849	33,965	± 5,420	3.7
Tailor *Pomatomus saltatrix*	7,990	± 2,630	3,598	± 1,439	7,246	± 3,514	2,960	± 1,545	21,794	± 4,870	2.4
Flat-tail Mullet *Liza argentea*	7,355	± 2,781	519	± 425	-	-	11,053	± 6,528	18,927	± 7,108	2.1
Fan-bellied Leatherjacket *Monacanthus chinensis*	3,677	± 922	125	± 69	899	± 367	8,934	± 4,321	13,635	± 4,434	1.5
Snapper *Pagrus auratus*	4,862	± 834	2,703	± 663	1,149	± 720	4,211	± 1,899	12,925	± 2,294	1.4

Table 28 – Continued.

	TOTAL HARVEST FOR WHOLE FISHERY										
	Autumn 1999		Winter 1999		Spring 1999		Summer 99/2000		Total		%
Taxon	No.	SE	No.	SE	No.	SE	No.	SE	No.	SE	total
River Garfish *Hyporhamphus regularis*	9,609	± 7,331	-	-	2,194	± 2,194	994	± 915	12,797	± 7,707	1.4
Large-toothed Flounder *Pseudorhombus arsius*	2,071	± 692	460	± 288	1,830	± 938	5,949	± 2,333	10,310	± 2,624	1.1
Six-spined Leatherjacket *Meuschenia freycineti*	2,337	± 1,258	2,731	± 950	763	± 305	4,264	± 3,592	10,095	± 3,934	1.1
Small-toothed Flounder *Pseudorhombus jenynsii*	2,547	± 878	779	± 329	1,301	± 549	2,795	± 992	7,422	± 1,471	0.8
Sand Whiting *Sillago ciliata*	1,930	± 681	287	± 177	1,021	± 327	3,723	± 2,349	6,961	± 2,474	0.8
Tarwhine *Rhabdosargus sarba*	3,287	± 2,438	-	-	1,076	± 561	1,601	± 774	5,964	± 2,618	0.7
Mud Crab *Scylla serrata*	4,287	± 2,764	-	-	125	± 125	471	± 471	4,883	± 2,806	0.5
Sea Garfish *Hyporhamphus australis*	105	± 94	-	-	34	± 34	4,358	± 3,723	4,497	± 3,724	0.5
Southern Herring *Herklotsichthys castelnaui*	111	± 100	-	-	717	± 717	2,976	± 1,033	3,804	± 1,261	0.4
Southern Calamari *Sepioteuthis australis*	-	-	2,320	± 1,570	72	± 48	-	-	2,392	± 1,570	0.3
Eastern Blue-spotted Flathead *Platycephalus caeruleopunctatus*	943	± 496	-	-	497	± 489	-	-	1,440	± 696	0.2
School Whiting *Sillago flindersi*	105	± 94	-	-	-	-	1,111	± 739	1,216	± 745	0.1
Black Trevally (Spinefoot)* *Siganus spp.*	-	-	938	± 506	89	± 77	131	± 87	1,158	± 519	0.1

Table 28 – Continued.

	TOTAL HARVEST FOR WHOLE FISHERY										
	Autumn 1999		Winter 1999		Spring 1999		Summer 99/2000		Total		%
Taxon	No.	SE	No.	SE	No.	SE	No.	SE	No.	SE	total
Stout Longtom* *Tylosurus gavialoides*	358 ±	193	-	-	-	-	402 ±	296	760 ±	353	< 0.1
Rough Leatherjacket *Scobinichthys granulatus*	182 ±	163	#1	-	-	-	395 ±	345	578 ±	381	< 0.1
Silver Trevally *Pseudocaranx dentex*	158 ±	123	5 ±	4	77 ±	50	36 ±	36	276 ±	138	< 0.1
Six-lined Trumpeter* *Pelates quadrilineatus*	-	-	#10	-	#4	-	-	-	#14	-	< 0.1
Red Bigeye* *Priacanthus sp.*	#12	-	#1	-	-	-	-	-	#13	-	< 0.1
Fan-tail Mullet *Mugil georgii*	#8	-	-	-	-	-	-	-	#8	-	< 0.1
Mulloway *Argyrosomus hololepidotus*	#1	-	-	-	#1	-	#4	-	#6	-	< 0.1
Chinaman Leatherjacket *Nelusetta ayraudi*	#5	-	-	-	-	-	-	-	#5	-	< 0.1
Teraglin *Atractoscion aequidens*	-	-	-	-	-	-	#5	-	#5	-	< 0.1
Dolphin Fish *Coryphaena hippurus*	#4	-	-	-	-	-	-	-	#4	-	< 0.1
Black Bream *Acanthopagrus butcheri*	#2	-	-	-	-	-	#1	-	#3	-	< 0.1
Kingfish *Seriola lalandi*	#1	-	#1	-	#1	-	-	-	#3	-	< 0.1
Wirrah *Acanthistius ocellatus*	-	-	-	-	#3	-	-	-	#3	-	< 0.1

Table 28 - Continued.

	TOTAL HARVEST FOR WHOLE FISHERY										
	Autumn 1999		Winter 1999		Spring 1999		Summer 99/2000		Total		%
Taxon	No.	SE	No.	SE	No.	SE	No.	SE	No.	SE	total
Crimson-banded Wrasse *Notolabrus gymnogenis*	#1	-	-	-	#1	-	-	-	#2	-	< 0.1
Rock Blackfish* *Girella elevata*	-	-	-	-	#2	-	-	-	#2	-	< 0.1
Sea Mullet *Mugil cephalus*	#2	-	-	-	-	-	-	-	#2	-	< 0.1
Black Sole* *Synaptura nigra*	#1	-	-	-	-	-	-	-	#1	-	< 0.1
Blue-striped Goatfish *Upeneichthys spp.*	-	-	-	-	#1	-	-	-	#1	-	< 0.1
Cobia *Rachycentron canadum*	#1	-	-	-	-	-	-	-	#1	-	< 0.1
Conger Eel* Congridae	#1	-	-	-	-	-	-	-	#1	-	< 0.1
Giant Herring* *Elops machnata*	-	-	#1	-	-	-	-	-	#1	-	< 0.1
Long-spined Flathead *Platycephalus longispinis*	#1	-	-	-	-	-	-	-	#1	-	< 0.1
Marbled Flathead *Platycephalus marmoratus*	#1	-	-	-	-	-	-	-	#1	-	< 0.1
Northern Sand Flathead *Platycephalus arenarius*	-	-	-	-	#1	-	-	-	#1	-	< 0.1
Salmon *Arripis trutta*	-	-	#1	-	-	-	-	-	#1	-	< 0.1
Shovelnose Ray* Rhinobatidae	-	-	#1	-	-	-	-	-	#1	-	< 0.1

Table 28 – Continued.

	TOTAL HARVEST FOR WHOLE FISHERY										
	Autumn 1999		Winter 1999		Spring 1999		Summer 99/2000		Total		%
Taxon	No.	SE	No.	SE	No.	SE	No.	SE	No.	SE	total
Silver Batfish* *Monodactylus argenteus*	-	-	-	-	-	-	#1	-	#1	-	< 0.1
Silver Sweep *Scorpis lineolatus*	-	-	-	-	-	-	#1	-	#1	-	< 0.1
Striped Seapike *Sphyraena obtusata*	-	-	-	-	#1	-	-	-	#1	-	< 0.1
Surgeon Fish* Acanthuridae	-	-	-	-	#1	-	-	-	#1	-	< 0.1
Tiger Flathead *Neoplatycephalus richardsoni*	-	-	-	-	-	-	#1	-	#1	-	< 0.1
Yellowtail Trachurus novaezelandiae	#1	-	-	-	-	-	-	-	#1	-	< 0.1
Arrow Squid *Nototodarus gouldi*	-	-	-	-	-	-	#1	-	#1	-	< 0.1
Octopus* *Octopus spp.*	-	-	-	-	#1	-	-	-	#1	-	< 0.1
Hairy-backed Crab* *Charybdis natator*	-	-	#1	-	-	-	-	-	#1	-	< 0.1
Total Taxa	**41**		**27**		**35**		**33**		**60**		

* Associated estimates of expanded weight (kg) are not provided for this taxon in Table 29 because a suitable length to weight conversion key was not available.
# Expanded estimates of harvest have not been calculated. This observation was classified as a rare event during this time period and its occurrence is simply noted.

Table 29. Seasonal and annual harvest estimates (kilograms) and standard errors for taxa taken by recreational fishers in the Lake Macquarie fishery. The daytime harvest data have been pooled across the three Lake areas and for the boat and shore fisheries.

	TOTAL HARVEST FOR WHOLE FISHERY										
	Autumn 1999		Winter 1999		Spring 1999		Summer 99/2000		Total		%
Taxon	kg	SE	kg	SE	kg	SE	kg	SE	kg	SE	total
Blue Swimmer Crab *Portunus pelagicus*	29,544	± 5,342	11,894	± 6,375	13,805	± 7,075	53,663	± 20,925	108,906	± 23,603	36.9
Luderick *Girella tricuspidata*	3,155	± 960	9,563	± 1,895	14,309	± 5,971	8,411	± 2,870	35,438	± 6,957	12.0
Yellowfin Bream *Acanthopagrus australis*	11,282	± 1,718	2,499	± 881	4,737	± 1,103	14,014	± 5,637	32,532	± 6,060	11.0
Dusky Flathead *Platycephalus fuscus*	8,187	± 1,934	585	± 165	2,925	± 904	9,744	± 2,143	21,441	± 3,029	7.3
Common Squid *Photololigo spp.*	9,376	± 2,118	2,723	± 620	999	± 326	4,771	± 1,351	17,869	± 2,608	6.0
Sand Mullet *Myxus elongatus*	5,970	± 2,268	189	± 155	2,742	± 1,544	4,936	± 2,053	13,837	± 3,430	4.7
Trumpeter Whiting *Sillago maculata*	5,672	± 2,701	1,040	± 280	1,466	± 531	4,206	± 1,375	12,384	± 3,089	4.2
Yellow-finned Leatherjacket *Meuschenia trachylepis*	3,783	± 1,983	188	± 82	2,072	± 1,040	4,196	± 1,246	10,239	± 2,564	3.5
Snapper *Pagrus auratus*	2,112	± 360	1,476	± 410	576	± 362	4,547	± 3,275	8,711	± 3,340	2.9
Tailor *Pomatomus saltatrix*	2,054	± 549	1,594	± 710	2,839	± 1,532	954	± 568	7,441	± 1,864	2.5
Flat-tail Mullet *Liza argentea*	3,202	± 1,313	160	± 131	-	-	2,856	± 1,603	6,218	± 2,076	2.1
Fan-bellied Leatherjacket *Monacanthus chinensis*	1,021	± 280	41	± 22	262	± 116	2,814	± 1,752	4,138	± 1,778	1.4

Table 29 - Continued.

	TOTAL HARVEST FOR WHOLE FISHERY										
	Autumn 1999		Winter 1999		Spring 1999		Summer 99/2000		Total		%
Taxon	kg	SE	kg	SE	kg	SE	kg	SE	kg	SE	total
Mud Crab *Scylla serrata*	2,673 ±	1,613	-	-	73 ±	73	441 ±	441	3,187 ±	1,674	1.1
Southern Calamari *Sepioteuthis australis*	-	-	2,196 ±	1,604	40 ±	27	-	-	2,236 ±	1,604	0.8
Tarwhine *Rhabdosargus sarba*	1,238 ±	928	-	-	274 ±	140	604 ±	294	2,116 ±	983	0.7
Large-toothed Flounder *Pseudorhombus arsius*	291 ±	95	97 ±	65	388 ±	172	1,130 ±	464	1,906 ±	508	0.6
Sand Whiting *Sillago ciliata*	510 ±	180	76 ±	47	385 ±	137	779 ±	479	1,750 ±	532	0.6
Small-toothed Flounder *Pseudorhombus jenynsii*	479 ±	162	184 ±	97	320 ±	144	630 ±	254	1,613 ±	348	0.5
Six-spined Leatherjacket *Meuschenia freycineti*	742 ±	405	334 ±	134	56 ±	22	428 ±	290	1,560 ±	516	0.5
River Garfish *Hyporhamphus regularis*	379 ±	295	-	-	91 ±	91	78 ±	74	548 ±	318	0.2
Eastern Blue-spotted Flathead *Platycephalus caeruleopunctatus*	363 ±	219	-	-	134 ±	129	-	-	497 ±	254	0.2
Sea Garfish *Hyporhamphus australis*	2 ±	1	-	-	2 ±	2	228 ±	200	232 ±	200	< 0.1
Rough Leatherjacket *Scobinichthys granulatus*	45 ±	40	-	-	-	-	163 ±	149	208 ±	154	< 0.1
Silver Trevally *Pseudocaranx dentex*	57 ±	44	2 ±	2	116 ±	104	10 ±	10	185 ±	114	< 0.1
School Whiting *Sillago flindersi*	18 ±	16	-	-	-	-	156 ±	106	174 ±	107	< 0.1

Table 29 - Continued.

	TOTAL HARVEST FOR WHOLE FISHERY										
	Autumn 1999		Winter 1999		Spring 1999		Summer 99/2000		Total		%
Taxon	kg	SE	kg	SE	kg	SE	kg	SE	kg	SE	total
Southern Herring *Herklotsichthys castelnaui*	1 ±	1	-	-	14 ±	14	95 ±	32	110 ±	35	< 0.1
Mulloway *Argyrosomus hololepidotus*	#4	-	-	-	#10	-	#11	-	#25	-	< 0.1
Kingfish *Seriola lalandi*	#< 1	-	#5	-	#2	-	-	-	#7	-	< 0.1
Dolphin Fish *Coryphaena hippurus*	#6	-	-	-	-	-	-	-	#6	-	< 0.1
Cobia *Rachycentron canadum*	#4	-	-	-	-	-	-	-	#4	-	< 0.1
Teraglin *Atractoscion aequidens*	-	-	-	-	-	-	#4	-	#4	-	< 0.1
Salmon *Arripis trutta*	-	-	#3	-	-	-	-	-	#3	-	< 0.1
Tiger Flathead *Neoplatycephalus richardsoni*	-	-	-	-	-	-	#3	-	#3	-	< 0.1
Fan-tail Mullet *Mugil georgii*	#2	-	-	-	-	-	-	-	#2	-	< 0.1
Black Bream *Acanthopagrus butcheri*	#< 1	-	-	-	-	-	#< 1	-	#1	-	< 0.1
Marbled Flathead *Platycephalus marmoratus*	#1	-	-	-	-	-	-	-	#1	-	< 0.1
Sea Mullet *Mugil cephalus*	#1	-	-	-	-	-	-	-	#1	-	< 0.1
Wirrah *Acanthistius ocellatus*	-	-	-	-	#1	-	-	-	#1	-	< 0.1

Table 29 - Continued.

	TOTAL HARVEST FOR WHOLE FISHERY										
	Autumn 1999		Winter 1999		Spring 1999		Summer 99/2000		Total		%
Taxon	kg	SE	kg	SE	kg	SE	kg	SE	kg	SE	total
Crimson-banded Wrasse *Notolabrus gymnogenis*	#< 1	-	-	-	#< 1	-	-	-	#< 1	-	< 0.1
Long-spined Flathead *Platycephalus longispinis*	#< 1	-	-	-	-	-	-	-	#< 1	-	< 0.1
Northern Sand Flathead *Platycephalus arenarius*	-	-	-	-	#< 1	-	-	-	#< 1	-	< 0.1
Silver Sweep *Scorpis lineolatus*	-	-	-	-	-	-	#< 1	-	#< 1	-	< 0.1
Striped Seapike *Sphyraena obtusata*	-	-	-	-	#< 1	-	-	-	#< 1	-	< 0.1
Yellowtail *Trachurus novaezelandiae*	#< 1	-	-	-	-	-	-	-	#< 1	-	< 0.1
Arrow Squid Nototodarus gouldi	#< 1	-	-	-	-	-	-	-	#< 1	-	< 0.1
Blue-striped Goatfish *Upeneichthys spp.*	-	-	-	-	†	-	-	-	†	-	-
Chinaman Leatherjacket *Nelusetta ayraudi*	†	-	-	-	-	-	-	-	†	-	-

Expanded estimates of harvest have not been calculated. This observation was classified as a rare event during this time period and its occurrence is simply noted.
† Estimates of weight (kg) are not provided for this taxon because no length measurements were made.

3.5.2. Boat fishery

We recorded 46 taxa in the retained catch of boat-based recreational fishers during the annual survey period (Table 30). We estimated that for boat-based recreational fishers, about 715,700 fish, crabs and cephalopods (± 60,900 individuals - approximate SE), were harvested in the daytime from Lake Macquarie and Swansea Channel during the survey year (Table 30). This represents 78.3%, by number, of the annual daytime harvest for the total fishery (boat and shore combined). The recreational harvest for the boat fishery (Table 30) consisted of about 358,700 finfish (± 40,800 individuals - approximate SE) and about 356,900 crabs and cephalopods (± 45,300 individuals - approximate SE). The ten most commonly harvested taxa by boat-based fishers, by number (Table 30), during the survey period were blue swimmer crab (≈233,400 - 32.6%), trumpeter whiting (≈129,700 - 18.1%), common squid (≈118,700 - 16.6%), yellowfin bream (≈42,400 - 5.9%), dusky flathead (≈32,100 - 4.5%), yellow-finned leatherjacket (≈22,900 - 3.2%), sand mullet (≈21,100 - 2.9%), tailor (≈17,100 - 2.4%), luderick (≈14,300 - 2.0%) and river garfish (≈12,800 - 1.8%). These ten taxa, by number, accounted for 90.0% of the daytime recreational harvest of the boat-based fishery during the annual survey period (Table 30).

We estimated that for boat-based recreational fishers, about 227 tonnes of fish, crabs and cephalopods (± 26 tonnes - approximate SE), were harvested in the daytime from Lake Macquarie and Swansea Channel during the survey year (Table 31). This represents 76.7%, by weight, of the annual daytime harvest for the total fishery (boat and shore combined). The recreational harvest for the boat fishery (Table 31) consisted of about 99 tonnes of finfish (± 9 tonnes - approximate SE) and about 128 tonnes of crabs and cephalopods (± 24 tonnes - approximate SE). The ten most commonly harvested taxa by boat-based fishers, by weight (Table 31), during the survey period were blue swimmer crab (≈108.3 tonnes - 47.7%), dusky flathead (≈20.0 tonnes - 8.8%), yellowfin bream (≈19.1 tonnes - 8.4%), common squid (≈16.7 tonnes - 7.4%), trumpeter whiting (≈12.1 tonnes - 5.3%), snapper (≈8.7 tonnes - 3.8%), luderick (≈8.5 tonnes - 3.7%), tailor (≈6.8 tonnes - 3.0%), sand mullet (≈5.9 tonnes - 2.6%) and yellow-finned leatherjacket (≈4.7 tonnes - 2.1%). These ten taxa, by weight, accounted for 92.8% of the daytime recreational harvest of the boat-based fishery during the annual survey period (Table 31).

Table 30. Seasonal and annual harvest estimates (number of individuals) and standard errors for taxa taken by boat-based recreational fishers in the Lake Macquarie fishery. The daytime harvest data have been pooled across the three Lake areas.

	BOAT-BASED HARVEST FOR WHOLE FISHERY										
	Autumn 1999		Winter 1999		Spring 1999		Summer 99/2000		Total		%
Taxon	No.	SE	No.	SE	No.	SE	No.	SE	No.	SE	total
Blue Swimmer Crab *Portunus pelagicus*	70,038	± 12,594	24,883	± 13,879	36,586	± 19,131	101,857	± 31,465	233,364	± 41,320	32.6
Trumpeter Whiting *Sillago maculata*	62,769	± 32,646	8,708	± 2,453	12,216	± 3,916	45,989	± 13,427	129,682	± 35,601	18.1
Common Squid *Photololigo spp.*	65,357	± 15,315	18,055	± 3,481	5,846	± 1,982	29,441	± 9,266	118,699	± 18,343	16.6
Yellowfin Bream *Acanthopagrus australis*	19,996	± 3,038	3,405	± 1,328	7,301	± 2,482	11,654	± 4,389	42,356	± 6,035	5.9
Dusky Flathead *Platycephalus fuscus*	12,814	± 4,016	941	± 276	5,817	± 2,224	12,529	± 2,810	32,101	± 5,389	4.5
Yellow-finned Leatherjacket *Meuschenia trachylepis*	2,690	± 2,099	957	± 474	6,698	± 4,055	12,523	± 4,736	22,868	± 6,596	3.2
Sand Mullet *Myxus elongatus*	9,436	± 5,382	1,402	± 1,148	71	± 50	10,185	± 6,218	21,094	± 8,304	2.9
Tailor *Pomatomus saltatrix*	4,807	± 1,195	3,034	± 1,385	6,281	± 3,475	2,960	± 1,545	17,082	± 4,220	2.4
Luderick *Girella tricuspidata*	884	± 791	1,925	± 1,147	10,508	± 8,521	967	± 1,043	14,284	± 8,697	2.0
River Garfish *Hyporhamphus regularis*	9,609	± 7,331	-	-	2,194	± 2,194	994	± 915	12,797	± 7,707	1.8
Snapper *Pagrus auratus*	4,557	± 799	2,696	± 663	1,149	± 720	4,211	± 1,899	12,613	± 2,281	1.8
Large-toothed Flounder *Pseudorhombus arsius*	2,070	± 692	460	± 288	1,830	± 938	5,949	± 2,333	10,309	± 2,624	1.4

Table 30 – Continued.

	BOAT-BASED HARVEST FOR WHOLE FISHERY										
	Autumn 1999		Winter 1999		Spring 1999		Summer 99/2000		Total		%
Taxon	No.	SE	No.	SE	No.	SE	No.	SE	No.	SE	total
Fan-bellied Leatherjacket *Monacanthus chinensis*	2,224	± 403	-	-	687	± 341	5,162	± 2,655	8,073	± 2,707	1.1
Flat-tail Mullet *Liza argentea*	6,577	± 2,737	519	± 425	-	-	818	± 882	7,914	± 2,907	1.1
Small-toothed Flounder *Pseudorhombus jenynsii*	2,546	± 878	779	± 329	1,301	± 549	2,795	± 992	7,421	± 1,471	1.0
Sand Whiting *Sillago ciliata*	1,859	± 679	65	± 53	1,021	± 327	3,691	± 2,349	6,636	± 2,467	0.9
Six-spined Leatherjacket *Meuschenia freycineti*	159	± 103	1,227	± 682	-	-	3,908	± 3,588	5,294	± 3,653	0.7
Mud Crab *Scylla serrata*	4,287	± 2,764	-	-	125	± 125	471	± 471	4,883	± 2,806	0.7
Sea Garfish *Hyporhamphus australis*	105	± 94	-	-	34	± 34	4,358	± 3,723	4,497	± 3,724	0.6
Eastern Blue-spotted Flathead *Platycephalus caeruleopunctatus*	943	± 496	-	-	497	± 489	-	-	1,440	± 696	0.2
School Whiting *Sillago flindersi*	105	± 94	-	-	-	-	1,111	± 739	1,216	± 745	0.2
Rough Leatherjacket *Scobinichthys granulatus*	182	± 163	-	-	-	-	395	± 345	577	± 381	0.1
Stout Longtom* *Tylosurus gavialoides*	53	± 47	-	-	-	-	402	± 296	455	± 300	0.1
Red Bigeye* *Priacanthus sp.*	#12	-	#1	-	-	-	-	-	#13	-	< 0.1
Tarwhine *Rhabdosargus sarba*	#5	-	-	-	-	-	#1	-	#6	-	< 0.1

Table 30 – Continued.

	BOAT-BASED HARVEST FOR WHOLE FISHERY										
	Autumn 1999		Winter 1999		Spring 1999		Summer 99/2000		Total		%
Taxon	No.	SE	No.	SE	No.	SE	No.	SE	No.	SE	total
Mulloway *Argyrosomus hololepidotus*	-	-	-	-	#1	-	#4	-	#5	-	< 0.1
Teraglin *Atractoscion aequidens*	-	-	-	-	-	-	#5	-	#5	-	< 0.1
Dolphin Fish *Coryphaena hippurus*	#4	-	-	-	-	-	-	-	#4	-	< 0.1
Black Bream *Acanthopagrus butcheri*	#2	-	-	-	-	-	#1	-	#3	-	< 0.1
Wirrah *Acanthistius ocellatus*	-	-	-	-	#3	-	-	-	#3	-	< 0.1
Kingfish *Seriola lalandi*	#1	-	-	-	#1	-	-	-	#2	-	< 0.1
Six-Lined Trumpeter* *Pelates quadrilineatus*	-	-	-	-	#2	-	-	-	#2	-	< 0.1
Southern Calamari *Sepioteuthis australis*	-	-	#2	-	-	-	-	-	#2	-	< 0.1
Black Sole* *Synaptura nigra*	#1	-	-	-	-	-	-	-	#1	-	< 0.1
Blue-striped Goatfish *Upeneichthys spp.*	-	-	-	-	#1	-	-	-	#1	-	< 0.1
Cobia *Rachycentron canadum*	#1	-	-	-	-	-	-	-	#1	-	< 0.1
Crimson-Banded Wrasse *Notolabrus gymnogenis*	-	-	-	-	#1	-	-	-	#1	-	< 0.1
Long-spined Flathead *Platycephalus longispinis*	#1	-	-	-	-	-	-	-	#1	-	< 0.1

Table 30 – Continued.

	BOAT-BASED HARVEST FOR WHOLE FISHERY										
	Autumn 1999		Winter 1999		Spring 1999		Summer 99/2000		Total		%
Taxon	No.	SE	No.	SE	No.	SE	No.	SE	No.	SE	total
Northern Sand Flathead *Platycephalus arenarius*	-	-	-	-	#1	-	-	-	#1	-	< 0.1
Shovelnose Ray* Rhinobatidae	-	-	#1	-	-	-	-	-	#1	-	< 0.1
Silver Sweep *Scorpis lineolatus*	-	-	-	-	-	-	#1	-	#1	-	< 0.1
Striped Seapike *Sphyraena obtusata*	-	-	-	-	#1	-	-	-	#1	-	< 0.1
Surgeon Fish* Acanthuridae	-	-	-	-	#1	-	-	-	#1	-	< 0.1
Yellowtail *Trachurus novaezelandiae*	#1	-	-	-	-	-	-	-	#1	-	< 0.1
Octopus* *Octopus spp.*	-	-	-	-	#1	-	-	-	#1	-	< 0.1
Hairy-backed Crab* *Charybdis natator*	-	-	#1	-	-	-	-	-	#1	-	< 0.1
Total Taxa	**32**		**19**		**28**		**27**		**46**		

* Associated estimates of expanded weight (kg) are not provided for this taxon in Table 31 because a suitable length to weight conversion key was not available.
# Expanded estimates of harvest have not been calculated. This observation was classified as a rare event during this time period and its occurrence is simply noted.

Table 31. Seasonal and annual harvest estimates (kilograms) and standard errors for taxa taken by boat-based recreational fishers in the Lake Macquarie fishery. The daytime harvest data have been pooled across the three Lake areas.

	BOAT-BASED HARVEST FOR WHOLE FISHERY										
	Autumn 1999		Winter 1999		Spring 1999		Summer 99/2000		Total		%
Taxon	kg	SE	kg	SE	kg	SE	kg	SE	kg	SE	total
Blue Swimmer Crab *Portunus pelagicus*	29,082	± 5,331	11,894	± 6,375	13,805	± 7,075	53,498	± 20,925	108,279	± 23,600	47.7
Dusky Flathead *Platycephalus fuscus*	7,673	± 1,914	462	± 136	2,875	± 903	9,030	± 2,097	20,040	± 2,983	8.8
Yellowfin Bream *Acanthopagrus australis*	8,108	± 1,492	2,034	± 870	3,079	± 998	5,890	± 2,356	19,111	± 3,087	8.4
Common Squid *Photololigo spp.*	9,307	± 2,117	2,142	± 469	935	± 324	4,352	± 1,337	16,736	± 2,568	7.4
Trumpeter Whiting *Sillago maculata*	5,558	± 2,700	1,040	± 280	1,466	± 531	4,018	± 1,362	12,082	± 3,083	5.3
Snapper *Pagrus auratus*	2,075	± 359	1,476	± 410	576	± 362	4,547	± 3,275	8,674	± 3,340	3.8
Luderick *Girella tricuspidata*	492	± 441	898	± 507	6,739	± 5,829	345	± 372	8,474	± 5,879	3.7
Tailor *Pomatomus saltatrix*	1,682	± 488	1,472	± 706	2,651	± 1,529	954	± 568	6,759	± 1,843	3.0
Sand Mullet *Myxus elongatus*	3,504	± 2,027	189	± 155	20	± 17	2,208	± 1,437	5,921	± 2,489	2.6
Yellow-finned Leatherjacket *Meuschenia trachylepis*	584	± 461	181	± 82	1,527	± 949	2,406	± 988	4,698	± 1,448	2.1
Flat-tail Mullet *Liza argentea*	3,013	± 1,307	160	± 131	-	-	202	± 218	3,375	± 1,332	1.5
Mud Crab *Scylla serrata*	2,673	± 1,613	-	-	73	± 73	441	± 441	3,187	± 1,674	1.4
Large-toothed Flounder *Pseudorhombus arsius*	291	± 95	97	± 65	388	± 172	1,130	± 464	1,906	± 508	0.8

Table 31 – Continued.

	BOAT-BASED HARVEST FOR WHOLE FISHERY										
	Autumn 1999		Winter 1999		Spring 1999		Summer 99/2000		Total		%
Taxon	kg	SE	kg	SE	kg	SE	kg	SE	kg	SE	total
Fan-bellied Leatherjacket *Monacanthus chinensis*	561 ±	97	-	-	192 ±	106	1,145 ±	560	1,898 ±	579	0.8
Sand Whiting *Sillago ciliata*	502 ±	180	16 ±	13	385 ±	137	771 ±	479	1,674 ±	530	0.7
Small-toothed Flounder *Pseudorhombus jenynsii*	479 ±	162	184 ±	97	320 ±	144	630 ±	254	1,613 ±	348	0.7
Six-spined Leatherjacket *Meuschenia freycineti*	19 ±	15	217 ±	123	-	-	391 ±	289	627 ±	315	0.3
River Garfish *Hyporhamphus regularis*	379 ±	295	-	-	91 ±	91	78 ±	74	548 ±	318	0.2
Eastern Blue-spotted Flathead *Platycephalus caeruleopunctatus*	363 ±	219	-	-	134 ±	129	-	-	497 ±	254	0.2
Sea Garfish *Hyporhamphus australis*	2 ±	1	-	-	2 ±	2	228 ±	200	232 ±	200	0.1
Rough Leatherjacket *Scobinichthys granulatus*	45 ±	40	-	-	-	-	163 ±	149	208 ±	154	0.1
School Whiting *Sillago flindersi*	18 ±	16	-	-	-	-	156 ±	106	174 ±	107	0.1
Mulloway *Argyrosomus hololepidotus*	-	-	-	-	#10	-	#11	-	#21	-	< 0.1
Cobia *Rachycentron canadum*	#4	-	-	-	-	-	-	-	#4	-	< 0.1
Dolphin Fish *Coryphaena hippurus*	#4	-	-	-	-	-	-	-	#4	-	< 0.1
Teraglin *Atractoscion aequidens*	-	-	-	-	-	-	#4	-	#4	-	< 0.1

Table 31 – Continued.

	BOAT-BASED HARVEST FOR WHOLE FISHERY										
	Autumn 1999		Winter 1999		Spring 1999		Summer 99/2000		Total		%
Taxon	kg	SE	kg	SE	kg	SE	kg	SE	kg	SE	total
Kingfish *Seriola lalandi*	#< 1	-	-	-	#2	-	-	-	#2	-	< 0.1
Tarwhine *Rhabdosargus sarba*	#1	-	-	-	-	-	#< 1	-	#2	-	< 0.1
Southern Calamari *Sepioteuthis australis*	-	-	#2	-	-	-	-	-	#2	-	< 0.1
Black Bream *Acanthopagrus butcheri*	#< 1	-	-	-	-	-	#< 1	-	#1	-	< 0.1
Wirrah *Acanthistius ocellatus*	-	-	-	-	#1	-	-	-	#1	-	< 0.1
Crimson-banded Wrasse *Notolabrus gymnogenis*	-	-	-	-	#< 1	-	-	-	#< 1	-	< 0.1
Long-spined Flathead *Platycephalus longispinis*	#< 1	-	-	-	-	-	-	-	#< 1	-	< 0.1
Northern Sand Flathead *Platycephalus arenarius*	-	-	-	-	#< 1	-	-	-	#< 1	-	< 0.1
Silver Sweep *Scorpis lineolatus*	-	-	-	-	-	-	#< 1	-	#< 1	-	< 0.1
Striped Seapike *Sphyraena obtusata*	-	-	-	-	#< 1	-	-	-	#< 1	-	< 0.1
Yellowtail *Trachurus novaezelandiae*	#< 1	-	-	-	-	-	-	-	#< 1	-	< 0.1
Blue-striped Goatfish *Upeneichthys spp.*	-	-	-	-	†	-	-	-	†	-	-

Expanded estimates of harvest have not been calculated. This observation was classified as a rare event during this time period and its occurrence is simply noted.
† Estimates of weight (kg) are not provided for this taxon because no length measurements were made.

3.5.3. *Shore fishery*

We recorded 38 taxa in the retained catch of shore-based recreational fishers during the annual survey period (Table 32). We estimated that for shore-based recreational fishers, about 197,800 fish, crabs and cephalopods (± 24,600 individuals - approximate SE), were harvested in the daytime from Lake Macquarie and Swansea Channel during the survey year (Table 32). This represents 21.7%, by number, of the annual daytime harvest for the total fishery (boat and shore combined). The recreational harvest for the shore fishery (Table 32) consisted of about 187,400 finfish (± 24,500 individuals - approximate SE) and about 10,400 crabs and cephalopods (± 2,700 individuals - approximate SE). The ten most commonly harvested taxa by shore-based fishers, by number (Table 32), during the survey period were luderick (≈52,500 - 26.4%), yellowfin bream (≈31,900 - 16.1%), yellow-finned leatherjacket (≈30,300 - 15.3%), sand mullet (≈29,900 - 15.1%), flat-tail mullet (≈11,000 - 5.6%), common squid (≈6,300 - 3.2%), tarwhine (≈6,000 - 3.0%), fan-bellied leatherjacket (≈5,600 - 2.8%), six-spined leatherjacket (≈4,800 - 2.4%) and tailor (≈4,700 - 2.4%). These ten taxa, by number, accounted for 92.3% of the daytime recreational harvest of the shore-based fishery during the annual survey period (Table 32).

We estimated that for shore-based recreational fishers, about 69 tonnes of fish, crabs and cephalopods (± 8 tonnes - approximate SE), were harvested in the daytime from Lake Macquarie and Swansea Channel during the survey year (Table 33). This represents 23.3%, by weight, of the annual daytime harvest for the total fishery (boat and shore combined). The recreational harvest for the shore fishery (Table 33) consisted of about 65 tonnes of finfish (± 8 tonnes - approximate SE) and about 4 tonnes of crabs and cephalopods (± 2 tonnes - approximate SE). The ten most commonly harvested taxa by shore-based fishers, by weight (Table 33), during the survey period were luderick (≈27.0 tonnes - 39.2%), yellowfin bream (≈13.4 tonnes - 19.5%), sand mullet (≈7.9 tonnes - 11.5%), yellow-finned leatherjacket (≈5.5 tonnes - 8.1%), flat-tail mullet (≈2.8 tonnes - 4.1%), fan-bellied leatherjacket (≈2.2 tonnes - 3.2%), southern calamari (≈2.2 tonnes - 3.2%), tarwhine (≈2.1 tonnes - 3.1%), dusky flathead (≈1.4 tonnes - 2.0%) and common squid (≈1.1 tonnes - 1.6%). These ten taxa, by weight, accounted for 95.5% of the daytime recreational harvest of the shore-based fishery during the annual survey period (Table 33).

Table 32. Seasonal and annual harvest estimates (number of individuals) and standard errors for taxa taken by shore-based recreational fishers in the Lake Macquarie fishery. The daytime harvest data have been pooled across the three Lake areas.

	SHORE-BASED HARVEST FOR WHOLE FISHERY										
	Autumn 1999		Winter 1999		Spring 1999		Summer 99/2000		Total		%
Taxon	No.	SE	No.	SE	No.	SE	No.	SE	No.	SE	total
Luderick *Girella tricuspidata*	5,586	± 1,835	18,341	± 3,701	15,729	± 2,724	12,831	± 4,564	52,487	± 6,732	26.4
Yellowfin Bream *Acanthopagrus australis*	7,327	± 2,397	849	± 240	3,147	± 851	20,544	± 13,625	31,867	± 13,863	16.1
Yellow-finned Leatherjacket *Meuschenia trachylepis*	18,757	± 12,793	34	± 28	2,352	± 1,711	9,196	± 4,111	30,339	± 13,546	15.3
Sand Mullet *Myxus elongatus*	7,513	± 3,254	-	-	13,826	± 8,702	8,576	± 4,325	29,915	± 10,248	15.1
Flat-tail Mullet *Liza argentea*	778	± 492	-	-	-	-	10,235	± 6,468	11,013	± 6,486	5.6
Common Squid *Photololigo spp.*	758	± 518	1,498	± 541	510	± 273	3,496	± 1,708	6,262	± 1,885	3.2
Tarwhine *Rhabdosargus sarba*	3,282	± 2,438	-	-	1,076	± 561	1,600	± 774	5,958	± 2,618	3.0
Fan-bellied Leatherjacket *Monacanthus chinensis*	1,453	± 829	125	± 69	212	± 134	3,772	± 3,409	5,562	± 3,512	2.8
Six-spined Leatherjacket *Meuschenia freycineti*	2,178	± 1,253	1,504	± 662	763	± 305	356	± 179	4,801	± 1,461	2.4
Tailor *Pomatomus saltatrix*	3,183	± 2,343	564	± 389	965	± 520	-	-	4,712	± 2,431	2.4
Southern Herring *Herklotsichthys castelnaui*	111	± 100	-	-	717	± 717	2,976	± 1,033	3,804	± 1,261	1.9
Trumpeter Whiting *Sillago maculata*	1,130	± 457	-	-	-	-	1,606	± 1,606	2,736	± 1,670	1.4
Southern Calamari *Sepioteuthis australis*	-	-	2,318	± 1,570	72	± 48	-	-	2,390	± 1,570	1.2

Table 32 – Continued.

	SHORE-BASED HARVEST FOR WHOLE FISHERY										
	Autumn 1999		Winter 1999		Spring 1999		Summer 99/2000		Total		%
Taxon	No.	SE	No.	SE	No.	SE	No.	SE	No.	SE	total
Dusky Flathead *Platycephalus fuscus*	700 ±	261	230 ±	185	74 ±	56	860 ±	470	1,864 ±	571	0.9
Blue Swimmer Crab *Portunus pelagicus*	1,317 ±	954	-	-	-	-	444 ±	308	1,761 ±	1,003	0.9
Black Trevally (Spinefoot)* *Siganus spp.*	-	-	938 ±	506	89 ±	77	131 ±	87	1,158 ±	519	0.6
Sand Whiting *Sillago ciliata*	71 ±	47	222 ±	168	-	-	32 ±	26	325 ±	177	0.2
Snapper *Pagrus auratus*	305 ±	239	7 ±	6	-	-	-	-	312 ±	239	0.2
Stout Longtom* *Tylosurus gavialoides*	305 ±	187	-	-	-	-	-	-	305 ±	187	0.2
Silver Trevally *Pseudocaranx dentex*	158 ±	123	5 ±	4	77 ±	50	36 ±	36	276 ±	138	0.1
Six-lined Trumpeter* *Pelates quadrilineatus*	-	-	#10	-	#2	-	-	-	#12	-	< 0.1
Fan-tail Mullet *Mugil georgii*	#8	-	-	-	-	-	-	-	#8	-	< 0.1
Chinaman Leatherjacket *Nelusetta ayraudi*	#5	-	-	-	-	-	-	-	#5	-	< 0.1
Rock Blackfish* *Girella elevata*	-	-	-	-	#2	-	-	-	#2	-	< 0.1
Sea Mullet *Mugil cephalus*	#2	-	-	-	-	-	-	-	#2	-	< 0.1
Crimson-banded Wrasse *Notolabrus gymnogenis*	#1	-	-	-	-	-	-	-	#1	-	< 0.1

Table 32 – Continued.

	SHORE-BASED HARVEST FOR WHOLE FISHERY										
	Autumn 1999		Winter 1999		Spring 1999		Summer 99/2000		Total		%
Taxon	No.	SE	No.	SE	No.	SE	No.	SE	No.	SE	total
Conger Eel* Congridae	#1	-	-	-	-	-	-	-	#1	-	< 0.1
Giant Herring* *Elops machnata*	-	-	#1	-	-	-	-	-	#1	-	< 0.1
Kingfish *Seriola lalandi*	-	-	#1	-	-	-	-	-	#1	-	< 0.1
Large-toothed Flounder *Pseudorhombus arsius*	#1	-	-	-	-	-	-	-	#1	-	< 0.1
Marbled Flathead *Platycephalus marmoratus*	#1	-	-	-	-	-	-	-	#1	-	< 0.1
Mulloway *Argyrosomus hololepidotus*	#1	-	-	-	-	-	-	-	#1	-	< 0.1
Rough Leatherjacket *Scobinichthys granulatus*	-	-	#1	-	-	-	-	-	#1	-	< 0.1
Salmon *Arripis trutta*	-	-	#1	-	-	-	-	-	#1	-	< 0.1
Silver Batfish* *Monodactylus argenteus*	-	-	-	-	-	-	#1	-	#1	-	< 0.1
Small-toothed Flounder *Pseudorhombus jenynsii*	#1	-	-	-	-	-	-	-	#1	-	< 0.1
Tiger Flathead *Neoplatycephalus richardsoni*	-	-	-	-	-	-	#1	-	#1	-	< 0.1
Arrow Squid *Nototodarus gouldi*	-	-	-	-	-	-	#1	-	#1	-	< 0.1
Total Taxa	**27**		**18**		**16**		**19**		**38**		

* Associated estimates of expanded weight (kg) are not provided for this taxon in Table 33 because a suitable length to weight conversion key was not available.
# Expanded estimates of harvest have not been calculated. This observation was classified as a rare event during this time period and its occurrence is simply noted.

Table 33. Seasonal and annual harvest estimates (kilograms) and standard errors for taxa taken by shore-based recreational fishers in the Lake Macquarie fishery. The daytime harvest data have been pooled across the three Lake areas.

	SHORE-BASED HARVEST FOR WHOLE FISHERY										
	Autumn 1999		Winter 1999		Spring 1999		Summer 99/2000		Total		%
Taxon	kg	SE	kg	SE	kg	SE	kg	SE	kg	SE	total
Luderick *Girella tricuspidata*	2,663	± 852	8,665	± 1,826	7,570	± 1,295	8,066	± 2,846	26,964	± 3,720	39.2
Yellowfin Bream *Acanthopagrus australis*	3,174	± 851	465	± 141	1,658	± 469	8,124	± 5,122	13,421	± 5,215	19.5
Sand Mullet *Myxus elongatus*	2,466	± 1,017	-	-	2,722	± 1,544	2,728	± 1,466	7,916	± 2,360	11.5
Yellow-finned Leatherjacket *Meuschenia trachylepis*	3,199	± 1,929	7	± 6	545	± 426	1,790	± 759	5,541	± 2,116	8.1
Flat-tail Mullet *Liza argentea*	189	± 121	-	-	-	-	2,654	± 1,588	2,843	± 1,592	4.1
Fan-bellied Leatherjacket *Monacanthus chinensis*	460	± 262	41	± 22	70	± 47	1,669	± 1,659	2,240	± 1,681	3.3
Southern Calamari *Sepioteuthis australis*	-	-	2,194	± 1,604	40	± 27	-	-	2,234	± 1,604	3.2
Tarwhine *Rhabdosargus sarba*	1,237	± 928	-	-	274	± 140	604	± 294	2,115	± 983	3.1
Dusky Flathead *Platycephalus fuscus*	514	± 276	123	± 94	50	± 37	714	± 440	1,401	± 529	2.0
Common Squid *Photololigo spp.*	69	± 44	581	± 405	64	± 33	419	± 194	1,133	± 452	1.6
Six-spined Leatherjacket *Meuschenia freycineti*	723	± 404	117	± 53	56	± 22	37	± 19	933	± 409	1.4
Tailor *Pomatomus saltatrix*	372	± 251	122	± 74	188	± 96	-	-	682	± 279	1.0

Table 33 – Continued.

	SHORE-BASED HARVEST FOR WHOLE FISHERY										
	Autumn 1999		Winter 1999		Spring 1999		Summer 99/2000		Total		%
Taxon	kg	SE	kg	SE	kg	SE	kg	SE	kg	SE	total
Blue Swimmer Crab *Portunus pelagicus*	462 ±	343	-	-	-	-	165 ±	122	627 ±	365	0.9
Trumpeter Whiting *Sillago maculata*	114 ±	60	-	-	-	-	188 ±	188	302 ±	197	0.4
Silver Trevally *Pseudocaranx dentex*	57 ±	44	2 ±	2	116 ±	104	10 ±	10	185 ±	114	0.3
Southern Herring *Herklotsichthys castelnaui*	1 ±	1	-	-	14 ±	14	95 ±	32	110 ±	35	0.2
Sand Whiting *Sillago ciliata*	8 ±	6	60 ±	45	-	-	8 ±	7	76 ±	46	0.1
Snapper *Pagrus auratus*	37 ±	29	< 1 ±	< 1	-	-	-	-	37 ±	29	< 0.1
Kingfish *Seriola lalandi*	-	-	#5	-	-	-	-	-	#5	-	< 0.1
Mulloway *Argyrosomus hololepidotus*	#4	-	-	-	-	-	-	-	#4	-	< 0.1
Salmon *Arripis trutta*	-	-	#3	-	-	-	-	-	#3	-	< 0.1
Tiger Flathead *Neoplatycephalus richardsoni*	-	-	-	-	-	-	#3	-	#3	-	< 0.1
Fan-tail Mullet *Mugil georgii*	#2	-	-	-	-	-	-	-	#2	-	< 0.1
Marbled Flathead *Platycephalus marmoratus*	#1	-	-	-	-	-	-	-	#1	-	< 0.1
Sea Mullet *Mugil cephalus*	#1	-	-	-	-	-	-	-	#1	-	< 0.1

Table 33 – Continued.

	SHORE-BASED HARVEST FOR WHOLE FISHERY										
	Autumn 1999		Winter 1999		Spring 1999		Summer 99/2000		Total		%
Taxon	kg	SE	kg	SE	kg	SE	kg	SE	kg	SE	total
Crimson-banded Wrasse *Notolabrus gymnogenis*	#< 1	-	-	-	-	-	-	-	#< 1	-	< 0.1
Large-toothed Flounder Pseudorhombus arsius	#< 1	-	-	-	-	-	-	-	#< 1	-	< 0.1
Rough Leatherjacket *Scobinichthys granulatus*	-	-	#< 1	-	-	-	-	-	#< 1	-	< 0.1
Small-toothed Flounder *Pseudorhombus jenynsii*	#< 1	-	-	-	-	-	-	-	#< 1	-	< 0.1
Arrow Squid *Nototodarus gouldi*	-	-	-	-	-	-	#< 1	-	#< 1	-	< 0.1
Chinaman Leatherjacket *Nelusetta ayraudi*	†	-	-	-	-	-	-	-	†	-	-

Expanded estimates of harvest have not been calculated. This observation was classified as a rare event during this time period and its occurrence is simply noted.
† Estimates of weight (kg) are not provided for this taxon because no length measurements were made.

3.5.4. Seasonality of recreational harvest

We present information describing the seasonality of the recreational harvest for the whole fishery (Tables 28 and 29), the boat-based fishery (Tables 30 and 31), and the shore-based fishery (Tables 32 and 33). In this way, the reader may extract seasonal information for particular species of interest. We now provide some examples of the more interesting seasonal patterns evident in these harvest data, by number, for the whole fishery. The harvest of many species was greatest in the Summer season, intermediate during Autumn and showed a marked decline during Spring and Winter. Examples of species having Summer harvest peaks were blue swimmer crab, yellowfin bream, fan-bellied leatherjacket, large-toothed flounder and sand whiting (Table 28). There were some species that had Autumn harvest peaks, intermediate harvest levels during Summer and showed a marked decline during Spring and Winter. Examples of these species having Autumn harvest peaks were trumpeter whiting, common squid and tarwhine (Table 28). The harvest of some species was mainly concentrated during the warmer seasons of the year, with similar levels of harvest recorded during Summer and Autumn, followed by marked declines in harvest during the Spring and Winter seasons. Examples of these species having an extended harvest peak across the Summer and Autumn seasons were yellow-finned leatherjacket, sand mullet, dusky flathead, snapper and small-toothed flounder (Table 28). The harvest of some species was mainly concentrated during the colder seasons of the year, with similar levels of harvest recorded during Spring and Winter, followed by marked declines in harvest during the Summer and Autumn seasons. An example of a species having an extended harvest peak across the Spring and Winter seasons was luderick (Table 28).

3.6. Harvest comparisons between the recreational and commercial fisheries

We have compared the estimates of daytime recreational harvest for the whole fishery (boat and shore fisheries combined) to the declared commercial landings taken from the Lake Macquarie estuary (Table 34). We urge caution when interpreting this information because several points need to be noted about these data:

(1) The recreational harvest estimates do not include any night-time component and are therefore under-estimates of the total recreational harvest.
(2) There is a level of uncertainty associated with the estimation of recreational harvest because it was impossible to measure all of the effort and harvest for the entire recreational fishing population. Instead, the estimates of total daytime recreational harvest have been derived by expanding samples from the total population. This means that the attributes of the whole population that are central to this study (i.e. annual recreational fishing effort, annual recreational harvest, and harvest rates) have been inferred from the samples taken from that population (the basic tenet of statistical inference - Pollock et al. 1994). Measures of the uncertainty associated with these estimates of effort, harvest and harvest rates are provided in the form of standard errors. The harvest estimates made for uncommon taxa that occur occasionally in the recreational harvests should be treated with caution due to poor precision. The reader is urged to examine harvest estimates in conjunction with their standard errors.
(3) There is a level of uncertainty associated with the use of declared commercial catch statistics. These data are self-reported by commercial fishers and the size and the identification of the declared landed catches have not been verified by independent observation.
(4) We have not included catches of prawns, pipis or cockles in any of the comparative data because these taxa were outside the scope of the study.
(5) We have had to amalgamate the recreational harvest estimates for many species so that we could match the taxonomic categories used to report commercial catches.
(6) We did not have suitable length to weight conversion keys for some taxa. This meant that we could not estimate the recreational harvest of these taxa by weight.

Allowing for the constraints outlined above, we have estimated that the total daytime recreational harvest for Lake Macquarie and Swansea Channel was about 295 tonnes of fish, crabs and cephalopods (± 27 tonnes - approximate SE) during the annual survey period and that the declared commercial catch was about 274 tonnes (Table 34). This represents a harvest ratio of 1.077 for fish, crabs and cephalopods which indicates the total daytime recreational harvest from the Lake Macquarie estuary was about 8% larger than the declared commercial catch. We divided the recreational harvest and the declared commercial catch into two main components for further comparison: (a) finfish; and (b) crabs and cephalopods.

The recreational harvest of finfish was estimated at about 163 tonnes (± 12 tonnes - approximate SE) and the declared commercial catch of finfish was about 252 tonnes (Table 34). This represents a harvest ratio of 0.647 for finfish during the survey period, which indicates that the total daytime recreational harvest of finfish from the Lake Macquarie estuary was about 35% smaller than the declared commercial finfish catch. The recreational harvest of crabs and cephalopods was estimated at about 132 tonnes (± 24 tonnes - approximate SE) and the declared commercial catch of crabs and cephalopods was about 22 tonnes (Table 34). This represents a harvest ratio of 6.0 for crabs and cephalopods during the survey period, which indicates that the total daytime recreational harvest of crabs and cephalopods from the Lake Macquarie estuary was about 500% larger than the declared commercial catch of crabs and cephalopods.

We listed 38 taxonomic categories that met the minimum harvest criterion as defined in the methods section. We found that of these 38 taxonomic categories, the recreational sector was the largest user-group for 17 taxa, and that the commercial sector was the largest user group for 16 taxa (Table 34). There were 2 taxa (tailor and silver trevally) for which there was little difference between the harvests of the two sectors, and for 3 taxa we did not have suitable length to weight conversion keys and so could not calculate harvest ratios (Table 34).

Table 34. Comparison of the estimated daytime harvest (kilograms) taken by recreational fishers (boat and shore fisheries combined) during the annual survey period and the declared commercial landings (kilograms) for the Lake Macquarie estuarine fishery. The harvest ratios provide a measure of relative harvest allocation between the recreational and commercial fisheries during the annual survey period.

Taxon	Recreational Harvest (kg)	Commercial Harvest (kg)	Harvest Ratio (Recreational/ Commercial)
Blue Swimmer Crab *Portunus pelagicus*	108,906	9,891	11.011
Luderick *Girella tricuspidata*	35,438	19,794	1.790
Bream, Yellowfin & Black *Acanthopagrus spp.*	32,533	17,159	1.896
Dusky Flathead *Platycephalus fuscus*	21,441	5,999	3.574
Squid All Species Combined	20,104	11,619	1.730
Leatherjackets Monacanthidae	16,145	2,129	7.583
Sand Mullet *Myxus elongatus*	13,837	802	17.253
Trumpeter Whiting *Sillago maculata*	12,384	8,373	1.479
Snapper *Pagrus auratus*	8,711	780	11.168
Tailor *Pomatomus saltatrix*	7,441	7,596	0.980
Flat-tail Mullet *Liza argentea*	6,218	-	Rec
Flounder *Pseudorhombus spp.*	3,519	332	10.599
Mud Crab *Scylla serrata*	3,187	260	12.258
Tarwhine *Rhabdosargus sarba*	2,225	244	9.119
Sand Whiting *Sillago ciliata*	1,750	2,863	0.611
River Garfish *Hyporhamphus regularis*	548	962	0.570
Eastern Blue-spotted Flathead *Platycephalus caeruleopunctatus*	497	92	5.402
Sea Garfish *Hyporhamphus australis*	232	4	58.000
Silver Trevally *Pseudocaranx dentex*	185	163	1.135
School Whiting *Sillago flindersi*	174	-	Rec
Southern Herring *Herklotsichthys castelnaui*	110	-	Rec
Mulloway *Argyrosomus japonicus*	#25	436	0.057

Table 34 – Continued.

Taxon	Recreational Harvest (kg)	Commercial Harvest (kg)	Harvest Ratio (Recreational/ Commercial)
Dolphin Fish *Coryphaena hippurus*	#6	123	0.049
Salmon *Arripis trutta*	#3	128	0.023
Fan-tail Mullet *Mugil georgii*	#2	7,522	< 0.001
Sea Mullet *Mugil cephalus*	#1	139,376	< 0.001
Striped Seapike *Sphyraena obtusata*	#< 1	1,814	< 0.001
Yellowtail *Trachurus novaezelandiae*	#< 1	1,749	< 0.001
Silver Biddy *Gerres subfasciatus*	-	24,621	Com
Butterfish Scatophagidae	-	1,243	Com
Freshwater Eels *Anguilla spp.*	-	482	Com
Catfish Plotosidae	-	242	Com
Unidentified Sharks All Species Combined	-	146	Com
Pilchard *Sardinops sagax*	-	115	Com
Hairtail *Trichiurus lepturus*	-	110	Com
Black Trevally (Spinefoot) *Siganus spp.*	*	1,592	?
Six-Lined Trumpeter *Pelates quadrilineatus*	*	997	?
Octopus *Octopus spp.*	*	300	?

* No suitable length to weight conversion key was available.
\# Expanded estimates of harvest have not been calculated. This observation was classified as a rare event during this time period and its occurrence is simply noted.
3.4t of commercial harvested fish were declared as unspecified estuary fish and have not been shown. Another 0.4t of commercially harvested fish, comprising 17 taxa, have also not been shown as the catch of each taxon was less than 100kg.

4. DISCUSSION

4.1. Overview of survey design and execution

Recreational fishing surveys of sound statistical design are essential for the collection of statistically unbiased information. In the absence of reliable information, usually the result of flawed survey designs, the interpretation of survey data can become equivocal and may compromise the quality of management decisions. The theoretical framework for valid survey designs has been readily available for a long time (see Cochran 1953, Yates 1965) and these texts provide detailed descriptions of the logistic and statistical issues that need to be addressed when planning and running surveys. Detailed recommendations concerning the reporting of survey findings were published in 1948 by The United Nations Sub-Commission on Statistical Sampling (Yates 1965 reproduces the recommendations). These recommendations clearly identify many important issues that need to be addressed in order to evaluate the validity of survey findings. These issues include detailed descriptions of: (a) the survey aims; (b) the survey design, which includes the method of sample selection and the designation of sampling units; and (c) the survey frame (spatial and temporal). Further, it was recommended that when reporting survey results, the authors should provide sufficient information for an assessment of: (1) the survey accuracy - which can be done by minimising bias with good survey design, by providing evidence of the completeness of frame coverage and by quantifying the level of non-response errors such as refusal rates, (2) the survey precision - which can be done by reporting the precision of estimates derived from data; and (3) the integrity of survey data - which can be done by providing information about various quality assurance issues.

An assessment of a recreational fishery requires a specialised type of survey design but such assessments still require that randomly selected samples from a population of known size are used to estimate parameters for the entire population. Whilst there have been recent advances in the theoretical understanding of recreational fishing survey designs and the statistical analysis of survey data (Robson and Jones 1989, Hoenig et al. 1993 and 1997, Pollock et al. 1994 and 1997, Jones et al. 1995), the theoretical basis of roving survey and access point survey designs (the most commonly used on-site survey methods) have been readily available for many years (Robson 1960 and 1961). As a consequence of this substantial literature, there is little excuse for poor survey design.

The successful planning, organisation and execution of a large on-site survey of recreational fishing is a demanding task (Pollock et al. 1994). The limited financial resources available to the current project led us to develop an innovative community-based approach to the survey work. This novel approach relied heavily on the support and involvement of local interest groups during all phases of the survey and proved to be highly successful. The assistance of many local volunteers when making counts of recreational fishing effort and when interviewing fishing parties made it possible to maximise the spatial coverage of the fishery and to increase levels of replication in a cost-effective way. The use of these local volunteers engendered high levels of community support and low refusal rates were recorded during the survey which indicated that the general fishing public were highly cooperative.

The use of complemented survey methods to estimate separately the effort, harvest rates and harvest of the boat-based and shore-based fisheries separately in Lake Macquarie recognised that important differences existed between these two fisheries. We used stratified random sampling procedures as the basis of the survey design and integrated many data quality checks into the survey work (see Methods). In summary, this survey provides valuable baseline information about the boat-based and shore-based recreational fisheries in Lake Macquarie, collected using statistically sound survey methods which, if repeated, can be used to assess future changes in the fishery.

4.2. Demography of the recreational fishing population

We found that the recreational fishing population of Lake Macquarie was dominated by males. Over 82% of the boat-based fishers and over 83% of the shore-based fishers interviewed were male (Table 6). It is a well established fact that recreational fishing is a male-dominated activity in Australia (see McGlennon 1995 for a review of national and statewide demographic characteristics of recreational fishing populations). A national study and all six statewide studies completed during the period 1978 to 1987 show that the proportion of male participants in the recreational fishing population ranged from about 67% to 75% (McGlennon 1995). The slightly higher proportions recorded during our on-site survey at Lake Macquarie were probably a reflection of the avidity of male fishers. It is well known that fishers are sampled in proportion to their avidity during on-site surveys and that off-site surveys, such as the telephone surveys used to collect statewide participation rates and demographics, sample fishers with equal probability (Pollock et al. 1994). Avidity bias may also explain the consistently higher proportion of female fishers observed in the boat-based and shore-based recreational fisheries on weekend days in Lake Macquarie (Table 6).

We found that the great majority of fishers interviewed were of local origin, ranging from about 75% from the local area in the shore-based fishery to about 80% in the boat-based fishery (Table 7). Not surprisingly, the proportion of visiting fishers was greater on weekend days compared to weekdays during the Autumn, Winter and Spring seasons, possibly indicating these fishers were spending the weekend in the Lake Macquarie area. This pattern was not evident in Summer, when a higher proportion of visiting fishers were interviewed during weekdays, presumably because many fishers were on their Summer vacation and were no longer restricted to fishing mainly on weekend days.

4.3. Recreational effort, harvest and harvest rates

We recorded a large amount of daytime recreational fishing effort, about 970,400 fisher hours (Table 2), in Lake Macquarie and Swansea Channel during the survey year. This amount of fishing effort is relatively large compared to effort estimates made five years earlier in the Clarence River (about 709,400 angler hours), the Richmond River (about 390,200 angler hours) and the Tweed River (about 557,400 angler hours - Steffe et al. 1996b). This indicates that the Lake Macquarie fishery is an important and popular recreational fishery. The proximity of the Lake to the large population centre of Newcastle and the reputation of the Lake area as a popular holiday location, probably explains why the level of recreational fishing effort is still high. The Lake proper received about 768,500 fisher hours of effort representing about 79% of the total annual daytime effort during the annual survey period. The Northern Lake area received an estimated 421,900 fisher hours of daytime effort, representing over 43% of the total annual daytime effort and the Southern Lake area received an estimated 346,600 fisher hours of daytime effort, which represents about 36% of the total annual daytime effort (Tables 3 and 4). The Swansea Channel, despite its small area relative to the Lake proper, received about 202,000 fisher hours of daytime effort, which represents about 21% of the total annual effort. The distribution of effort throughout the Lake Macquarie fishery indicates that all areas are important to recreational fishers.

We estimated that the daytime recreational harvest from the Lake Macquarie fishery was about 295 tonnes (± 27 tonnes - approximate SE) consisting of about 913,500 fish, crabs and squid (± 65,700 individuals - approximate SE) from 60 taxa (Table 28). The bulk of this harvest (Table

29) was made up of blue swimmer crab (≈108.9 tonnes), luderick (≈35.4 tonnes), yellowfin bream (≈32.5 tonnes), dusky flathead (≈21.4 tonnes), common squid (≈17.9 tonnes), sand mullet (≈13.8 tonnes), trumpeter whiting (≈12.4 tonnes), yellow-finned leatherjacket (≈10.2 tonnes), snapper (≈8.7 tonnes) and tailor (≈7.4 tonnes). These ten taxa, by weight, accounted for about 91% of the daytime recreational harvest during the annual survey period, indicating that the recreational harvest was very selective. Interestingly, this relatively large recreational harvest (see Table 36 for comparisons with other estuarine recreational fisheries) was achieved even though a large proportion of fishing parties were unsuccessful (Fig. 2). The proportion of unsuccessful boat-based fishing parties was about 42% overall (ranging from about 32% to 49% on a seasonal basis) and the proportion of unsuccessful shore-based fishing parties was about 61% overall (ranging from about 54% to 68% on a seasonal basis). The explanation for this relatively large harvest is simple. Harvest is calculated as the product of fishing effort and the average daily harvest rate. The level of fishing effort in the Lake Macquarie fishery is relatively high and the average daily harvest rate of the fishing population is small, but similar to the harvest rates measured in other estuarine fisheries (e.g. SPCC 1981, Williams et al. 1993, West and Gordon 1994). Therefore, total harvest in the Lake Macquarie fishery is relatively large because of the high level of fishing effort exerted in the fishery.

The Northern and Southern Lake areas received different levels of commercial fishing effort both before and during the survey period. The Southern Lake area was fished extensively by commercial operators using seine and mesh nets. Recreational anglers have often expressed the opinion that fish are more difficult to catch in the Southern Lake area as a result of the over-exploitation of fish stocks by commercial fishing practices. We could find little evidence to support this opinion but we did find that the seasonal harvest rates of bream taken by recreational anglers (Table 13) were higher in the Northern Lake area and Swansea Channel, and there is some evidence to suggest that tailor catches in the vicinity of the Eraring hotwater outlet have declined from the previously high levels recorded by Scanes (1988). In contrast, boat-based recreational fishers from the Southern Lake area achieved consistently higher seasonal harvest rates of trumpeter whiting (Table 12), common squid (Table 14), and blue swimmer crabs (Table 11) than boat-based fishers in the Northern Lake area suggesting that the greater level of commercial fishing in the Southern area had a minimal direct impact on the stocks of these species. Similarly, shore-based fishers from the Southern Lake area achieved consistently higher seasonal harvest rates of luderick than the shore-based fishers from the Northern Lake area (Table 10). Also, there were other species, such as the dusky flathead (Table 15), which had similar seasonal harvest rates in the Northern and Southern Lake areas.

4.4. Power station effects on the recreational fisheries

We have found inferential evidence that the thermal plumes generated by the two power stations in the southern part of the Lake may be having a beneficial effect on the boat-based and shore-based recreational fisheries in that part of the Lake. The main evidence to support our interpretation comes in the form of harvest rate comparisons for luderick, blue swimmer crabs and common squid from the three areas of the Lake. We supplemented this harvest rate information with the observed behaviour of the recreational fishers, measured in terms of seasonal patterns of effort distribution throughout the Lake. The warm thermal plumes generated by the two power stations are extensive and can usually be detected more than 6 kilometers from the source (SPCC 1983). We believe that the thermal plumes enhance the fishing opportunities available to recreational fishers by concentrating fish, increasing the activity and feeding rates of these fish by elevating their metabolism, and it is likely that the rate of productivity in the southern part of the Lake has also increased above background levels.

We found large aggregations of shore-based fishers around the hot water outlet of the Eraring power station throughout the Winter and Spring seasons. This distribution of effort is consistent with the observations of Scanes (1988) who reported that angling effort was concentrated at the power station outlets. The aggregation of shore-based fishing effort around these hot water plumes in the southern part of the Lake were sufficiently great to create a different pattern of seasonal fishing effort between the Southern and Northern Lake areas (see Tables 3 and 4). The Northern Lake area was not influenced by the thermal plumes and the seasonal pattern of fishing effort was typical of an urban estuarine recreational fishery. We found that Summer had the highest level of shore-based effort (about 36% of annual effort), with declining effort levels recorded during Autumn (about 31% of annual effort) and Spring (about 20% of annual effort) and the lowest effort level was measured during the Winter season (about 13% of annual effort - Table 3). In contrast, much of the large Southern Lake area was influenced by the warm water plumes and we found that Summer had the highest level of shore-based effort (about 34% of annual effort), declining effort levels recorded during the Autumn (about 30% of annual effort) and Winter (about 22% of annual effort), and the lowest effort level was measured during the Spring season (about 14% of annual effort - Table 4). The increase in the levels of recreational fishing effort during Winter were due to anglers fishing in the vicinity of the hot water outlets.

The highest harvest rates for luderick were achieved by shore-based fishers during the Winter and Spring seasons in the Southern Lake area (Table 10). These high harvest rates (about 4 to 5 times greater than comparable harvest rates measured in the Swansea Channel) were attained by shore-based fishers at the hotwater outlets. This confirms the findings of Scanes (1988) who reported that an important recreational fishery for luderick had become established in the vicinity of the Eraring outfall. Scanes (1988) had also found an important fishery targeted at tailor in the vicinity of the Eraring outlet. We found evidence of a much smaller tailor fishery than that described by Scanes (1988) during the period of our survey. This finding was consistent with the anecdotal evidence provided by many local recreational fishers who had described a perceived decline in the tailor fishery within the Lake. Alternatively, the smaller tailor fishery we found may have been due to interannual fluctuations in abundances of tailor. Further survey work replicated over several years would be needed to address the issue of the apparent decline of the tailor fishery.

The boat-based fishery for blue swimmer crabs is another example of the effect of warm water enhancing fishing success in the southern part of the Lake (Table 11). The seasonal harvest rates of blue swimmer crabs taken by boat-based fishers were always greater in the Southern Lake area. It could be argued that this Southern area has always been a better area, relative to other comparable areas in the Lake, for sustaining large populations of blue swimmer crabs because of some inherent and as yet unknown properties that are favourable to the survival, growth and carrying capacity of blue swimmer crabs. If this hypothesis is true, we would expect to find consistent seasonal differences between the harvest rates of recreational fishers in the Southern and Northern Lake areas. If the Southern Lake area was simply a better area for blue swimmer crabs regardless of the presence of the power station, then it would be expected that the same seasonal patterns would be evident in both Lake areas but that the Southern Lake area would have consistently higher harvest rates than the Northern Lake area. Instead, we found that there was a large difference in seasonal patterns between the harvest rates of recreational fishers from the Southern and Northern Lake areas. We recorded consistently high harvest rates of blue swimmer crabs during all seasons in the Southern Lake area, with the highest harvest rate achieved during the Winter season (Table 11). In contrast, the harvest rates of blue swimmer crabs in the Northern Lake area were highest in Autumn, relatively low during Summer, and the lowest harvest rates were recorded in the Spring and Winter seasons (Table 11). The seasonal harvest rates observed in the Southern Lake area indicate that another factor, either in isolation or in addition to an inherent difference between Lake areas, is responsible for the high harvest rates achieved during the colder seasons of the year. We believe that it is the warm water plumes from the power stations that may be enhancing the blue swimmer crab fishery in the Southern Lake area.

The common squid, *Photololigo spp.*, have a mainly sub-tropical distribution which extends southward to the Wollongong area (Ken Graham NSW Fisheries, pers. comm.). This squid is commonly taken by recreational fishers in the Sydney estuaries during the Summer and Autumn seasons and becomes uncommon in catches during the Spring and Winter (A. Steffe pers. observation). The harvest rates of common squid achieved by boat-based fishers in the Lake Macquarie fishery (Table 14) indicated that there is a large resident population of common squid present in the Lake throughout the year. In the Autumn and Summer seasons the greatest harvest rates for boat-based fishers were recorded from the Swansea Channel, a pattern consistent with that observed in the Sydney estuaries (A. Steffe pers. observation). In contrast, the highest harvest rates of common squid during Winter were achieved by boat-based fishers in the Southern Lake area (Table 14). This is further evidence of the enhancement of the recreational fishery in the Southern Lake area during the Winter season, possibly because of the effects of the warm water plumes from the power stations.

4.5. Indicators of recreational fishing quality

Reliable indicators of recreational fishing quality should be developed for estuarine fisheries and would provide a cost-effective means of monitoring the relative quality of important recreational fisheries. We have presented three indicators in this study: the proportion of unsuccessful fishing parties, non-directed harvest rates for the boat-based and shore-based fisheries, and size-frequency distributions for some important taxa harvested by the recreational sector.

The proportion of unsuccessful fishing parties is a measure of "lack of success" and it is believed that a strong positive correlation exists between the experience of fishers and the size of their harvests. That is, the least experienced fishers tend to catch fewer fish and the more experienced fishers tend to have larger harvests. Therefore, changes in the proportion of unsuccessful fishing parties through time would provide an indication of changes in a fishery (beneficial or detrimental) as they affect the largest and most inexperienced group of fishers in the recreational fishing population. The harvest rates we calculated and presented are based on the total non-directed fishing effort. The use of harvest rates as indicators of recreational fishing quality would be improved by using the directed fishing effort that is targeted at a particular species of interest. In this way, a multi-species fishery could be partitioned according to the targeting preferences of fishers and more accurate harvest rate comparisons could be made among sites and through time (Steffe and Murphy 1995).

The use of size-frequency distributions complements the interpretations made from harvest rate data. For example, it is conceivable that the harvest in a fishery, measured in terms of the number of fish taken, could remain constant through time but that the average size of the fish has become smaller. The regular monitoring of size-frequency distributions taken from the recreational fishery would allow the detection of this type of change in the fishery. Size-frequency distributions of species having minimum legal length restrictions are also useful for evaluating compliance rates for the fishery. The proportion of undersized fish in the recreational harvest could also be used as an important indicator of fishing quality because the rate of compliance with regulations may be directly linked to the availability of legal sized fish to the recreational fishing population. For example, the proportion of undersized fish retained would be expected to be low when legal sized fish are abundant in a fishery, and conversely, in fisheries that contain relatively low numbers of legal sized fish, it should be expected that compliance rates would be lower and that the proportion of undersized fish retained would be higher. We found that in the recreational harvest the proportions of undersized: (a) blue swimmer crab and luderick were very low; (b) bream and dusky flathead were less than 10%; and (c) snapper, sand whiting and tailor were relatively high. The proportions of undersized fish retained by recreational fishers in the Lake Macquarie fishery (boat and shore-based) were comparable to rates measured in some other estuarine fisheries in NSW (Table 35). The use of these indicators is not intended to be an exhaustive analysis of the recreational survey data. We recommend that further analyses be done on the survey data to provide additional indicators which could be used to assess future changes in the Lake Macquarie fishery.

Table 35. Comparisons among estuarine recreational fisheries in New South Wales of the proportion of undersized fish retained by recreational fishers for five important species.

		PROPORTION OF UNDERSIZED FISH RETAINED					
Area	Period of survey (inclusive)	Yellowfin Bream	Dusky Flathead	Snapper	Luderick	Sand Whiting	Reference
Tuggerah Lakes	Mar 1978 to Feb 1979	64% of 1340	46% of 270	Not given	21% of 910	Not given	Henry and Virgona 1981
Botany Bay	May 1978 to Jan 1980	12% of 965	16% of 321	95% of 809	17% of 283	34% of 88	SPCC 1981
Lake Macquarie	Jul 1980 to Jun 1981	67% of 340	10% of 167	97% of 497	48% of 500	Not given	Virgona 1983
Sydney Harbour	Sep 1980 to Aug 1981	30% of 432	Not given	93% of 33	Not given	Not given	Henry 1984
Lake Macquarie[1]	Jan 1987 to Dec 1987	51% of 227	3% of 78	100% of 115	0% of 521	Not given	Scanes 1988
Richmond River	Mar 1988 to May 1989	26% of 1115	16% of 691	Not given	4% of 279	48% of 370	West and Gordon 1994
Clarence River	Mar 1988 to May 1989	20% of 2610	35% of 1240	Not given	15% of 821	56% of 779	West and Gordon 1994
Jervis Bay	Aug 1988 to Feb 1990	16% of 261	Not given	34% of 381	10% of 207	20% of 221	Williams et al. 1993
Lake Macquarie	Mar 1999 to Feb 2000	10% of 615	9% of 311	32% of 95	1% of 1226	18% of 109	This study

[1] Southern part of the Lake only

4.6. Comparisons with previous studies

Fisheries managers and the general public have a reasonable expectation that meaningful comparisons should be made between the current study and previous work done on the recreational fisheries of Lake Macquarie and other estuarine areas in NSW. Unfortunately, the previous studies contain survey design and estimation errors which limit their comparison with the present study. A brief description of the problems detected in the previous work is provided (see Tables 36 and 37) and this summary highlights the need to develop a framework for evaluating the quality of recreational fishing surveys so that the validity, integrity and utility of such survey data can be documented. It is important to investigate and understand the causes of previous mistakes so that improvements can be made when designing future surveys. This survey evaluation framework would also facilitate meaningful comparisons (if possible) between studies. We also recommend that statistical power analyses be done on the dataset from this study before future surveys or monitoring programmes are done in Lake Macquarie. Power analyses are based on four parameters of statistical inference: power, significance criterion, sample size, and effect size (Cohen 1988). The use of appropriate power analyses that specify the values of power, significance criterion and effect size should be done to determine, in a scientifically defensible way, the necessary sample size needed to detect future changes in the Lake Macquarie fishery.

Table 36. Comparisons among estuarine recreational fisheries in New South Wales of the estimated harvests and standard errors. The inclusion of surveys in these comparisons required a minimum survey period of one year. The footnotes provide important information on the quality of the survey design and estimation methods used in each study.

Area	Period of estimate (inclusive)	Estimated Harvest (tonnes)	Estimate of Precision (≈ SE - tonnes)	Reference	Source of statistical error and estimation bias
Tuggerah Lakes	Mar 1978 to Feb 1979	≈ 67 - finfish	None given	Henry and Virgona 1981	1,3,8
Botany Bay	Jan 1979 to Dec 1979	≈ 63 - finfish[a]	None given	SPCC 1981	1,2,5,8
Lake Macquarie	Jul 1980 to Jun 1981	≈ 98 - finfish	None given	Virgona 1983	1,3,6,8,9
Sydney Harbour	Sep 1980 to Aug 1981	≈ 165 - finfish	None given	Henry 1984	1,3,8
Richmond River	Mar 1988 to Feb 1989	≈ 33 - finfish[b]	2.4	West and Gordon 1994	1,4,6
Clarence River	Mar 1988 to Feb 1989	≈ 58 - finfish[b]	2.8	West and Gordon 1994	1,4,6
Jervis Bay	Aug 1988 to Feb 1990	≈ 65 - finfish, crabs & cephalopods[c]	None given	Williams et al. 1993	2,3,5,7
Lake Macquarie	Mar 1999 to Feb 2000	≈ 163 - finfish	12	This study	
Lake Macquarie	Mar 1999 to Feb 2000	≈ 132 - crabs & cephalopods	24	This study	

1 Refusal rate not given.
2 Inappropriate pooling of interviews from incomplete and complete trips.
3 Incorrect harvest rate estimator was used for estimating total harvest.
4 Inappropriate pooling of data across years.
5 Incomplete coverage of temporal frame (annual estimates provided but some months not sampled).
6 Angler counts are not statistically independent.
7 Non-random selection of survey days.
8 Insufficient detail provided to completely assess the survey design.
9 Incomplete coverage of spatial frame caused by inadequate level of replication within many spatio-temporal strata.

[a] Weight estimates available for 25 main species. SPCC 1981 states that the top 20 species accounted for 95% by weight of the total catch. The total estimate provided has been adjusted accordingly.

[b] Weight estimates available for 6 main species, approximate standard error for total tonnage of these species was recalculated from the 95% confidence limits provided.

[c] Weight estimate derived from multiplying the estimated total number of finfish, crabs and cephalopods kept by an average weight of 250 grams - Williams et al. 1993.

Table 37. A scientific evaluation of the methods used in previous studies of recreational fishing in Lake Macquarie.

Main study objective relating to recreational fishery	Period of Study (inclusive)	Reference	Source of statistical error and estimation bias
Recreational fishery assessment for the whole Lake	July 1980 to June 1981	Virgona 1983	1,2,3,4,5,8
Assess possible impact of Eraring power station on the distribution of angling effort	Data collection is from three separate time periods.	Virgona and Henry 1987	5,7
Assess possible effects of Eraring power station on the recreational fishery	January 1987 to December 1987	Scanes 1988	2,3,4,5
Quantify catch rates and harvest rates for the recreational fishery	September 1994 to February 1995	Lake Macquarie Concerned Anglers Group 1995	2,5,6,8

1 Incomplete coverage of spatial frame caused by inadequate level of replication within many spatio-temporal strata.
2 Refusal rate not given.
3 Incorrect harvest rate estimator was used for estimating total harvest.
4 Angler counts not statistically independent.
5 No measures of precision given.
6 Non-random selection of anglers. Interviews derived mainly from known anglers – inexperienced anglers were under-represented. Bill Gray (Lake Macquarie Concerned Anglers Group) – personal communication.
7 Pre-operational data are from Virgona (1983), post-operational data is provided for two time periods as a mean number of anglers per headcount.
8 Insufficient detail provided to completely assess the survey design and/or estimation methods used.

4.7. Harvest comparisons between the recreational and commercial user-groups

There is a long history of conflict between the recreational and commercial user-groups over appropriate management strategies for sharing the fisheries resources in Lake Macquarie (Virgona 1983, Otway et al. 1995, Lake Macquarie Task Force 1999). We compared the relative sizes of the recreational and commercial harvests for: (a) finfish; (b) crabs and squid; and (c) 38 taxa separately (see Table 34). Each harvest ratio is a measure of the realised share of the resource taken by each sector. We estimated that the daytime recreational harvest from the Lake Macquarie fishery was about 295 tonnes (± 27 tonnes - approximate SE) consisting of about 913,500 fish, crabs and squid (± 65,700 individuals - approximate SE) from 60 taxa. The declared commercial catch for the same period was about 274 tonnes (Table 34). This represents a harvest ratio of 1.077 which indicates that the daytime recreational harvest from the Lake Macquarie estuary was about 8% larger than the declared commercial catch (excluding prawns, pipis and cockles). A similar comparison for finfish harvests is not possible for 1980/81 because crabs and squid were not included from the previous survey by Virgona (1983).

The recreational harvest of finfish was estimated at about 163 tonnes (± 12 tonnes - approximate SE) in the current study and the declared commercial catch of finfish was about 252 tonnes (Table 34). This represents a harvest ratio of 0.647 for finfish during the survey period, which indicates that the total daytime recreational harvest of finfish from the Lake Macquarie estuary was about 35% smaller than the declared commercial finfish catch. Virgona (1983) reported an estimated recreational finfish harvest of about 98 tonnes during 1980/81 and a commercial finfish catch of about 415 tonnes which represented a harvest ratio of 0.236 during that period. It must be noted that the recreational harvest estimate given by Virgona (1983) is likely to be inaccurate because of statistical bias resulting from methodological errors in the survey design (see Tables 36 and 37). Even so, these figures suggest that there may have been a major shift in the relative share of these fisheries resources between the recreational and commercial sectors with proportionally more finfish being taken by recreational fishers.

The recreational harvest of crabs and cephalopods was estimated at about 132 tonnes (± 24 tonnes - approximate SE) and the declared commercial catch of crabs and cephalopods was about 22 tonnes (Table 34). This represents a harvest ratio of 6.0 for crabs and cephalopods during the survey period, which indicates that the total daytime recreational harvest of crabs and cephalopods from the Lake Macquarie estuary was about 500% larger than the declared commercial catch of crabs and cephalopods. A similar comparison for the combined harvests of crabs and cephalopods is not possible for 1980/81 because these taxa were not included in the previous survey by Virgona (1983).

We have presented harvest ratios for 38 taxonomic categories (Table 34). The recreational sector was the largest user-group for 17 taxa, blue-swimmer crab, luderick, bream, dusky flathead, squid, leatherjackets, sand mullet, trumpeter whiting, snapper, flat-tail mullet, flounder, mud crab, tarwhine, eastern blue-spotted flathead, sea garfish, school whiting and southern herring (Table 34). There were two taxa for which there was little difference between the two sectors, tailor and silver trevally (Table 34). The commercial sector was the largest user-group for 16 taxa, sea mullet, silver biddy, fan-tail mullet, striped seapike, yellowtail, butterfish, sand whiting, river garfish, mulloway, dolphin fish, salmon, freshwater eels, catfish, unidentified sharks, pilchard and hairtail (Table 34). These harvest ratios show that the recreational sector is a large and important user-group having a considerable direct impact on fisheries resources in the Lake Macquarie fishery. Thus, the activities of the recreational sector should be considered when making stock assessments to determine the size of sustainable catches for many species that are exploited by both the recreational and commercial sectors. Failure to include recreational harvest estimates in stock assessments would, for many important species, ignore the direct impact of the stakeholder group taking the largest share of the resource.

5. CONCLUSIONS

This recreational fishing survey provides evidence of a relatively productive recreational fishery in Lake Macquarie and Swansea Channel. A summary of the evidence is that: (a) the levels of daytime recreational fishing effort were high; (b) the harvest rates recorded were similar to those reported in other surveys of estuarine recreational fisheries, (c) the size-frequency distributions of important recreational species showed that large individuals were present in the recreational harvest; (d) the proportions of under-sized fish in the recreational harvest were comparable to compliance rates measured in other NSW estuarine fisheries; and (e) the daytime recreational harvest of many important recreational species was greater than that taken by the commercial sector. However, persistent anecdotal accounts of a recreational fishery that is in decline cannot be dismissed. For example, many recreational anglers had mentioned that the tailor fishery within the Lake had declined greatly over the preceding decade and Scanes (1988) reported that a large tailor fishery existed in the vicinity of the Eraring hot water outlet during the Winter season. Yet, tailor were not particularly abundant during our survey period. Despite these trends, we do not have any statistically valid historical data to enable meaningful comparisons that would either confirm or deny that changes have occurred in the quality of fishing opportunities available throughout the whole Lake Macquarie fishery. It is possible that the Lake Macquarie recreational fishery for many species, other than tailor, was also much better in the past and that it now takes longer for fishers to catch the same number of fish. This would be expected in a situation where a limited number of fish are being taken by an ever increasing number of fishers. That is, the number of fish available to anglers may be similar but the total amount of fishing effort has increased throughout time. This may be the case in the Lake Macquarie fishery.

6. RECOMMENDATIONS

1. When based on statistically valid survey designs, on-site surveys of recreational fishing are valuable tools for collecting information to describe the status of a recreational fishery. On-site recreational fishing surveys should be repeated regularly to monitor the recreational fishery in Lake Macquarie.

2. Community involvement should be encouraged in any future recreational surveys and/or monitoring programmes. This project has proven that the direct participation of local interest groups in the running of the survey provides a valuable opportunity to improve communication and to build a sound working relationship with recreational stakeholders.

3. There is a clear need to develop a framework for evaluating the quality of recreational fishing surveys. This survey evaluation framework should provide a way of making detailed assessments of survey designs and the estimation methods used to calculate recreational harvest, fishing effort and harvest rates. We recommend that a survey evaluation framework be developed so that the validity, integrity and utility of survey data can be documented objectively, thereby allowing meaningful comparisons to be made between studies.

4. Before future surveys or monitoring programmes are done in Lake Macquarie, it is recommended that statistical power analyses should be done of the recreational fishing dataset collected during this study. Power analyses are vital for determining scientifically defensible and cost-effective survey designs that have sufficient statistical power to detect changes in the recreational fishery throughout time.

5. The development of robust and reliable indicators of recreational fishing quality would lead to more cost-effective ways of monitoring estuarine fisheries throughout NSW. We recommend that additional work be done to develop robust and reliable indicators of fishing quality for all recreational fisheries in NSW. This would require more detailed analyses of: (a) the data collected during this survey; and (b) the survey data collected during previous recreational fishing surveys done in NSW.

7. REFERENCES

Australian National Recreational Fisheries Working Group (1994). Recreational fishing in Australia: A national policy. Australian National Recreational Fisheries Working Group, Department of Primary Industries and Energy, Canberra, pp. 25.

Baas Becking, L.G.M. (1959). Some aspects of the ecology of Lake Macquarie, N.S.W., with regard to an alleged depletion of fish. III. Characteristics of water and mud. Australian Journal of Marine and Freshwater Research 10, 297-303.

Baas Becking, L.G.M., Thomson, J.M. and Wood, E.J.F. (1959). Some aspects of the ecology of Lake Macquarie, N.S.W., with regard to an alleged depletion of fish. I. General Introduction. Australian Journal of Marine and Freshwater Research 10, 269-278.

Best, E.A. and Boles, H.D. (1956). An evaluation of creel census methods. California Fish and Game 42, 109-115.

Cochran, W.G. (1953). Sampling Techniques. John Wiley and Sons, New York, 330pp.

Cohen, J. (1988). Statistical Power Analysis for the Behavioral Sciences. Second edition, Lawrence Erlbaum Associates, New Jersey, 567 pp.

Davis, P.S. (1959). Some aspects of the ecology of Lake Macquarie, N.S.W., with regard to an alleged depletion of fish. V. Chlorophyll distribution. Australian Journal of Marine and Freshwater Research 10, 316-321.

Dovers, S. (1994). Recreational fishing in Australia: review and policy issues. Australian Geographical Studies 32, 102-114.

Hall, D.A. (1986). An assessment of the mulloway (*Argyrosomus hololepidotus*) fishery in South Australia with particular reference to the Coorong Lagoon. Discussion paper from the Department of Fisheries, South Australia, October 1986, 41 pp.

Hayne, D.W. (1991). The access point creel survey: procedures and comparison with the roving-clerk creel survey. American Fisheries Society Symposium 12, 123-138.

Henry, G.W. (1984). Commercial and recreational fishing in Sydney estuary. N.S.W. Department of Agriculture, Sydney, Fisheries Bulletin 1, 47pp.

Henry, G.W. and Virgona, J.L. (1981). The impact of the Munmorah power station on the recreational and commercial finfish fisheries of Tuggerah Lakes. Report to the Electricity Commission of New South Wales. N.S.W. State Fisheries, Sydney, 95pp.

Hoenig, J.M., Jones, C.M., Pollock, K.H., Robson, D.S. and Wade, D.L. (1997). Calculation of catch rate and total catch in roving surveys of anglers. Biometrics 53, 306-317.

Hoenig, J.M., Robson, D.S., Jones C.M. and Pollock K.H. (1993). Scheduling counts in the instantaneous and progressive count methods for estimating sportfishing effort. North American Journal of Fisheries Management 13, 723-736.

Jones, C.M., Robson, D.S., Lakkis, H.D. and Kressel, J. (1995). Properties of catch rates used in analysis of angler surveys. Transactions of the American Fisheries Society 124, 911-928.

Kailola, P.J., Williams, M.J., Stewart, P.C., Reichelt, R.E., McNee, A. and Grieve, C. (1993). Australian Fisheries Resources. Bureau of Resource Sciences, Department of Primary Industries and Energy, and the Fisheries Research and Development Corporation, Canberra, Australia, 422pp.

Kearney, R.E. (1995). Recreational fishing: what's the catch? pp. 10-23, In: Recreational Fishing: What's The Catch? Australian Society for Fish Biology Workshop Proceedings, Canberra 1994, Editor D.A. Hancock, Australian Society of Fish Biology, Canberra.

Lake Macquarie Concerned Anglers Group (1995). Creel survey of recreational catches in Lake Macquarie. Lake Macquarie Concerned Anglers Group, Newcastle, 10pp.

Lake Macquarie Taskforce (1999). Lake Macquarie – A healthy sustainable lake for a quality lifestyle. Lake Macquarie Taskforce – Integrated Estuary and Catchment Management Framework, 141pp.

Lyle, J.M. and Ford, W.B. (1993). Review of trawl research 1979-1987, with summaries of biological information for the major species. Department of Sea Fisheries, Tasmania Marine Laboratories, Technical Report 46, 169 pp.

MacIntyre, R.J. (1959). Some aspects of the ecology of Lake Macquarie, N.S.W., with regard to an alleged depletion of fish. VII. The benthic macrofauna. Australian Journal of Marine and Freshwater Research 10, 341-353.

Malcolm, W.B. (1966). Synopsis for F.A.O. species and stocks thesaurus of data on *Arripis trutta* (Bloch and Schneider). pp. 1-17 In: Commonwealth-States Fisheries Conference, Southern Pelagic Project Committee Technical Session, Cronulla, 1966. Volume 3, SPP(T)66/1/4, CSIRO, Cronulla.

Malvestuto, S.P. (1983). Sampling the recreational fishery. pp. 397-419. In: Fisheries Techniques. Editors L.A. Neilsen and D.L. Johnson. American Fisheries Society, Bethesda, Maryland.

McGlennon, D. (1995). A review of recreational fishing surveys in Australia. pp. 61-70, In: Recreational Fishing: What's The Catch? Australian Society for Fish Biology Workshop Proceedings, Canberra 1994, Editor D.A. Hancock, Australian Society of Fish Biology, Canberra.

Montgomery, S.S. (1986). Studies on the population dynamics of the tiger flathead *Platycephalus richardsoni* (Castelnau) (Pisces: Platycephalidae), I - age determination and growth. In: N.S.W. Trawl Fishery Assessment and Monitoring Programme. Progress Report November 1986. Fisheries Research Institute, N.S.W. Department of Agriculture.

Moran, M.J. and Burton, C. (1990). Relationships among partial and whole lengths and weights for Western Australian pink snapper *Chrysophrys auratus* (Sparidae). Fisheries Research Report, Fisheries Department of Western Australia 89, 1-13.

New South Wales Fisheries (2000). Status of fisheries resources 1998/99. Editors W. Fletcher and T. McVea. N.S.W. Fisheries Research Institute, Sydney, 219pp.

New South Wales Parliament – Fisheries Inquiry Commission (1880). Report of the royal commission to inquire into and report upon the actual state and prospect of fisheries in this colony. Government Printers, Sydney.

Otway, N.M, West, R.J. and Gibbs, P.J. (1995). A review of the information on the factors affecting the fisheries of Lake Macquarie. N.S.W. Fisheries Research Institute, Sydney, 95pp.

Phippen, K.W. and Bergersen, E.P. (1991). Accuracy of a roving creel survey's harvest estimate and evaluation of possible sources of bias. American Fisheries Society Symposium 12, 51-60.

Pollock, K.H., Hoenig, J.M., Jones, C.M., Robson, D.S. and Greene, C.J. (1997). Catch rate estimation for roving and access point surveys. North American Journal of Fisheries Management 17, 11-19.

Pollock, K.H., Jones, C.M. and Brown, T.L. (1994). Angler Survey Methods and Their Applications in Fisheries Management. American Fisheries Society Special Publication 25, American Fisheries Society, Bethesda, 371pp.

Richards, C.E. (1967). Age, growth and fecundity of the cobia, *Rachycentron canadum*, from Chesapeake Bay and adjacent mid-Atlantic waters. Transactions of the American Fisheries Society 96, 343-50.

Robson, D.S. (1960). An unbiased sampling and estimation procedure for creel censuses of fishermen. Biometrics 16, 261-277.

Robson, D.S. (1961). On the statistical theory of a roving creel census. Biometrics 17, 415-437.

Robson, D.S. (1991). The roving creel survey. American Fisheries Society Symposium 12, 19-24.

Robson, D.S. and Jones, C.M. (1989). The theoretical basis of an access site angler survey design. Biometrics 45, 83-98.

Rose, C.D. and Hassler, W.W. (1969). Age and growth of the dolphin fish, *Coryphaena hippurus* (Linnaeus), in North Carolina waters. Transactions of the American Fisheries Society 98, 94-103.

Ruello, N.V. and Henry, G.W. (1977). Conflict between commercial and amateur fishermen. Australian Fisheries 36, 8pp.

Scanes, P.R. (1988). The impact of Eraring power station on the fish and fisheries of Lake Macquarie. Report to the Electricity Commission of New South Wales. N.S.W. Agriculture and Fisheries, Fisheries Research Institute, Sydney, 111pp.

Sokal, R.R. and Rohlf, F.J. (1969). Biometry: The Principles and Practice of Statistics in Biological Research. W.H. Freeman and Company, San Francisco, 776pp.

Spencer, R.S. (1959). Some aspects of the ecology of Lake Macquarie, N.S.W., with regard to an alleged depletion of fish. II. Hydrology. Australian Journal of Marine and Freshwater Research 10, 279-296.

State Pollution Control Commission (1981). Amateur angling in Botany Bay. Environmental Control Study of Botany Bay, BBS24, State Pollution Control Commission, Sydney, 72pp.

State Pollution Control Commission (1983). Environmental audit of Lake Macquarie. State Pollution Control Commission, Newcastle, 159pp.

Steffe, A.S. and Murphy, J.J. (1995). A survey of recreational trailer boat fishing in the marine waters of New South Wales - a case study. pp. 106-112, In: Recreational Fishing: What's The Catch? Australian Society for Fish Biology Workshop Proceedings, Canberra 1994, Editor D.A. Hancock, Australian Society of Fish Biology, Canberra.

Steffe, A.S., Murphy, J.J., Chapman, D.J., Tarlinton, B.E., Gordon, G.N.G. and Grinberg A. (1996a). An assessment of the impact of offshore recreational fishing in New South Wales waters on the management of commercial fisheries. Final report to The Fisheries Research and Development Corporation, Project No. 94/053. N.S.W. Fisheries Research Institute, Sydney, 139pp.

Steffe, A.S., Staines, J.F. and Murphy, J.J. (1996b). Recreational use of fisheries resources in northern New South Wales. Final report to the Resource and Conservation Assessment Council, Project S7. N.S.W. Fisheries Research Institute, Sydney, 37pp.

Thomson, J.M. (1959a). Some aspects of the ecology of Lake Macquarie, N.S.W., with regard to an alleged depletion of fish. VIII. Trends of the commercial fish catch and management of the fishery. Australian Journal of Marine and Freshwater Research 10, 354-364.

Thomson, J.M. (1959b). Some aspects of the ecology of Lake Macquarie, N.S.W., with regard to an alleged depletion of fish. IX. The fishes and their food. Australian Journal of Marine and Freshwater Research 10, 365-374.

Thomson, J.M. (1959c). Some aspects of the ecology of Lake Macquarie, N.S.W., with regard to an alleged depletion of fish. X. The movements of fish. Australian Journal of Marine and Freshwater Research 10, 375-387.

Thomson, J.M. (1959d). Some aspects of the ecology of Lake Macquarie, N.S.W., with regard to an alleged depletion of fish. XI. Estimation of fish populations. Australian Journal of Marine and Freshwater Research 10, 388-398.

Thomson, J.M. (1959e). Some aspects of the ecology of Lake Macquarie, N.S.W., with regard to an alleged depletion of fish. XII. Summary review. Australian Journal of Marine and Freshwater Research 10, 399-408.

Virgona. J.L. (1983). Lake Macquarie fish study. Report to the Electricity Commission of New South Wales. N.S.W. State Fisheries, Sydney, 131pp.

Virgona, J.L. and Henry, G.W. (1987). Investigations into the commercial and recreational fisheries of Lake Macquarie and Tuggerah Lakes. Report to the Electricity Commission of New South Wales. N.S.W. Fisheries Research Institute, Sydney, 42pp.

West, R.J. and Gordon, G.N.G. (1994). Commercial and recreational harvest of fish from two Australian coastal rivers. Australian Journal of Marine and Freshwater Research 45, 1259-1279.

Williams, R.J., Henry, G.W., Murphy, J.J., Smith, A.K., Grima, D.M., and Harvey, J.R. (1993). Jervis Bay Marine Ecology Study, Project 9: Commercial and recreational fishing and diving in Jervis Bay. Report to Department of Defence. N.S.W. Fisheries Research Institute, Sydney, 320pp.

Wood, E.F.J. (1959a). Some aspects of the ecology of Lake Macquarie, N.S.W., with regard to an alleged depletion of fish. IV. Bacterial and fungal studies. Australian Journal of Marine and Freshwater Research 10, 304-315.

Wood, E.F.J. (1959b). Some aspects of the ecology of Lake Macquarie, N.S.W., with regard to an alleged depletion of fish. VI. Plant communities and their significance. Australian Journal of Marine and Freshwater Research 10, 322-340.

Yates, F. (1965). Sampling Methods for Censuses and Surveys. Third edition, Charles Griffin and Company Limited, London. 440pp.

8. APPENDICES

Appendix 1. List of recognised boat ramps in Lake Macquarie. The list order starts at the most seaward ramp on the northern breakwater of Swansea Channel and continues counter-clockwise around the lake shoreline. Note: Locations of recognised boat ramps can be found in Figure 1.

	Ramp Description
1.	Blacksmiths - Ungala Street
2.	Pelican - Lakeview Parade
3.	Pelican - off Naru Street (near airport)
4.	Belmont South - Paley Crescent
5.	Belmont - Brooks Parade
6.	Valetine - Bennett Park off Dilkera Avenue
7.	Croudace Bay - Thomas Halton Park, Bareki Road
8.	Eleebana - Lions Park, Bareki Road
9.	Speers Point - Cockle Creek, Creek Reserve Road
10.	Marmong Point - Off Nanda Street
11.	Bolton Point - Off Middle Point Road
12.	Toronto - Lions Park, Anzac Parade
13.	Toronto - Wharf Street
14.	Coal Point - Birraban Reserve Robey Crescent
15.	Rathmines - Styles Point off Overhill Road
16.	Rathmines - Rathmines Park off Dorrington Road
17.	Balmoral - Letchworth Parade
18.	Wangi Wangi - Kent Place
19.	Wangi Wangi - Wangi Caravan Park (Watkins Road)
20.	Wangi Wangi - off Dobell Drive (Wangi Wangi Beach)
21.	Dora Creek - Dora Street
22.	Bonnells Bay - Pendlebury Park, Grand Parade West
23.	Balcolyn - Shingle Splitters Point King Street
24.	Balcolyn - Balcolyn Street (near Progress Hall)
25.	Sunshine - Sunshine Reserve off Sunshine Parade
26.	Morisset Park - Lakeview Road
27.	Wyee - Behind Mecca Caravan Park Ruttleys Road
28.	Vales Point - off Peveril Street (The Cut)
29.	Summerland Point - off Cams Boulevarde
30.	Gwandalan - Garema Road
31.	Gwandalan - off Koowong Road (Crangan Bay)
32.	Gwandalan - off Gamban Road
33.	Nords Wharf - Branter Road
34.	Cams Wharf - Cams Wharf Road
35.	Swansea - The Esplanade
36.	Swansea - Coon Island 1 off Wallarah Street
37.	Swansea - Coon Island 2 off Wallarah Street
38.	Swansea - Opposite Chapman Oval, Channel Street

Appendix 2. Glossary of technical terms. This is a modified version of the glossary provided by Pollock et al. (1994).

The terms in this glossary are defined in the context of recreational fishing, the focus of this report. Some terms may have slightly different (but analogous) meanings for recreational and commercial fishing.

Access point design: an on-site, intercept design that is used when fishers use defined access points to enter and leave the fishery. This method works best when there are few access points (e.g. boat ramps, wharves, breakwalls) and most fishers use these defined access points. The access point design can be used to estimate fishing effort, harvest rates and harvest and relies on complete trip interviews. (Compare *Roving design*.)

Accuracy: Degree of conformity to a true value. An accurate estimator has a small mean squared error, implying little or no bias and small standard error. (Compare *Precision.)*

Angler: Person participating in a line fishing activity. Recreational line fishing activities include trolling, drifting, fishing with lures or bait. (Compare *Fisher*.)

Angler survey: General term for any survey of anglers by an off-site method (mail, telephone, door-to-door) or an on-site method (access, roving, aerial). (Compare *Creel survey.)*

Avidity bias: Bias arising in on-site surveys when anglers are sampled in proportion to their fishing avidity (time spent fishing or frequency of fishing), not with equal probability.

Biased estimator: Estimator whose average value over many hypothetical repetitions of a study deviates from the true parameter value.

Catch rate: Number or weight of all fish caught (kept or released) per trip, per angler hour, or per some other unit of fishing effort. The catch per unit effort can be used as a measure of success rate. (Compare *Harvest rate*.)

Catch: Number or weight of all fish caught, whether the fish are kept or released. Sometimes the term is also used (less precisely) to mean harvest. (Compare *Harvest.)*

Census: Sampling of every unit in the sampled population.

Complemented survey: Survey combining two or more contact methods (e.g., a telephone survey to estimate effort and an access survey to estimate catch rate).

Complete trip interview: Interview conducted as an angler leaves the water at the end of fishing. (Compare *Incomplete trip interview.)*

Consistent estimator: Estimator that gets closer and closer to the true parameter value as the size of the sample increases.

Contact method: Any method used to contact fishers for a survey (mail, telephone, door-to-door, access, roving, or aerial).

Creel survey: On-site angler survey during which the harvests of fishers are examined by the survey agent.

Direct impact of fishing: The immediate, main effect caused by fishers on a population or stock. In any extractive fishery (recreational or commercial) this main, immediate impact can be assessed by estimating the harvest. (Compare *Indirect impact of fishing.*)

Directed fishing effort: Fishing effort directed at a particular species or group of species. (Compare *Non-directed fishing effort*.)

Directed harvest rate: A harvest rate that has been calculated using directed fishing effort and the associated harvest from that directed effort. (Compare *Non-directed harvest rate*.)

Effort: See *Fishing effort.*

Estimate: Realised value of an estimator calculated from a particular sample.

Estimation methods: General term to describe the methods used to calculate estimates of population parameters (e.g. effort, harvest rate, and harvest) and estimates of their precision (e.g. variances and standard errors). (Compare *Survey methods*.)

Estimator: Formula or sample statistic used to estimate a population parameter.

Fisher: Person participating in any fishing activity. Recreational fishing activities include all forms of line fishing, bait collecting, and the setting of crab traps. (Compare *Angler*.)

Fishing effort (fishing pressure): A measure of resource use by anglers or fishers. Typical units of effort are number of trips on the water, angler hours, party hours, and boat hours.

Fishing party: A group of anglers or fishers participating in a recreational fishing activity. A fishing party can consist of a single individual or a large number of persons fishing together.

Frame: See *Sampling frame.*

Harvest: Number or weight of the fish caught that are kept, not released. (Compare *Catch.*)

Harvest rate: Number or weight of fish retained (fish released are not included) per trip, per angler hour, or per some other unit of fishing effort. The harvest per unit effort can be used as a measure of success rate. (Compare *Catch rate*.)

Incomplete trip interview: Interview conducted before an angler has finished fishing. (Compare *Complete trip interview.)*

Indirect impact of fishing: An incidental, secondary effect caused by fishers on a population or stock. In any extractive fishery (recreational or commercial) these secondary impacts may include physical and genetic changes in population structures, post-release mortality of discards, and numerous effects on fish and fish habitats caused by factors such as pollution from outboard motors, anchoring in seagrass beds, loss of lead sinkers and fishing lines. (Compare *Direct impact of fishing.*)

Independence: See *Statistical independence*.

Instantaneous count: Count of anglers/fishers or boats made quickly from an aeroplane, a vantage point (bridge, hilltop, etc.), a fast-moving boat, or an automobile. (*Compare Progressive count.*)

Large individual: Being of more than common size.

Length-of-stay bias: Bias arising in roving surveys when anglers are interviewed with probability proportional to the length of their fishing trip, not with equal probability.

Mean: The arithmetic mean or average is calculated by summing all the individual observations (sampling units) of a sample and dividing this sum by the number of observations in the sample.

Median: The value of a variable (in an ordered array) that has an equal number of observations on either side of it. The median is used to divide a frequency distribution into two halves.

Non-directed fishing effort: The combined fishing effort regardless of targeting preferences. This term refers to the amalgamation of directed effort for different species and species groups and the effort of generalist fishers that had no specific target species. (Compare *Directed fishing effort*.)

Non-directed harvest rate: A harvest rate that has been calculated using non-directed fishing effort and the associated harvest from that non-directed effort. (Compare *Directed harvest rate*.)

Non-response bias: Bias arising when people refuse or are unable to answer a survey question. (See *Refusal rate*.)

Off-site survey: A recreational fishing survey that is carried out away from the fishing sites of a defined fishery. Off-site survey methods include mail, telephone, door-to-door, logbooks, diaries and catch cards. (Compare *On-site survey*.)

On-site survey: A recreational fishing survey that is carried out at the fishing sites within a defined fishery. On-site survey methods include access point, roving, and aerial surveys. (Compare *Off-site survey*.)

Parameter: Characteristic of the population under study.

Precision: Degree of variation. A precise estimator has a small standard error (or variance). (Compare *Accuracy.*)

Probability sampling: Sampling in which all possible samples have known probabilities of being drawn.

Progressive count: Count of anglers/fishers or boats made over time as a survey agent moves through a fishery area. Within each small subarea, the count may be instantaneous. (Compare *Instantaneous count*.)

Quality assurance: A continual process of checks and refinements aimed at maximising data integrity and hence also improving the credibility of survey results.

Random sampling: Independent sampling in which the replicate sampling units were selected at random for inclusion in the sample.

Recall bias: Bias arising when anglers/fishers inaccurately remember past events or the time in which they occurred.

Recreational fishing survey: General term for any survey of fishers by an off-site or on-site method. (Compare *Angler survey*.)

Refusal rate: The proportion of fishers or fishing parties that refused or were unable to answer survey questions. The refusal rate is an important measure of the non-response error within a survey. (See *Non-response bias*.)

Response error: Error arising because of recall, prestige, or rounding bias, or because an angler lied, misinterpreted a question, misidentified a species, or measured fish incorrectly.

Roving design: an on-site, intercept design that is used when access to a fishery is diffuse, occurring at too many points for the use of an access point survey. The roving design can be used to estimate fishing effort, harvest rates and harvest but relies on incomplete trip interviews. (Compare *Access point design*.)

Sample: Group of sampling units drawn from the sampled population.

Sample size: The number of sampling units in the sample.

Sampled population: Actual population from which information is collected. (Compare *Target population.*)

Sampling error: Error arising from improper sample selection, an incomplete sampling frame, duplications within the frame, avidity bias, or length-of-stay bias.

Sampling frame: Complete set or list of all sampling units.

Sampling unit: Basic unit of sampling (e.g., an angler/fisher, a fishing party, a fishing day or a particular combination of space and time).

Standard error: Square root of an estimator's variance.

Statistic: Characteristic of the sample drawn.

Statistical independence: The inherent assumption in all survey work that the sampling error associated with each sample is independent of the other samples. Random sampling is the mechanism used to safeguard against lack of independence problems.

Stratified sampling: Independent sampling within two or more defined subgroups of a sampled population. (See *Stratum*).

Stratum: A defined subgroup of a sampled population that does not overlap with any other subgroups and is of known size (See *Stratified sampling*.)

Survey error: General term embracing sampling, response, and non-response errors.

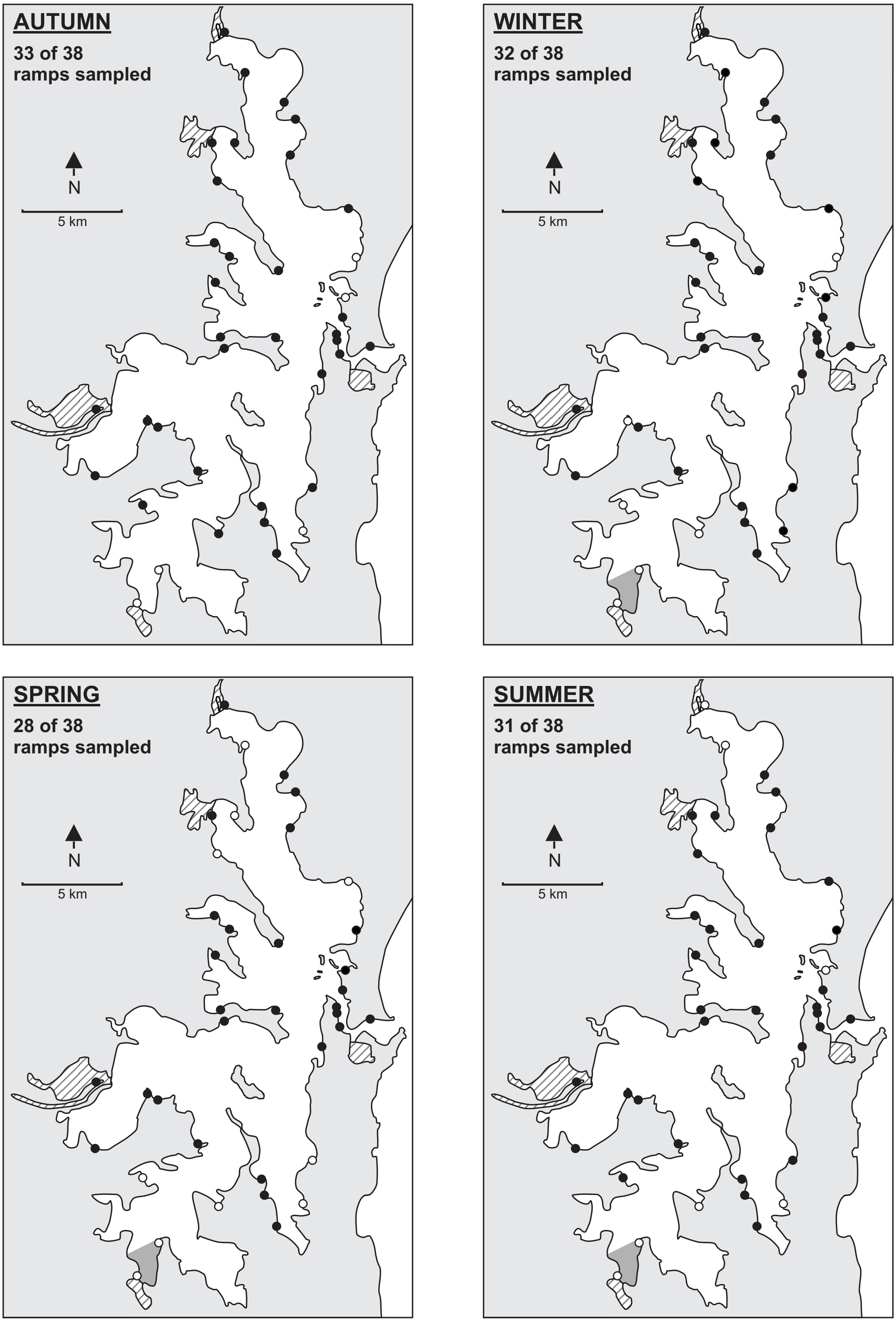
Survey methods: General term to describe the sampling methods used to survey the fishery (e.g. frame definition, levels of stratification, contact methods used, definition of basic sampling units, sample size). (Compare *Estimation methods*.)

Target population: Population about which information is desired. (Compare *Sampled population*.)

Unbiased estimator: Estimator whose average (or expected) value over many hypothetical repetitions of a study is the true parameter value.

Variance: The average (or expected) value of the squared deviations of an estimator from its expected value.

Appendix 3. Seasonal coverage by interviewers of the boat and shore fisheries in Lake Macquarie. Black circles indicate a boat ramp that was sampled at least once during the season. White circles indicate a boat ramp that was not sampled during a season. Dark shaded areas of the lake indicate that no shore sampling was done during the season. Hatched areas were excluded from the survey.



Appendix 4.1. Recreational harvest rate estimates (fish per boat hour) and standard errors for Luderick (*Girella tricuspidata*) taken by boat-based fishers in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/boat hr)		SE	Harvest Rate (fish/boat hr)		SE	Harvest Rate (fish/boat hr)		SE
Autumn 1999	Weekday	0.020	±	0.040	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**0.014**	±	**0.028**	**-**		**-**	**-**		**-**
Winter 1999	Weekday	0.101	±	0.203	-		-	0.093	±	0.186
	Weekend	0.029	±	0.057	-		-	-		-
	Total	**0.080**	±	**0.144**	**-**		**-**	**0.066**	±	**0.131**
Spring 1999	Weekday	0.250	±	0.612	-		-	0.017	±	0.042
	Weekend	0.022	±	0.053	-		-	0.356	±	0.871
	Total	**0.182**	±	**0.431**	**-**		**-**	**0.118**	±	**0.260**
Summer 99/2000	Weekday	0.018	±	0.047	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**0.012**	±	**0.031**	**-**		**-**	**-**		**-**

Appendix 4.2. Recreational harvest rate estimates (fish per boat hour) and standard errors for Blue Swimmer Crab (*Portunus pelagicus*) taken by boat-based fishers in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (crabs/boat hr)		SE	Harvest Rate (crabs/boat hr)		SE	Harvest Rate (crabs/boat hr)		SE
Autumn 1999	Weekday	0.467	±	0.311	0.731	±	0.492	-		-
	Weekend	0.195	±	0.146	0.376	±	0.274	0.003	±	0.006
	Total	**0.381**	±	**0.218**	**0.619**	±	**0.347**	**0.001**	±	**0.002**
Winter 1999	Weekday	-		-	1.172	±	1.968	-		-
	Weekend	0.084	±	0.168	0.234	±	0.332	-		-
	Total	**0.025**	±	**0.049**	**0.897**	±	**1.394**	**-**		**-**
Spring 1999	Weekday	0.062	±	0.106	0.274	±	0.575	0.004	±	0.009
	Weekend	0.162	±	0.179	1.252	±	2.435	0.010	±	0.016
	Total	**0.092**	±	**0.091**	**0.564**	±	**0.828**	**0.006**	±	**0.008**
Summer 99/2000	Weekday	0.192	±	0.343	0.584	±	0.368	0.004	±	0.009
	Weekend	0.192	±	0.299	0.692	±	1.167	0.003	±	0.008
	Total	**0.192**	±	**0.248**	**0.621**	±	**0.466**	**0.003**	±	**0.007**

Appendix 4.3. Recreational harvest rate estimates (fish per boat hour) and standard errors for Trumpeter Whiting (*Sillago maculata*) taken by boat-based fishers in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/boat hr)		SE	Harvest Rate (fish/boat hr)		SE	Harvest Rate (fish/boat hr)		SE
Autumn 1999	Weekday	0.319	±	0.290	0.884	±	1.696	-		-
	Weekend	0.020	±	0.027	0.316	±	0.212	-		-
	Total	**0.225**	±	**0.199**	**0.705**	±	**1.164**	**-**		**-**
Winter 1999	Weekday	-		-	0.059	±	0.119	-		-
	Weekend	0.091	±	0.149	0.393	±	0.305	-		-
	Total	**0.027**	±	**0.044**	**0.157**	±	**0.123**	**-**		**-**
Spring 1999	Weekday	0.045	±	0.092	0.078	±	0.192	-		-
	Weekend	0.040	±	0.065	0.417	±	0.361	-		-
	Total	**0.043**	±	**0.068**	**0.179**	±	**0.172**	**-**		**-**
Summer 99/2000	Weekday	0.011	±	0.029	0.271	±	0.271	-		-
	Weekend	0.240	±	0.372	0.210	±	0.226	-		-
	Total	**0.089**	±	**0.128**	**0.251**	±	**0.194**	**-**		**-**

Appendix 4.4. Recreational harvest rate estimates (fish per boat hour) and standard errors for Yellowfin Bream (*Acanthopagrus australis*) taken by boat-based fishers in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/boat hr)		SE	Harvest Rate (fish/boat hr)		SE	Harvest Rate (fish/boat hr)		SE
Autumn 1999	Weekday	0.245	±	0.124	-		-	0.081	±	0.072
	Weekend	0.159	±	0.069	0.100	±	0.068	0.108	±	0.131
	Total	**0.218**	±	**0.088**	**0.032**	±	**0.022**	**0.089**	±	**0.064**
Winter 1999	Weekday	0.091	±	0.157	-		-	0.012	±	0.023
	Weekend	0.109	±	0.140	0.016	±	0.022	0.012	±	0.024
	Total	**0.096**	±	**0.118**	**0.005**	±	**0.006**	**0.012**	±	**0.018**
Spring 1999	Weekday	0.048	±	0.061	0.107	±	0.167	0.116	±	0.134
	Weekend	0.048	±	0.072	0.018	±	0.036	0.066	±	0.055
	Total	**0.048**	±	**0.048**	**0.080**	±	**0.118**	**0.101**	±	**0.095**
Summer 99/2000	Weekday	0.064	±	0.093	0.008	±	0.021	0.326	±	0.674
	Weekend	0.037	±	0.054	-		-	0.105	±	0.023
	Total	**0.055**	±	**0.064**	**0.005**	±	**0.014**	**0.251**	±	**0.444**

Appendix 4.5. Recreational harvest rate estimates (squid per boat hour) and standard errors for Common Squid (*Photololigo spp.*) taken by boat-based fishers in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (squid/boat hr)		SE	Harvest Rate (squid/boat hr)		SE	Harvest Rate (squid/boat hr)		SE
Autumn 1999	Weekday	0.100	±	0.200	0.443	±	0.537	1.534	±	2.788
	Weekend	0.183	±	0.189	0.692	±	0.202	0.258	±	0.337
	Total	**0.126**	±	**0.149**	**0.521**	±	**0.373**	**1.132**	±	**1.912**
Winter 1999	Weekday	0.119	±	0.238	0.045	±	0.089	0.044	±	0.089
	Weekend	0.076	±	0.129	0.919	±	0.411	0.048	±	0.097
	Total	**0.107**	±	**0.173**	**0.301**	±	**0.136**	**0.046**	±	**0.069**
Spring 1999	Weekday	0.006	±	0.015	0.035	±	0.085	0.113	±	0.278
	Weekend	0.010	±	0.012	0.129	±	0.155	0.340	±	0.558
	Total	**0.007**	±	**0.011**	**0.063**	±	**0.075**	**0.181**	±	**0.256**
Summer 99/2000	Weekday	-		-	0.108	±	0.204	0.840	±	1.073
	Weekend	0.008	±	0.020	0.120	±	0.158	0.352	±	0.351
	Total	**0.003**	±	**0.007**	**0.112**	±	**0.145**	**0.674**	±	**0.717**

Appendix 4.6. Recreational harvest rate estimates (fish per boat hour) and standard errors for Dusky Flathead (*Platycephalus fuscus*) taken by boat-based fishers in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/boat hr)		SE	Harvest Rate (fish/boat hr)		SE	Harvest Rate (fish/boat hr)		SE
Autumn 1999	Weekday	0.089	±	0.062	0.112	±	0.193	0.016	±	0.020
	Weekend	0.074	±	0.063	0.052	±	0.047	0.032	±	0.048
	Total	**0.084**	±	**0.047**	**0.093**	±	**0.133**	**0.021**	±	**0.020**
Winter 1999	Weekday	-		-	-		-	-		-
	Weekend	0.042	±	0.034	0.013	±	0.016	-		-
	Total	**0.012**	±	**0.010**	**0.004**	±	**0.005**	**-**		**-**
Spring 1999	Weekday	0.009	±	0.016	0.051	±	0.104	0.062	±	0.096
	Weekend	0.122	±	0.170	0.028	±	0.055	0.039	±	0.079
	Total	**0.043**	±	**0.052**	**0.044**	±	**0.075**	**0.055**	±	**0.072**
Summer 99/2000	Weekday	0.039	±	0.050	0.044	±	0.059	0.092	±	0.170
	Weekend	0.056	±	0.049	0.032	±	0.047	0.081	±	0.062
	Total	**0.044**	±	**0.037**	**0.040**	±	**0.042**	**0.088**	±	**0.114**

Appendix 4.7. Recreational harvest rate estimates (fish per boat hour) and standard errors for Flat-tail Mullet (*Liza argentea*) taken by boat-based fishers in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/boat hr)		SE	Harvest Rate (fish/boat hr)		SE	Harvest Rate (fish/boat hr)		SE
Autumn 1999	Weekday	0.021	±	0.042	-		-	-		-
	Weekend	0.141	±	0.166	0.043	±	0.087	-		-
	Total	**0.059**	±	**0.059**	**0.014**	±	**0.027**	**-**		**-**
Winter 1999	Weekday	0.041	±	0.081	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**0.029**	±	**0.057**	**-**		**-**	**-**		**-**
Spring 1999	Weekday	-		-	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**-**		**-**	**-**		**-**
Summer 99/2000	Weekday	0.015	±	0.039	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**0.010**	±	**0.026**	**-**		**-**	**-**		**-**

Appendix 4.8. Recreational harvest rate estimates (fish per boat hour) and standard errors for Fan-bellied Leatherjacket (*Monacanthus chinensis*) taken by boat-based fishers in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/boat hr)		SE	Harvest Rate (fish/boat hr)		SE	Harvest Rate (fish/boat hr)		SE
Autumn 1999	Weekday	-		-	-		-	-		-
	Weekend	0.006	±	0.012	0.058	±	0.021	0.003	±	0.006
	Total	**0.002**	±	**0.004**	**0.018**	±	**0.007**	**0.001**	±	**0.002**
Winter 1999	Weekday	-		-	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**-**		**-**	**-**		**-**
Spring 1999	Weekday	-		-	0.009	±	0.021	-		-
	Weekend	0.005	±	0.006	0.016	±	0.027	-		-
	Total	**0.002**	±	**0.002**	**0.011**	±	**0.017**	**-**		**-**
Summer 99/2000	Weekday	0.021	±	0.037	0.036	±	0.083	-		-
	Weekend	0.013	±	0.031	0.012	±	0.020	0.003	±	0.008
	Total	**0.018**	±	**0.027**	**0.028**	±	**0.055**	**0.001**	±	**0.003**

Appendix 4.9. Recreational harvest rate estimates (fish per boat hour) and standard errors for Large-toothed Flounder (*Pseudorhombus arsius*) taken by boat-based fishers in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/boat hr)		SE	Harvest Rate (fish/boat hr)		SE	Harvest Rate (fish/boat hr)		SE
Autumn 1999	Weekday	0.010	±	0.011	0.008	±	0.017	-		-
	Weekend	0.013	±	0.012	0.026	±	0.035	0.003	±	0.006
	Total	**0.011**	±	**0.008**	**0.014**	±	**0.016**	**0.001**	±	**0.002**
Winter 1999	Weekday	-		-	-		-	-		-
	Weekend	0.008	±	0.015	0.021	±	0.042	-		-
	Total	**0.002**	±	**0.004**	**0.006**	±	**0.012**	**-**		**-**
Spring 1999	Weekday	0.003	±	0.007	0.034	±	0.063	-		-
	Weekend	0.022	±	0.045	0.008	±	0.016	-		-
	Total	**0.009**	±	**0.014**	**0.026**	±	**0.044**	**-**		**-**
Summer 99/2000	Weekday	0.023	±	0.026	0.021	±	0.036	-		-
	Weekend	0.031	±	0.075	0.024	±	0.028	-		-
	Total	**0.026**	±	**0.031**	**0.022**	±	**0.026**	**-**		**-**

Appendix 4.10. Recreational harvest rate estimates (fish per boat hour) and standard errors for Six-spined Leatherjacket (*Meuschenia freycineti*) taken by boat-based fishers in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/boat hr)		SE	Harvest Rate (fish/boat hr)		SE	Harvest Rate (fish/boat hr)		SE
Autumn 1999	Weekday	0.002	±	0.004	-		-	-		-
	Weekend	0.002	±	0.004	-		-	-		-
	Total	**0.002**	±	**0.003**	**-**		**-**	**-**		**-**
Winter 1999	Weekday	0.020	±	0.040	-		-	0.786	±	1.207
	Weekend	-		-	-		-	-		-
	Total	**0.014**	±	**0.028**	**-**		**-**	**0.556**	±	**0.853**
Spring 1999	Weekday	-		-	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**-**		**-**	**-**		**-**
Summer 99/2000	Weekday	0.004	±	0.010	0.048	±	0.126	0.033	±	0.087
	Weekend	-		-	-		-	-		-
	Total	**0.002**	±	**0.006**	**0.031**	±	**0.083**	**0.022**	±	**0.057**

Appendix 4.11. Recreational harvest rate estimates (fish per boat hour) and standard errors for Yellow-finned Leatherjacket (*Meuschenia trachylepis*) taken by boat-based fishers in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/boat hr)		SE	Harvest Rate (fish/boat hr)		SE	Harvest Rate (fish/boat hr)		SE
Autumn 1999	Weekday	-		-	0.004	±	0.008	-		-
	Weekend	0.083	±	0.158	0.002	±	0.003	0.007	±	0.009
	Total	**0.026**	±	**0.050**	**0.003**	±	**0.005**	**0.002**	±	**0.003**
Winter 1999	Weekday	-		-	0.050	±	0.067	0.022	±	0.044
	Weekend	0.005	±	0.010	-		-	-		-
	Total	**0.001**	±	**0.003**	**0.035**	±	**0.047**	**0.016**	±	**0.031**
Spring 1999	Weekday	0.036	±	0.089	0.120	±	0.294	-		-
	Weekend	0.051	±	0.075	0.002	±	0.005	0.103	±	0.160
	Total	**0.041**	±	**0.067**	**0.085**	±	**0.207**	**0.031**	±	**0.048**
Summer 99/2000	Weekday	0.112	±	0.168	0.022	±	0.037	0.017	±	0.044
	Weekend	0.057	±	0.094	0.019	±	0.041	0.001	±	0.003
	Total	**0.094**	±	**0.115**	**0.021**	±	**0.028**	**0.011**	±	**0.029**

Appendix 4.12. Recreational harvest rate estimates (fish per boat hour) and standard errors for River Garfish (*Hyporhamphus regularis*) taken by boat-based fishers in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/boat hr)		SE	Harvest Rate (fish/boat hr)		SE	Harvest Rate (fish/boat hr)		SE
Autumn 1999	Weekday	-		-	0.191	±	0.382	-		-
	Weekend	-		-	0.045	±	0.090	-		-
	Total	**-**		**-**	**0.145**	±	**0.263**	**-**		**-**
Winter 1999	Weekday	-		-	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**-**		**-**	**-**		**-**
Spring 1999	Weekday	-		-	0.070	±	0.170	-		-
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**0.049**	±	**0.120**	**-**		**-**
Summer 99/2000	Weekday	-		-	-		-	-		-
	Weekend	0.001	±	0.003	-		-	0.078	±	0.192
	Total	**< 0.001**	±	**0.001**	**-**		**-**	**0.027**	±	**0.065**

Appendix 4.13. Recreational harvest rate estimates (fish per boat hour) and standard errors for Sand Whiting (*Sillago ciliata*) taken by boat-based fishers in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/boat hr)		SE	Harvest Rate (fish/boat hr)		SE	Harvest Rate (fish/boat hr)		SE
Autumn 1999	Weekday	0.009	±	0.018	-		-	-		-
	Weekend	0.033	±	0.032	-		-	0.113	±	0.193
	Total	**0.017**	**±**	**0.016**	**-**		**-**	**0.036**	**±**	**0.061**
Winter 1999	Weekday	-		-	-		-	-		-
	Weekend	-		-	0.004	±	0.008	-		-
	Total	**-**		**-**	**0.001**	**±**	**0.002**	**-**		**-**
Spring 1999	Weekday	-		-	-		-	0.050	±	0.079
	Weekend	0.019	±	0.023	0.004	±	0.009	0.055	±	0.066
	Total	**0.006**	**±**	**0.007**	**0.001**	**±**	**0.003**	**0.052**	**±**	**0.059**
Summer 99/2000	Weekday	0.022	±	0.049	-		-	0.172	±	0.400
	Weekend	0.003	±	0.007	-		-	0.011	±	0.023
	Total	**0.016**	**±**	**0.032**	**-**		**-**	**0.117**	**±**	**0.264**

Appendix 4.14. Recreational harvest rate estimates (fish per boat hour) and standard errors for Small-toothed Flounder (*Pseudorhombus jenynsii*) taken by boat-based fishers in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/boat hr)		SE	Harvest Rate (fish/boat hr)		SE	Harvest Rate (fish/boat hr)		SE
Autumn 1999	Weekday	0.018	±	0.024	-		-	-		-
	Weekend	0.033	±	0.034	0.023	±	0.037	-		-
	Total	**0.022**	**±**	**0.019**	**0.007**	**±**	**0.012**	**-**		**-**
Winter 1999	Weekday	-		-	-		-	-		-
	Weekend	0.013	±	0.015	0.034	±	0.048	0.012	±	0.024
	Total	**0.004**	**±**	**0.005**	**0.010**	**±**	**0.014**	**0.004**	**±**	**0.007**
Spring 1999	Weekday	0.013	±	0.031	0.009	±	0.021	-		-
	Weekend	0.002	±	0.005	0.030	±	0.027	0.004	±	0.010
	Total	**0.010**	**±**	**0.022**	**0.015**	**±**	**0.017**	**0.001**	**±**	**0.003**
Summer 99/2000	Weekday	0.007	±	0.019	0.015	±	0.026	0.011	±	0.028
	Weekend	0.010	±	0.011	0.010	±	0.017	0.005	±	0.011
	Total	**0.008**	**±**	**0.013**	**0.013**	**±**	**0.018**	**0.009**	**±**	**0.019**

Appendix 4.15. Recreational harvest rate estimates (fish per boat hour) and standard errors for Sand Mullet (*Myxus elongatus*) taken by boat-based fishers in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/boat hr)		SE	Harvest Rate (fish/boat hr)		SE	Harvest Rate (fish/boat hr)		SE
Autumn 1999	Weekday	0.100	±	0.200	0.025	±	0.032	0.532	±	1.065
	Weekend	-		-	-		-	-		-
	Total	**0.068**	±	**0.137**	**0.017**	±	**0.022**	**0.365**	±	**0.729**
Winter 1999	Weekday	-		-	-		-	-		-
	Weekend	0.079	±	0.157	-		-	-		-
	Total	**0.023**	±	**0.046**	**-**		**-**	**-**		**-**
Spring 1999	Weekday	-		-	-		-	-		-
	Weekend	0.003	±	0.005	-		-	-		-
	Total	**0.001**	±	**0.002**	**-**		**-**	**-**		**-**
Summer 99/2000	Weekday	0.099	±	0.227	0.041	±	0.109	-		-
	Weekend	0.001	±	0.003	-		-	0.157	±	0.384
	Total	**0.066**	±	**0.149**	**0.027**	±	**0.072**	**0.053**	±	**0.131**

Appendix 4.16. Recreational harvest rate estimates (fish per boat hour) and standard errors for Snapper (*Pagrus auratus*) taken by boat-based fishers in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/boat hr)		SE	Harvest Rate (fish/boat hr)		SE	Harvest Rate (fish/boat hr)		SE
Autumn 1999	Weekday	0.060	±	0.029	-		-	-		-
	Weekend	0.047	±	0.033	0.016	±	0.013	-		-
	Total	**0.056**	±	**0.023**	**0.005**	±	**0.004**	**-**		**-**
Winter 1999	Weekday	0.050	±	0.077	-		-	-		-
	Weekend	0.115	±	0.067	-		-	-		-
	Total	**0.069**	±	**0.058**	**-**		**-**	**-**		**-**
Spring 1999	Weekday	0.010	±	0.024	0.020	±	0.049	-		-
	Weekend	0.007	±	0.010	-		-	0.002	±	0.005
	Total	**0.009**	±	**0.017**	**0.014**	±	**0.034**	**0.001**	±	**0.001**
Summer 99/2000	Weekday	0.046	±	0.055	0.018	±	0.049	-		-
	Weekend	0.007	±	0.011	-		-	0.003	±	0.007
	Total	**0.032**	±	**0.037**	**0.012**	±	**0.032**	**0.001**	±	**0.002**

Appendix 4.17. Recreational harvest rate estimates (fish per boat hour) and standard errors for Tailor (*Pomatomus saltatrix*) taken by boat-based fishers in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/boat hr)		SE	Harvest Rate (fish/boat hr)		SE	Harvest Rate (fish/boat hr)		SE
Autumn 1999	Weekday	0.023	±	0.018	-		-	-		-
	Weekend	0.101	±	0.075	0.023	±	0.027	0.004	±	0.008
	Total	**0.048**	±	**0.027**	**0.007**	±	**0.008**	**0.001**	±	**0.003**
Winter 1999	Weekday	0.210	±	0.255	-		-	-		-
	Weekend	0.019	±	0.038	-		-	-		-
	Total	**0.154**	±	**0.181**	**-**		**-**	**-**		**-**
Spring 1999	Weekday	0.085	±	0.165	0.009	±	0.021	-		-
	Weekend	0.130	±	0.269	0.003	±	0.008	-		-
	Total	**0.099**	±	**0.141**	**0.007**	±	**0.015**	**-**		**-**
Summer 99/2000	Weekday	0.031	±	0.062	0.005	±	0.013	0.007	±	0.019
	Weekend	0.009	±	0.018	-		-	0.024	±	0.058
	Total	**0.024**	±	**0.041**	**0.003**	±	**0.008**	**0.013**	±	**0.023**

Appendix 4.18. Recreational harvest rate estimates (fish per boat hour) and standard errors for Tarwhine (*Rhabdosargus sarba*) taken by boat-based fishers in the Northern Lake, Southern Lake, and Swansea Channel areas during the annual survey period.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL		
Season/Year	Day-Type	Harvest Rate (fish/boat hr)		SE	Harvest Rate (fish/boat hr)		SE	Harvest Rate (fish/boat hr)		SE
Autumn 1999	Weekday	-		-	-		-	-		-
	Weekend	0.010	±	0.021	-		-	-		-
	Total	**0.003**	±	**0.006**	**-**		**-**	**-**		**-**
Winter 1999	Weekday	-		-	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**-**		**-**	**-**		**-**
Spring 1999	Weekday	-		-	-		-	-		-
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**-**		**-**	**-**		**-**
Summer 99/2000	Weekday	-		-	-		-	0.003	±	0.009
	Weekend	-		-	-		-	-		-
	Total	**-**		**-**	**-**		**-**	**0.002**	±	**0.006**

Appendix 5. Length to weight conversion keys [$W(grams) = a * L(cm)^b$] used to estimate weights for various taxa. Relevant details which describe the sample material used to calculate the length to weight key is provided. In all length to weights keys (except Tiger Flathead which were females) the sexes have been combined.

Common Name	Taxon	Sample Size	Size Range (cm)	Length to Weight Key $W(grams) = a * L(cm)^b$	Adjusted r^2	Region of Sample	Source of Key
Bream, Black*	*Acanthopagrus butcheri*	-	- -	Yellowfin Bream Key Used	-	-	-
Bream, Yellowfin	*Acanthopagrus australis*	758	15.0 – 40.5	$W=0.024787915*FL^{2.99584}$	0.980	NSW	Steffe et al. (1996)
Cobia	*Rachycentron canadum*	270	20.0 – 155.0	$W=0.0079533483*FL^{3.08800}$	Not Given	Chesapeake Bay (USA)	Richards (1967)
Crab, Blue Swimmer	*Portunus pelagicus*	186	1.3 – 9.3	$W=0.9219*CL^{2.8855}$	0.967	NSW	Ken Graham unpub. data
Crab, Mud	*Scylla serrata*	30	8.7 – 12.7	$W=15.9866*CL^{1.6375}$	0.346	NSW	This study
Dolphin Fish	*Coryphaena hippurus*	501	26.0 – 137.0	$W=0.0372726*FL^{2.67}$	Not Given	N. Carolina (USA)	Rose & Hassler (1969)
Flathead, Dusky	*Platycephalus fuscus*	589	20.3 – 88.0	$W=0.0026864577*FL^{3.22910}$	0.992	NSW	Steffe et al. (1996)
Flathead, Eastern Blue-spotted	*Platycephalus caeruleopunctatus*	272	20.1 – 66.5	$W=0.0022403713*FL^{3.29590}$	0.995	NSW	Steffe et al. (1996)
Flathead, Long-spined*	*Platycepalus longispinis*	-	- -	Eastern Blue-spotted Flathead Key Used	-	-	-
Flathead, Marbled	*Platycephalus marmoratus*	58	23.5 – 54.0	$W=0.0023467131*FL^{3.29759}$	0.983	NSW	Steffe et al. (1996)
Flathead, Northern Sand*	*Platycephalus arenarius*	-	- -	Eastern Blue-spotted Flathead Key Used	-	-	-
Flathead, Tiger	*Neoplatycephalus richardsoni*	720	22.5 – 65.5	$W=0.00365*FL^{3.1922}$	0.988	Southern NSW	Montgomery (1986)
Flounder, Large-toothed	*Pseudorhombus arsius*	1061	15.0 – 31.5	$W=0.0053053006*FL^{3.18944}$	0.971	Botany Bay, NSW	Steffe et al. (1996)
Flounder, Small-toothed	*Pseudorhombus jenynsii*	138	15.0 – 33.4	$W=0.0014768963*FL^{3.62935}$	0.961	Botany Bay, NSW	Steffe et al. (1996)
Garfish, Sea	*Hyporhamphus australis*	259	10.2 – 31.5	$W=0.0008*FL^{3.4561}$	0.971	Botany Bay, NSW	SPCC (1981)
Garfish, River*	*Hyporhamphus regularis*	-	- -	Sea Garfish Key Used	-	-	-
Herring, Southern	*Herklotsichthys castelnaui*	557	5.2 – 18.1	$W=0.0119*FL^{3.1687}$	0.962	Botany Bay, NSW	SPCC (1981)
Kingfish	*Seriola lalandi*	123	41.5 – 160.0	$W=0.017234949*FL^{2.92134}$	0.988	NSW	Steffe et al. (1996)
Leatherjacket, Six-spined	*Meuschenia freycineti*	223	10.0 – 41.0	$W=0.016472898*FL^{3.01383}$	0.994	NSW	Steffe et al. (1996)
Leatherjacket, Yellow-finned	*Meuschenia trachylepis*	570	5.0 – 35.0	$W=0.0078*FL^{3.2233}$	0.962	Botany Bay, NSW	SPCC (1981)
Leatherjacket, Fan-bellied	*Monacanthus chinensis*	107	10.0 – 33.6	$W=0.017746389*FL^{2.97665}$	0.979	Botany Bay, NSW	SPCC (1981)
Leatherjacket, Rough*	*Scobinichthys granulatus*	-	- -	Six-spined Leatherjacket Key Used	-	-	-
Luderick	*Girella tricuspidata*	186	10.0 – 38.8	$W=0.0099659797*FL^{3.22212}$	0.990	Botany Bay, NSW	SPCC (1981)
Mullet, Fan-tail*	*Mugil georgii*	-	- -	Flat-tail Mullet Key Used	-	-	-
Mullet, Flat-tail	*Liza argentea*	657	10.5 – 35.8	$W=0.0291*FL^{2.7951}$	0.837	Botany Bay, NSW	SPCC (1981)
Mullet, Sand	*Myxus elongatus*	336	10.0 – 39.5	$W=0.0097*FL^{3.0967}$	0.963	Botany Bay, NSW	SPCC (1981)
Mullet, Sea	*Mugil cephalus*	216	6.9 – 43.8	$W=0.0078*FL^{3.2097}$	0.970	Botany Bay, NSW	SPCC (1981)

Appendix 5. Continued.

Common Name	Taxon	Sample Size	Size Range (cm)	Length to Weight Key $W(grams) = a * L(cm)^b$	Adjusted r^2	Region of Sample	Source of Key
Mulloway	*Argyrosomus hololepidotus*	141	21.7 – 139.0	$W=0.01355*FL^{2.94}$	Not Given	S. A.	Hall (1986)
Salmon	*Arripis trutta*	8232	4.0 – 77.0	$W=0.0132678*FL^{3.0485}$	Not Given	Australia	Malcolm (1966)
Seapike, Long-finned	*Dinolestes lewini*	87	13.0 – 43.5	$W=0.0024685959*FL^{3.30752}$	0.995	NSW	Steffe et al. (1996)
Seapike, Striped*	*Sphyraena obtusata*	-	- -	Long-finned Seapike Key Used		-	-
Snapper	*Pagrus auratus*	2646	6.5 – 82.0	$W=0.0467727*FL^{2.781}$	0.990	W.A.	Moran & Burton (1990)
Squid, Arrow*	*Nototodarus gouldi*	-	- -	Southern Calamari Key Used	-	-	-
Squid, Common	*Photololigo spp.*	15	8.7 – 29.3	$W=0.6059*ML^{1.9287}$	0.992	Lake Macquarie, NSW	This study
Squid, Southern Calamari	*Sepioteuthis australis*	101	11.0 – 39.0	$W=0.24976409*ML^{2.44095}$	0.977	NSW	Steffe et al. (1996)
Sweep, Silver	*Scorpis lineolatus*	82	14.5 – 32.0	$W=0.071518764*FL^{2.64994}$	0.947	NSW	Steffe et al. (1996)
Tailor	*Pomatomus saltatrix*	1028	10.0 – 58.5	$W=0.0075039512*FL^{3.15753}$	0.994	NSW	Steffe et al. (1996)
Tarwhine	*Rhabdosargus sarba*	730	10.0 – 30.5	$W=0.014914888*FL^{3.16297}$	0.986	NSW	Steffe et al. (1996)
Teraglin	*Atractoscion aequidens*	59	36.0 – 57.0	$W=0.017450184*FL^{2.85053}$	0.956	NSW	Steffe et al. (1996)
Trevally, Silver	*Pseudocaranx dentex*	43	19.5 – 39.0	$W=0.033516603*FL^{2.84574}$	0.991	NSW	Steffe et al. (1996)
Whiting, Sand	*Sillago ciliata*	1198	10.0 – 39.5	$W=0.0040*FL^{3.3137}$	0.973	Botany Bay, NSW	SPCC (1981)
Whiting, School	*Sillago flindersi*	1492	6.0 – 29.0	$W=0.00556*FL^{3.188}$	0.989	Tasmania	Lyle & Ford (1993)
Whiting, Trumpeter	*Sillago maculata*	977	5.0 – 31.4	$W=0.0052*FL^{3.2240}$	0.965	Botany Bay & Lake Macquarie, NSW	This Study, SPCC (1981)
Wirrah	*Acanthistius ocellatus*	67	19.8 – 48.0	$W=0.013524151*FL^{3.09921}$	0.975	NSW	Steffe et al. (1996)
Wrasse, Crimson-banded	*Notolabrus gymnogenis*	24	20.0 – 33.5	$W=0.057253231*FL^{2.6490}$	0.957	NSW	Steffe et al. (1996)
Yellowtail	*Trachurus novaezelandiae*	740	10.0 – 32.5	$W=0.0088204349*FL^{3.14215}$	0.987	NSW	Steffe et al. (1996)

This study - refers to addition material collected during the survey.
Steffe et al. (1996). - refers to the amalgamation of material from a variety of sources and the recalculation of a length to weight key. These sources include material from market measuring, ramp measuring, and unpublished material taken from the Botany Bay project (SPCC, 1981), the Northern Rivers project and the Deep Ocean Outfall Monitoring project.
* Length to weight equation for this taxon was not available. Estimates of weight were obtained by using a length to weight key for a closely related taxon.
FL - Fork Length, ML - Mantle Length, CL - Carapace Length.

Appendix 6. Estimates of daytime recreational fishing effort (boat hours) for the boat-based fishery in the Northern Lake, Southern Lake, and Swansea Channel areas. Data are presented for all temporal strata and have also been combined to provide effort estimates for the whole Lake fishery.

		NORTHERN LAKE			SOUTHERN LAKE			SWANSEA CHANNEL			TOTAL LAKE		
Season/Year	Day-Type	Boat Effort (boat hrs)		SE	Boat Effort (boat hrs)		SE	Boat Effort (boat hrs)		SE	Boat Effort (boat hrs)		SE
Autumn 99	Weekday	21,867	±	2,586	19,295	±	3,012	7,575	±	2,151	48,737	±	4,515
	Weekend	14,737	±	2,766	15,790	±	2,029	4,408	±	1,114	34,935	±	3,607
	Total	**36,604**	±	**3,787**	**35,085**	±	**3,631**	**11,983**	±	**2,422**	**83,672**	±	**5,779**
Winter 99	Weekday	6,405	±	955	8,091	±	1,365	1,236	±	366	15,732	±	1,706
	Weekend	8,916	±	1,248	7,562	±	1,236	2,381	±	287	18,859	±	1,779
	Total	**15,321**	±	**1,571**	**15,653**	±	**1,841**	**3,617**	±	**465**	**34,591**	±	**2,465**
Spring 99	Weekday	16,727	±	2,468	14,945	±	2,852	5,073	±	1,963	36,745	±	4,252
	Weekend	11,916	±	2,420	8,156	±	1,303	4,338	±	1,205	24,410	±	3,001
	Total	**28,643**	±	**3,457**	**23,101**	±	**3,136**	**9,411**	±	**2,303**	**61,155**	±	**5,204**
Summer 99/00	Weekday	27,500	±	6,114	32,084	±	6,321	12,639	±	2,691	72,223	±	9,197
	Weekend	30,641	±	2,876	25,475	±	5,029	11,625	±	3,421	67,741	±	6,728
	Total	**58,141**	±	**6,757**	**57,559**	±	**8,077**	**24,264**	±	**4,353**	**139,964**	±	**11,395**
Yearly Total	Weekday	72,499	±	7,147	74,415	±	7,682	26,523	±	3,982	173,437	±	11,223
	Weekend	66,210	±	4,831	56,983	±	5,712	22,752	±	3,805	145,945	±	8,393
	Total	**138,709**	±	**8,626**	**131,398**	±	**9,573**	**49,275**	±	**5,508**	**319,382**	±	**14,014**

Appendix 7. The number of individuals observed (N), the number of individuals measured (n), size range (cm), median length (cm), and mean length (cm) for all taxa measured during interviews with boat-based and shore-based recreational fishers in the Lake Macquarie fishery during the annual survey period.

	BOAT FISHERY					SHORE FISHERY					TOTAL FISHERY				
Common Name	N	n	Range	Median	Mean	N	n	Range	Median	Mean	N	n	Range	Median	Mean
Batfish, Silver	-	-	- -	-	-	1	1	14	14.0	14.0	1	1	14	14.0	14.0
Bigeye, Red	13	13	25 – 28	26.0	26.4	-	-	- -	-	-	13	13	25 – 28	26.0	26.4
Bream, Black	3	3	25 – 27	26.0	26.0	-	-	- -	-	-	3	3	25 – 27	26.0	26.0
Bream, Yellowfin	407	391	8 – 43	26.0	25.9	239	224	9 – 42	27.0	26.6	646	615	8 – 43	26.0	26.2
Cobia	1	1	71	71.0	71.0	-	-	- -	-	-	1	1	71	71.0	71.0
Crab, Blue Swimmer	1039	784	4 – 14	8.0	8.3	25	8	7 – 9	8.0	7.8	1064	792	4 – 14	8.0	8.2
Crab, Hairy-backed	1	1	9	9.0	9.0	-	-	- -	-	-	1	1	9	9.0	9.0
Crab, Mud	32	31	7 – 15	9.0	9.5	-	-	- -	-	-	32	31	7 – 15	9.0	9.5
Dolphin Fish	4	3	44 – 58	58.0	53.3	-	-	- -	-	-	4	3	44 – 58	58.0	53.3
Eel, Conger	-	-	- -	-	-	1	1	65	65.0	65.0	1	1	65	65.0	65.0
Flathead, Dusky	289	278	20 – 80	41.0	43.2	33	33	24 – 72	47.0	48.2	322	311	20 – 80	41.0	43.7
Flathead, Eastern Blue-spotted	13	13	30 – 45	38.0	37.8	-	-	- -	-	-	13	13	30 – 45	38.0	37.8
Flathead, Long-spined	1	1	24	24.0	24.0	-	-	- -	-	-	1	1	24	24.0	24.0
Flathead, Marbled	-	-	- -	-	-	1	1	51	51.0	51.0	1	1	51	51.0	51.0
Flathead, Northern Sand	1	1	44	44.0	44.0	-	-	- -	-	-	1	1	44	44.0	44.0
Flathead, Tiger	-	-	- -	-	-	1	1	68	68.0	68.0	1	1	68	68.0	68.0
Flounder, Large-toothed	73	71	13 – 36	27.0	26.1	1	1	27	27.0	27.0	74	72	13 – 36	27.0	26.1
Flounder, Small-toothed	72	65	12 – 40	26.0	26.1	1	1	28	28.0	28.0	73	66	12 – 40	26.0	26.1
Garfish, River	72	27	19 – 29	24.0	23.9	-	-	- -	-	-	72	27	19 – 29	24.0	23.9
Garfish, Sea	25	24	17 – 29	24.0	23.8	-	-	- -	-	-	25	24	17 – 29	24.0	23.8
Goatfish, Blue-striped	1	-	- -	-	-	-	-	- -	-	-	1	-	- -	-	-
Herring, Giant	-	-	- -	-	-	1	1	62	62.0	62.0	1	1	62	62.0	62.0
Herring, Southern	-	-	- -	-	-	125	125	5 – 20	10.0	10.7	125	125	5 – 20	10.0	10.7
Kingfish	2	2	23 – 55	39.0	39.0	1	1	76	76.0	76.0	3	3	23 – 76	55.0	51.3

Appendix 7 – Continued.

	BOAT FISHERY					SHORE FISHERY					TOTAL FISHERY				
Common Name	N	n	Range	Median	Mean	N	n	Range	Median	Mean	N	n	Range	Median	Mean
Leatherjacket, Chinaman	-	-	- -	-	-	5	-	- -	-	-	5	-	- -	-	-
Leatherjacket, Fan-bellied	56	46	10 – 32	25.0	24.2	22	17	16 – 31	25.0	24.1	78	63	10 – 32	25.0	24.2
Leatherjacket, Rough	6	6	20 – 32	26.0	25.8	1	1	22	22.0	22.0	7	7	20 – 32	26.0	25.3
Leatherjacket, Six-spined	45	16	11 – 33	21.5	20.9	109	100	7 – 32	17.0	17.2	154	116	7 – 33	18.0	17.7
Leatherjacket, Yellow-finned	179	108	9 – 32	22.5	22.0	70	65	8 – 30	24.0	23.0	249	173	8 – 32	24.0	22.4
Longtom, Stout	3	2	65 – 72	68.5	68.5	6	6	29 – 105	54.0	57.3	9	8	29 – 105	61.0	60.1
Luderick	86	67	24 – 37	28.0	28.7	1207	1159	22 – 44	28.0	28.5	1293	1226	22 – 44	28.0	28.5
Mullet, Fan-tail	-	-	- -	-	-	8	3	25 – 28	26.0	26.3	8	3	25 – 28	26.0	26.3
Mullet, Flat-tail	71	37	20 – 37	28.0	29.3	50	43	17 – 38	27.0	25.5	121	80	17 – 38	28.0	27.3
Mullet, Sand	151	64	18 – 37	26.0	26.3	146	54	13 – 36	27.0	25.9	297	118	13 – 37	26.0	26.1
Mullet, Sea	-	-	- -	-	-	2	2	32 – 33	32.5	32.5	2	2	32 – 33	32.5	32.5
Mulloway	5	5	58 – 99	67.0	70.6	1	1	72	72.0	72.0	6	6	58 – 99	68.0	70.8
Octopus	1	-	- -	-	-	-	-	- -	-	-	1	-	- -	-	-
Ray, Shovelnose	1	1	75	75.0	75.0	-	-	- -	-	-	1	1	75	75.0	75.0
Rock Blackfish	-	-	- -	-	-	2	2	25 – 26	25.5	25.5	2	2	25 – 26	25.5	25.5
Salmon	-	-	- -	-	-	1	1	58	58.0	58.0	1	1	58	58.0	58.0
Seapike, Striped	1	1	30	30.0	30.0	-	-	- -	-	-	1	1	30	30.0	30.0
Snapper	97	91	10 – 54	27.0	26.8	4	4	8 – 18	15.0	14.0	101	95	8 – 54	27.0	26.3
Sole, Black	1	-	- -	-	-	-	-	- -	-	-	1	-	- -	-	-
Squid, Arrow	-	-	- -	-	-	1	1	12	12.0	12.0	1	1	12	12.0	12.0
Squid, Common	1200	833	6 – 33	16.0	16.7	96	86	6 – 50	14.0	15.2	1296	919	6 – 50	16.0	16.6
Squid, Southern Calamari	2	2	30 – 35	32.5	32.5	9	5	23 – 36	26.0	27.4	11	7	23 – 36	28.0	28.9
Surgeon Fish	1	1	27	27.0	27.0	-	-	- -	-	-	1	1	27	27.0	27.0
Sweep, Silver	1	1	15	15.0	15.0	-	-	- -	-	-	1	1	15	15.0	15.0

Appendix 7 – Continued.

	BOAT FISHERY					SHORE FISHERY					TOTAL FISHERY				
Common Name	N	n	Range	Median	Mean	N	n	Range	Median	Mean	N	n	Range	Median	Mean
Tailor	176	135	11 – 45	32.0	31.3	30	30	18 – 32	23.5	23.9	206	165	11 – 45	30.0	30.0
Tarwhine	6	2	22 – 30	26.0	26.0	65	59	18 – 31	24.0	23.8	71	61	18 – 31	24.0	23.9
Teraglin	5	5	40 – 45	42.0	41.8	-	-	- -	-	-	5	5	40 – 45	42.0	41.8
Trevally, Black (Spinefoot)	-	-	- -	-	-	74	33	10 – 19	14.0	14.5	74	33	10 – 19	14.0	14.5
Trevally, Silver	-	-	- -	-	-	8	8	23 – 59	25.0	29.1	8	8	23 – 59	25.0	29.1
Trumpeter, Six-lined	2	-	- -	-	-	12	10	6 – 10	7.5	7.7	14	10	6 – 10	7.5	7.7
Whiting, Sand	96	94	19 – 38	27.5	27.9	15	15	15 – 30	25.0	24.1	111	109	15 – 38	27.0	27.3
Whiting, School	7	7	21 – 26	25.0	24.3	-	-	- -	-	-	7	7	21 – 26	25.0	24.3
Whiting, Trumpeter	674	498	7 – 34	21.0	20.7	22	22	8 – 26	22.0	21.1	696	520	7 – 34	21.0	20.7
Wirrah	3	3	28 – 30	28.0	28.7	-	-	- -	-	-	3	3	28 – 30	28.0	28.7
Wrasse, Crimson-banded	1	1	31	31.0	31.0	1	1	24	24.0	24.0	2	2	24 – 31	27.5	27.5
Yellowtail	1	1	27	27.0	27.0	-	-	- -	-	-	1	1	27	27.0	27.0

Appendix 8. List of postcodes that were used to classify fishers of local origin with respect to the Lake Macquarie fishery.

2250	2262	2280	2286	2294	2301	2307	2322
2251	2263	2281	2287	2295	2302	2308	2323
2256	2264	2282	2289	2297	2303	2314	2324
2257	2265	2283	2290	2298	2304	2318	2325
2258	2267	2284	2292	2299	2305	2320	2326
2259	2278	2285	2293	2300	2306	2321	2327

Other titles in this series:

ISSN 1440-3544

No. 1 Andrew, N.L., Graham, K.J., Hodgson, K.E. and Gordon, G.N.G., 1998. Changes after 20 years in relative abundance and size composition of commercial fishes caught during fishery independent surveys on SEF trawl grounds. Final Report to Fisheries Research and Development Corporation. Project No. 96/139.

No. 2 Virgona, J.L., Deguara, K.L., Sullings, D.J., Halliday, I. and Kelly, K., 1998. Assessment of the stocks of sea mullet in New South Wales and Queensland waters. Final Report to Fisheries Research and Development Corporation. Project No. 94/024.

No. 3 Stewart, J., Ferrell, D.J. and Andrew, N.L., 1998. Ageing Yellowtail (*Trachurus novaezelandiae*) and Blue Mackerel (*Scomber australasicus*) in New South Wales. Final Report to Fisheries Research and Development Corporation. Project No. 95/151.

No. 4 Pethebridge, R., Lugg, A. and Harris, J., 1998. Obstructions to fish passage in New South Wales South Coast streams. Final report to Cooperative Research Centre for Freshwater Ecology. 70pp.

No. 5 Kennelly, S.J. and Broadhurst, M.K., 1998. Development of by-catch reducing prawn-trawls and fishing practices in NSW's prawn-trawl fisheries (and incorporating an assessment of the effect of increasing mesh size in fish trawl gear). Final Report to Fisheries Research and Development Corporation. Project No. 93/180. 18pp + appendices.

No. 6 Allan, G.L. and Rowland, S.J., 1998. Fish meal replacement in aquaculture feeds for silver perch. Final Report to Fisheries Research and Development Corporation. Project No. 93/120-03. 237pp + appendices.

No. 7 Allan, G.L., 1998. Fish meal replacement in aquaculture feeds: subprogram administration. Final Report to Fisheries Research and Development Corporation. Project No. 93/120. 54pp + appendices.

No. 8 Heasman, M.P., O'Connor, W.A. and O'Connor, S.J., 1998. Enhancement and farming of scallops in NSW using hatchery produced seedstock. Final Report to Fisheries Research and Development Corporation. Project No. 94/083. 146pp.

No. 9 Nell, J.A., McMahon, G.A. and Hand, R.E., 1998. Tetraploidy induction in Sydney rock oysters. Final Report to Cooperative Research Centre for Aquaculture. Project No. D.4.2. 25pp.

No. 10 Nell, J.A. and Maguire, G.B., 1998. Commercialisation of triploid Sydney rock and Pacific oysters. Part 1: Sydney rock oysters. Final Report to Fisheries Research and Development Corporation. Project No. 93/151. 122pp.

No. 11 Watford, F.A. and Williams, R.J., 1998. Inventory of estuarine vegetation in Botany Bay, with special reference to changes in the distribution of seagrass. Final Report to Fishcare Australia. Project No. 97/003741. 51pp.

No. 12 Andrew, N.L., Worthington D.G., Brett, P.A. and Bentley N., 1998. Interactions between the abalone fishery and sea urchins in New South Wales. Final Report to Fisheries Research and Development Corporation. Project No. 93/102.

No. 13 Jackson, K.L. and Ogburn, D.M., 1999. Review of depuration and its role in shellfish quality assurance. Final Report to Fisheries Research and Development Corporation. Project No. 96/355. 77pp.

No. 14 Fielder, D.S., Bardsley, W.J. and Allan, G.L., 1999. Enhancement of Mulloway (*Argyrosomus japonicus*) in intermittently opening lagoons. Final Report to Fisheries Research and Development Corporation. Project No. 95/148. 50pp + appendices.

No. 15 Otway, N.M. and Macbeth, W.G., 1999. The physical effects of hauling on seagrass beds. Final Report to Fisheries Research and Development Corporation. Project No. 95/149 and 96/286. 86pp.

No. 16 Gibbs, P., McVea, T. and Louden, B., 1999. Utilisation of restored wetlands by fish and invertebrates. Final Report to Fisheries Research and Development Corporation. Project No. 95/150. 142pp.

No. 17 Ogburn, D. and Ruello, N., 1999. Waterproof labelling and identification systems suitable for shellfish and other seafood and aquaculture products. Whose oyster is that? Final Report to Fisheries Research and Development Corporation. Project No. 95/360. 50pp.

No. 18 Gray, C.A., Pease, B.C., Stringfellow, S.L., Raines, L.P. and Walford, T.R., 2000. Sampling estuarine fish species for stock assessment. Includes appendices by D.J. Ferrell, B.C. Pease, T.R. Walford, G.N.G. Gordon, C.A. Gray and G.W. Liggins. Final Report to Fisheries Research and Development Corporation. Project No. 94/042. 194pp.

No. 19 Otway, N.M. and Parker, P.C., 2000. The biology, ecology, distribution, abundance and identification of marine protected areas for the conservation of threatened Grey Nurse Sharks in south east Australian waters. Final Report to Environment Australia. 101pp.

No. 20 Allan, G.L. and Rowland, S.J., 2000. Consumer sensory evaluation of silver perch cultured in ponds on meat meal based diets. Final Report to Meat & Livestock Australia. Project No. PRCOP.009. 21pp + appendices.

No. 21 Kennelly, S.J. and Scandol, J. P., 2000. Relative abundances of spanner crabs and the development of a population model for managing the NSW spanner crab fishery. Final Report to Fisheries Research and Development Corporation. Project No. 96/135. 43pp + appendices.

No. 22 Williams, R.J., Watford, F.A. and Balashov, V., 2000. Kooragang Wetland Rehabilitation Project: History of changes to estuarine wetlands of the lower Hunter River. Final Report to Kooragang Wetland Rehabilitation Project Steering Committee. 82pp.

No. 23 Survey Development Working Group, 2000. Development of the National Recreational and Indigenous Fishing Survey. Final Report to Fisheries Research and Development Corporation. Project No. 98/169. (Volume 1 – 36pp + Volume 2 – attachments).

No.24 Rowling, K.R and Raines, L.P., 2000. Description of the biology and an assessment of the fishery of Silver Trevally *Pseudocaranx dentex* off New South Wales. Final Report to Fisheries Research and Development Corporation. Project No. 97/125. 69pp.

No. 25 Allan, G.L., Jantrarotai, W., Rowland, S., Kosuturak, P. and Booth, M., 2000. Replacing fishmeal in aquaculture diets. Final Report to the Australian Centre for International Agricultural Research. Project No. 9207. 13pp.

No. 26 Gehrke, P.C., Gilligan, D.M. and Barwick, M., 2001. Fish communities and migration in the Shoalhaven River – Before construction of a fishway. Final Report to Sydney Catchment Authority. 126pp.

No. 27 Rowling, K.R. and Makin, D.L., 2001. Monitoring of the fishery for Gemfish *Rexea solandri*, 1996 to 2000. Final Report to the Australian Fisheries Management Authority. 44pp.

No. 28 Otway, N.M., 1999. Identification of candidate sites for declaration of aquatic reserves for the conservation of rocky intertidal communities in the Hawkesbury Shelf and Batemans Shelf Bioregions. Final Report to Environment Australia for the Marine Protected Areas Program. Project No. OR22. 88pp.

No. 29 Heasman, M.P., Goard, L., Diemar, J. and Callinan, R., 2000. Improved Early Survival of Molluscs: Sydney Rock Oyster (*Saccostrea glomerata*). Final report to the Aquaculture Cooperative Research Centre. Project No. A.2.1. 63pp.

No. 30 Allan, G.L., Dignam, A and Fielder, S., 2001. Developing Commercial Inland Saline Aquaculture in Australia: Part 1. R&D Plan. Final Report to Fisheries Research and Development Corporation. Project No. 1998/335.

No. 31 Allan, G.L., Banens, B. and Fielder, S., 2001. Developing Commercial Inland Saline Aquaculture in Australia: Part 2. Resource Inventory and Assessment. Final report to Fisheries Research and Development Corporation. Project No. 1998/335. 33pp.

No. 32 Bruce, A., Growns, I. and Gehrke, P., 2001. Woronora River Macquarie Perch Survey. Final report to Sydney Catchment Authority, April 2001. 116pp.

No. 33 Morris, S.A., Pollard, D.A., Gehrke, P.C. and Pogonoski, J.J., 2001. Threatened and Potentially Threatened Freshwater Fishes of Coastal New South Wales and the Murray-Darling Basin. Report to Fisheries Action Program and World Wide Fund for Nature. Project No. AA 0959.98. 177pp.

No. 34 Heasman, M.P., Sushames, T.M., Diemar, J.A., O'Connor, W.A. and Foulkes, L.A., 2001. Production of Micro-algal Concentrates for Aquaculture Part 2: Development and Evaluation of Harvesting, Preservation, Storage and Feeding Technology. Final Report to Fisheries Research and Development Corporation. Project No. 1993/123 and 1996/342. 150pp + appendices.

No. 35 Stewart, J. and Ferrell, D.J., 2001. Mesh selectivity in the NSW demersal trap fishery. Final Report to Fisheries Research and Development Corporation. Project No. 1998/138. 86pp.

No. 36 Stewart, J., Ferrell, D.J., van der Walt, B., Johnson, D. and Lowry, M., 2001. Assessment of length and age composition of commercial kingfish landings. Final Report to Fisheries Research and Development Corporation. Project No. 1997/126. 49pp.

No. 37 Gray, C.A. and Kennelly, S.J., 2001. Development of discard-reducing gears and practices in the estuarine prawn and fish haul fisheries of NSW. Final Report to Fisheries Research and Development Corporation. Project No. 1997/207. 151pp.

No. 38 Murphy, J.J., Lowry, M.B., Henry, G.W. and Chapman, D., 2002. The Gamefish Tournament Monitoring Program – 1993 to 2000. Final report to Australian Fisheries Management Authority. 93pp.

No. 39 Kennelly, S.J. and McVea, T.A. (Ed), 2002. Scientific reports on the recovery of the Richmond and Macleay Rivers following fish kills in February and March 2001. 325pp.

No. 40 Pollard, D.A. and Pethebridge, R.L., 2002. Report on Port of Botany Bay Introduced Marine Pest Species Survey. Final Report to Sydney Ports Corporation. 69pp.

No. 41 Pollard, D.A. and Pethebridge, R.L., 2002. Report on Port Kembla Introduced Marine Pest Species Survey. Final Report to Port Kembla Port Corporation. 72pp.

No. 42 O'Connor, W.A, Lawler, N.F. and Heasman, M.P., 2003. Trial farming the akoya pearl oyster, *Pinctada imbricata*, in Port Stephens, NSW. Final Report to Australian Radiata Pty. Ltd. 170pp.

No. 43 Fielder, D.S. and Allan, G.L., 2003. Improving fingerling production and evaluating inland saline water culture of snapper, *Pagrus auratus*. Final Report to the Aquaculture Cooperative Research Centre. Project No. C4.2. 62pp.

No. 44 Astles, K.L., Winstanley, R.K., Harris, J.H. and Gehrke, P.C., 2003. Experimental study of the effects of cold water pollution on native fish. A Final Report for the Regulated Rivers and Fisheries Restoration Project. 55pp.

No. 45 Gilligan, D.M., Harris, J.H. and Mallen-Cooper, M., 2003. Monitoring changes in the Crawford River fish community following replacement of an effective fishway with a vertical-slot fishway design: Results of an eight year monitoring program. Final Report to the Cooperative Research Centre for Freshwater Ecology. 80pp.

No. 46 Pollard, D.A. and Rankin, B.K., 2003. Port of Eden Introduced Marine Pest Species Survey. Final Report to Coasts & Clean Seas Program. 67pp.

No. 47 Otway, N.M., Burke, A.L., Morrison, NS. and Parker, P.C., 2003. Monitoring and identification of NSW Critical Habitat Sites for conservation of Grey Nurse Sharks. Final Report to Environment Australia. Project No. 22499. 62pp.

No. 48 Henry, G.W. and Lyle, J.M. (Ed), 2003. The National Recreational and Indigenous Fishing Survey. Final Report to Fisheries Research and Development Corporation. Project No. 1999/158. 188 pp.

No. 49 Nell, J.A., 2003. Selective breeding for disease resistance and fast growth in Sydney rock oysters. Final Report to Fisheries Research and Development Corporation. Project No. 1996/357. 44pp.

No. 50 Gilligan, D. and Schiller, S., 2003. Downstream transport of larval and juvenile fish. A final report for the Natural Resources Management Strategy. Project No. NRMS R7019. 66pp.

No. 51 Liggins, G.W., Scandol, J.P. and Kennelly, S.J., 2003. Recruitment of Population Dynamacist. Final Report to Fisheries Research and Development Corporation. Project No. 1993/214.05. 44pp.

No. 52 Steffe, A.S. and Chapman, J.P., 2003. A survey of daytime recreational fishing during the annual period, March 1999 to February 2000, in Lake Macquarie, New South Wales. NSW Fisheries Final Report. 124pp.