An assessment of changes in the daytime recreational fishery of Lake Macquarie following the establishment of a 'Recreational Fishing Haven'

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A full list of all personnel that were involved with the 1999/2000 and/or 2003/2004 surveys and their affiliations is provided in Section 10 of this report.

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This report is dedicated to the memories of our colleague Doug Chapman and to Bill Gray, a driving force for a net free Lake Macquarie. Their energy and dedication will be missed by all.

EXECUTIVE SUMMARY

Resource sharing and the allocation of fisheries resources between recreational and commercial user groups has long been a contentious management issue in New South Wales (NSW). The introduction of a general recreational fishing fee in March 2001 generated considerable funding that was used to undertake significant changes in the management of fisheries in NSW. Lake Macquarie was zoned a 'Recreational Fishing Haven' (RFH) following extensive community consultation. This management initiative changed the allocation of fisheries resources in this waterway between the recreational and commercial sectors. This major re-allocation of access to the estuarine fisheries resources in Lake Macquarie has undoubtedly created additional recreational fishing opportunities. Thus, there was an important need to assess whether the recreational fisheries in this RFH were improving and providing better quality recreational fishing. This report focuses on comparisons made between two separate daytime recreational fishing surveys of Lake Macquarie (including Swansea Channel). The first annual survey was done during the pre-RFH period (March 1999 to February 2000) and the second annual survey was done during the post-RFH period (December 2003 to November 2004). These annual surveys provide a snapshot of the recreational fishery of Lake Macquarie before RFH implementation and after RFH implementation. The same complemented, on-site, survey design was used in both surveys. The shore-based fishery was assessed by using a roving(effort)-roving(harvest) design combination and the boat-based fishery was assessed by using a roving(effort)-access(harvest) design combination using stratified random sampling methods.

The two recreational fishing surveys provide evidence of a relatively productive recreational fishery in Lake Macquarie. Comparisons made between the two separate daytime recreational fishing surveys indicate that the post-RFH recreational fishery was very different to the fishery that had existed prior to the implementation of the RFH. We documented statistically significant increases in recreational harvest for some prized recreational species and also some significant decreases for some other important recreational species. Overall, the indicators of recreational fishing quality that we examined indicated that the post-RFH fishery had improved in many ways since the pre-RFH survey period. A summary of the evidence provided in this report is that:

(a) the recreational harvest in both survey years was dominated by a relatively small number of taxa, however, the composition and relative contribution of these dominant taxa changed markedly between survey years. These changes occurred even though there was no significant difference between survey years in the total annual harvest, by number or weight, for the whole fishery;

(b) the recreational harvest of dusky flathead, tailor, sand whiting and trumpeter whiting (number and weight) and large-toothed flounder (weight only) increased significantly during the post-RFH survey year;

(c) the recreational harvest of common squid, yellow-finned leatherjacket and sand mullet, by number and weight, decreased significantly during the post-RFH survey year;

(d) total fishing effort (boat and shore combined) showed little change (about 2%), however, different trends were evident in the boat-based and shore-based fisheries. Fishing effort in the larger boat-based fishery increased by about 13% but this change was not statistically significant. In contrast, there was a statistically significant reduction of about 22% in the level of shore-based fishing;

(e) seasonal harvest rate comparisons between survey years tended to confirm the increasing or decreasing trends found in the annual recreational harvest estimates for the main species;

(f) comparisons of length frequency information, mean and median lengths between survey years indicated that most species were harvested at larger sizes during the post-RFH survey year. The mean and median sizes of dusky flathead, sand whiting, tailor, common squid, yellowfin bream, blue swimmer crab, large-toothed flounder and sand mullet were all larger during the second survey year.

This survey provides the first snapshot (point estimate) of the Lake Macquarie recreational fishery following the establishment of the waterway as a RFH. On-site surveys of recreational fishing are valuable tools for collecting information to describe the status of a fishery and any changes that may have occurred since previous survey periods. On-site surveys of the recreational fishery should be repeated regularly (every 3-5 years) to monitor the recreational fishery in Lake Macquarie.

1. INTRODUCTION

Resource sharing and the allocation of fisheries resources between recreational and commercial user groups has long been a contentious management issue in New South Wales (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, usually 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. A survey of daytime recreational fishing, commenced in March 1999 and completed at the end of February 2000, provided the baseline quantitative information needed to describe and assess the status of the recreational fishery in Lake Macquarie (Steffe and Chapman 2003).

The introduction of a general recreational fishing fee in March 2001 generated funding that was used to undertake significant changes in the management of fisheries in NSW. Extensive community consultation was undertaken to identify suitable estuarine areas that could be zoned 'Recreational Fishing Havens' (RFH). The intent was that areas declared 'Recreational Fishing Havens' would improve recreational fishing opportunities by removing commercial fishing from them. Thirty locations, including the whole of Lake Macquarie, were declared 'Recreational Fishing Havens' during the period May to September 2002. This resulted in a total estuarine area of 27% being made substantially free of commercial fishing (some RFH areas still have limited commercial fishing). This major re-allocation of access to the estuarine fisheries resources in NSW has undoubtedly created additional recreational fishing opportunities. Thus, there was an important need to assess whether these 'Recreational Fishing Havens' were actually improving the recreational fisheries.

The previous recreational fishing survey done in Lake Macquarie during 1999-2000 (Steffe and Chapman 2003) provided a pre-RFH benchmark that could be used to assess any post-RFH changes that had occurred in the fishery. Hence, another survey of recreational fishing was done so that we could assess changes in the harvest, effort and quality of fishing that had occurred after the implementation of the RFH.

2. OBJECTIVES

The principal aims of this project were:

- To estimate the level of daytime recreational fishing effort and harvest in Lake Macquarie during the annual period, December 2003 to November 2004 inclusive.
- To assess changes in the fishing effort and harvest of recreational fishers that had occurred since the establishment of Lake Macquarie as a Recreational Fishing Haven (RFH) in May 2002.
- To use selected indicators of recreational fishing quality to assess changes in the Lake Macquarie fishery after its establishment as a Recreational Fishing Haven.

3. METHODS

3.1. General comments

Data comparisons are derived from two separate recreational fishing surveys of Lake Macquarie (including the Swansea Channel). The first annual survey was carried out during March 1999 to February 2000 inclusive and represents a snapshot of the recreational fishery (boat and shore) before the area was declared a Recreational Fishing Haven. The second annual survey was carried out during December 2003 to November 2004 inclusive and represents a snapshot of the recreational fishery covering a period of 1.5 to 2.5 years after the area was made a Recreational Fishing Haven. The same survey methods were used for both survey years, however, the level of daily replication was greater in the second survey period (see Table 1). Description of study area and access for recreational fishers to the fishery.

An error in the structure of a database query was found during the preparation of comparative data analyses from the two survey periods. This error resulted in the overestimation of the harvest (number of fish and weight) reported for the first survey period by Steffe and Chapman (2003). All fishing effort and harvest rate estimates reported by Steffe and Chapman (2003) are correct. Revised harvest estimates for the first survey period are presented in this report.

3.2. Description of study area and access for recreational fishers to the fishery

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 115 km^2, a total catchment area of about 700 km^2 and an average depth of about 6 to 7 meters (Baas Becking *et al.* 1959, Roy *et al.* 2001). The Lake is a wave-dominated barrier estuary (Roy *et al.* 2001) 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). Lake Macquarie contains approximately 1.0 km^2 of mangroves, approximately 13.4 km^2 of seagrass and approximately 0.7 km^2 of saltmarsh vegetation (Roy *et al*. 2001).

The fisheries resources within Lake Macquarie and the Swansea Channel were accessible to recreational fishers from boats and from the shore. Boat-based fishers were able to access the recreational fishery from a great number of access points (Figure 1, Appendix 1). During the survey periods, there were 38 public boat ramps, more than 2100 boat moorings, 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 during the first survey period.

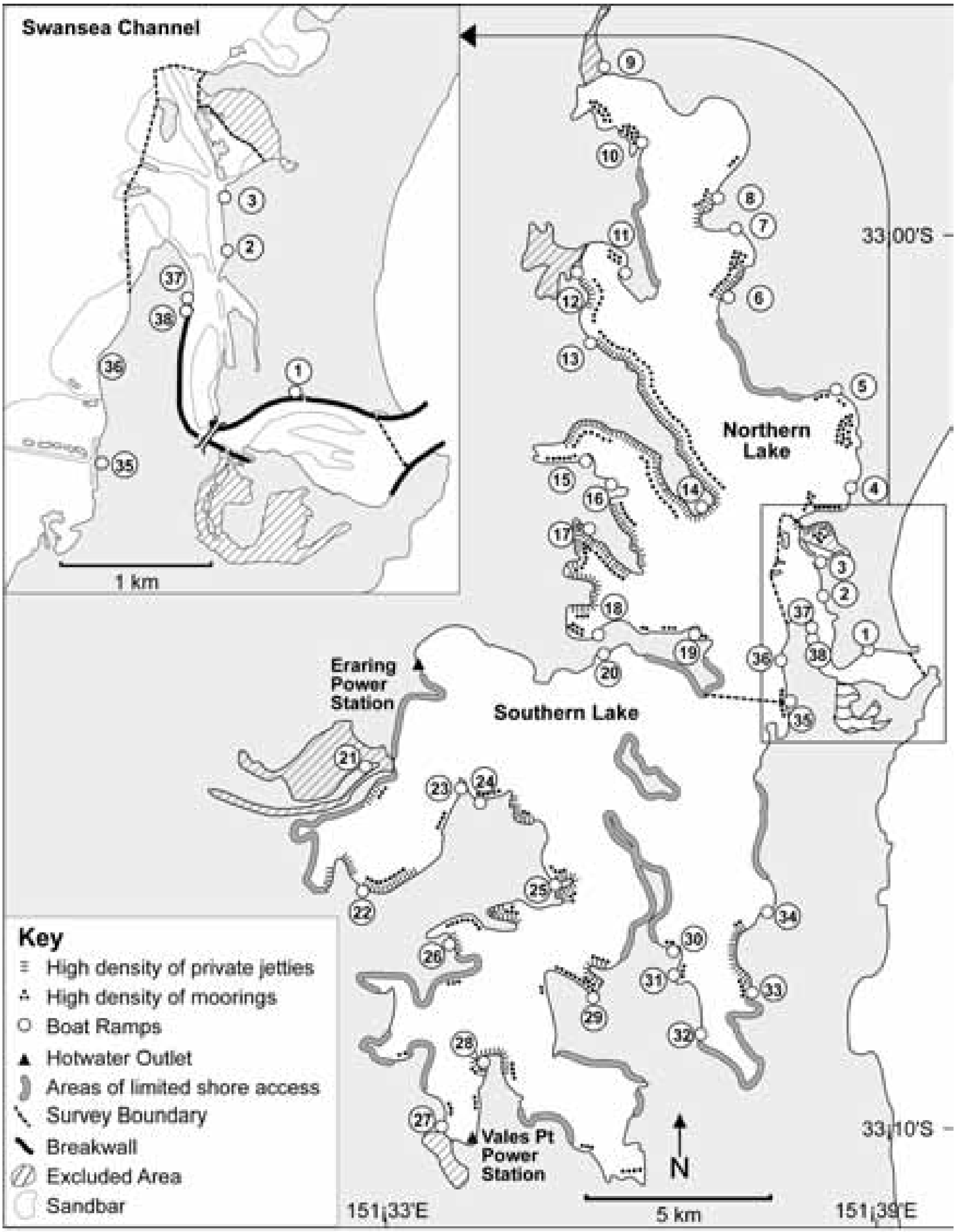

Figure 1. Map of Lake Macquarie showing the spatial extent of the survey and the boundaries used to divide the fishery into the Northern Lake, Southern Lake and Swansea Channel areas. Circled numbers refer to recognised boat ramps, see Appendix 1 for location descriptions.

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

SURVEY YEAR 1					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	0.0%	122	4	3.3%
	Weekend	27	6	4	108	2	1.9%	161	0	0.0%
	Total	**92**	**12**	**8**	**142**	**2**	1.4%	**283**	**4**	1.4%
Spring 1999	Weekday	64	6	6	68	0	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 1999/2000	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%
Survey Year 1 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**	**1277**	**27**	2.1%	**1462**	**19**	1.3%
SURVEY YEAR 2					BOAT FISHERY			SHORE FISHERY		
Summer 2003/2004	Weekday	61	10	9	589	19	3.2%	290	3	1.0%
	Weekend	30	10	9	1164	38	3.3%	331	7	2.1%
	Total	**91**	**20**	**18**	**1753**	**57**	3.3%	**621**	**10**	1.6%
Autumn 2004	Weekday	63	10	9	491	11	2.2%	248	7	2.8%
	Weekend	29	10	9	911	31	3.4%	388	4	1.0%
	Total	**92**	**20**	**18**	**1402**	**42**	3.0%	**636**	**11**	1.7%
Winter 2004	Weekday	65	10	9	199	2	1.0%	263	8	3.0%
	Weekend	27	10	9	570	9	1.6%	291	4	1.4%
	Total	**92**	**20**	**18**	**769**	**11**	1.4%	**554**	**12**	2.2%
Spring 2004	Weekday	64	10	9	257	4	1.6%	228	6	2.6%
	Weekend	27	10	9	751	14	1.9%	253	2	0.8%
	Total	**91**	**20**	**18**	**1008**	**18**	1.8%	**481**	**8**	1.7%
Survey Year 2 Total	Weekday	253	40	36	1536	36	2.3%	1029	24	2.3%
	Weekend	113	40	36	3396	92	2.7%	1263	17	1.3%
	Total	**366**	**80**	**72**	**4932**	**128**	2.6%	**2292**	**41**	1.8%

Recreational anglers were excluded from the immediate vicinity of the hot water outlet at the Eraring power station during the second survey period. This area had previously received high levels of shore-based angling effort, particularly during Winter and Spring. Most of the Swansea Channel was accessible to shore-based anglers. The channel has long areas of breakwall and some public jetties that were all frequently used as fishing platforms by anglers.

3.3. Survey design

The same complemented, on-site, survey design (see Pollock *et al.* 1994 for a review of angler survey methods) was used to assess the recreational fisheries prior to and after the implementation of the Recreational Fishing Haven in Lake Macquarie. The shore-based fishery was assessed by using a roving(effort)-roving(harvest) design combination whereas the boat-based fishery was assessed by using a roving(effort)-access(harvest) design combination. Stratified random sampling methods were used with days being the primary sampling unit for all strata. By definition, a survey day started at sunrise and ended at sunset.

3.3.1. Spatial and temporal sampling frames and stratification

The spatial sampling frame (geographical boundary) of the two recreational fishing surveys is shown in Figure 1. 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; to improve the precision of the estimates of effort and harvest for the total fishery. These spatial strata were selected to reflect major differences in fish habitats, commercial fishing practices (prior to the creation of the RFH) and perceived differences in recreational fishing quality among the three areas.

The temporal sampling frame of each survey spanned a one year period. Each survey year was stratified into seasons and day-types within season (Weekdays and Weekend days). Public holidays were classified as weekend days. The sequence of seasonal sampling differed between survey years. Survey work done during the first survey year covered Autumn, Winter, Spring, and then Summer, whereas, the sequence of surveying during the second survey year was Summer, Autumn, Winter and then Spring. This difference in the sequence of seasonal sampling is important when considering seasonal comparisons between survey periods because the Summer season comparisons are based on a four year difference whilst the Autumn, Spring and Winter seasonal comparisons are based on a five year difference between sampling periods.

3.4. Data collection 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: (a) progressive counts of recreational fishing effort; and (b) interviews with recreational fishing parties. These two datasets were then used to obtain estimates of boat-based and shore-based recreational harvest.

3.4.1. 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 estuary 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 or their immediate intent to engage in any recreational fishing activity. All boats engaged in drift fishing were included in the counts when they were observed traveling to start another “drift” upstream. Drift fishing was common throughout Swansea Channel and the Southern and Northern Lake areas.

The time needed to complete a circuit of the entire Lake Macquarie fishery by boat was determined during a pilot study. These data were used to schedule the 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. 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 interview data. The number of replicate progressive counts done during each survey year for each area of the Lake, and for each day-type stratum within each season is summarised in Table 1. The level of replication achieved during survey years 1 and 2 respectively represents annual sampling fractions of about 20% and 35% for the weekend day-type stratum and about 9% and 16% for the weekday stratum (Table 1).

3.4.2. Interviews with recreational 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 systematically subsample every second or third fishing party (depending on the number of fishing parties available for interview). The number of days spent interviewing recreational fishing parties and the number of interviews obtained are summarised for each day-type within each season for both survey years (Table 1). Refusals to provide information, or to show the fish retained, were also recorded (Table 1). We asked co-operative recreational fishers about their targeting preferences during their current fishing trip, the time they started fishing and their fishing locations. We also recorded the number of fishers in the fishing party (non-fishers were not included as part of a fishing party). 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. Machine-readable interview forms were used to record the information from interviews.

Most interviews with recreational fishing parties were done in areas that had public access. Therefore, we assumed that the fishing activities of recreational fishers using the public boat ramps, wharves and easily accessible shoreline were representative of recreational fishing parties that used private access points to enter and leave the fishery. Although we did not formally test this important assumption, we have no reason to expect that fishers using private access points and other upstream boat ramps would have behaved differently to those fishers that used the public boat ramps within the survey area because these populations of fishers (regardless of where they entered the fishery) use the same methods to target the same species in the same fishing grounds within the survey area. Some limited interview data from fishers using private access points was collected during the surveys. A graphical comparison of these private access point data and the public access point data did not show any major differences between them.

3.5. Estimation methods

The following sections provide brief explanations of the estimation methods used to calculate: (a) fishing effort; (b) harvest rates for the boat-based and shore-based fisheries; and (c) harvest. Equations for estimating total recreational fishing effort, recreational harvest rates, and total recreational harvest for the boat-based and shore-based fisheries are provided by Steffe and Chapman (2003). 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.* (1994 & 1997).

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

Estimation of recreational 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 Macquarie fishery (see Figure 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. These daily effort replicates for each area were expanded to estimate day-type stratum totals within each season. Seasonal estimates of effort were obtained by adding the estimates from the day-type strata together. Total fishery effort estimates (boat-based plus shore-based) were calculated after the conversion of the boat-based data into units of fisher hours. Whenever strata were combined their variances were additive.

3.5.2. Harvest rate estimators for the boat-based and shore-based fisheries

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*. 1994 & 1997). When the objective is to estimate total harvest, and the interview data are derived from 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 mean daily 'ratio of means' estimator calculated for each base stratum was used for estimating the harvest of the boat-based fishery.

The diffuse access across large stretches of shoreline and breakwater compelled us to use roving survey methods to locate shore-based fishers. The shore-based fishery within the survey area was searched entirely at least once (usually many times) during each survey day by interviewers, thus providing coverage of the entire shore-based fishery on each survey day. 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 roving survey methods 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 and discard 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). 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 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 removal from harvest calculations of 104 (7.2%) usable shore-based interviews from the first survey period and 171 (7.5%) usable shore-based interviews from the second survey period. We had routinely asked shore-based fishing parties about the intended finishing time for their current trip. We retained and used 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. The mean daily ‘mean of ratios’ estimator calculated for each base stratum was used for estimating the harvest of the shore-based fishery.

Seasonal harvest rates were calculated by combining estimates derived from day-type strata within each 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 month than there are weekend days in a month.

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

The complemented survey designs used to assess the recreational fisheries used different on-site, contact methods to estimate effort and catch. Harvest estimation in the boat-based fishery used interviews derived from completed trips, whereas the shore-based fishery used interviews derived from incomplete trips. Thus, boat-based harvest was calculated as the product of boat-based effort and the mean daily ‘ratio of means’ harvest rate. Shore-based harvest was calculated as the product of shore-based effort and the truncated mean daily ‘mean of ratios’ harvest rate. Harvest estimation for both the boat-based and shore-based fisheries was done for each day-type stratum in a season. Seasonal estimates of harvest for the boat and shore fisheries were obtained by adding the estimates from the day-type strata together. Total fishery harvest estimates for each season were calculated by adding the boat-based and shore-based harvests together. Whenever strata were combined their variances were additive.

We did not attempt to make expanded estimates of harvest for any taxon that was considered to have been “rare” throughout the survey period - defined as any taxon that had been recorded from two or less interviews during a survey year, regardless of the number of individuals harvested in those trips. This definition of rarity was applied separately during each survey year 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.

We converted the length measurements of fish, cephalopods and crabs taken during interviews into weights using length to weight keys (see Steffe and Chapman 2003). 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 from the pooled interview data for each season within a survey year. 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 some cases, the use of a mean would have resulted in higher estimates of harvest. We calculated medians separately for the boat-based and shore-based fisheries. When no measurements had been made for a taxon in a particular fishery (e.g. the boat fishery), we used the available measurements from the other fishery (e.g. the shore fishery). In some cases, measurements were not available for some taxa and so we could not estimate weights.

3.6. Statistical comparisons between survey periods

Annual estimates of recreational fishing effort and harvest (total fishery, boat-based fishery and shore-based fishery) and seasonal estimates of harvest rates for the boat-based and shore-based fisheries have been made for each survey period. We have presented 95% confidence limits for each of these estimated values. The 95% confidence limits provide information about the plausible range that contains the true value of the parameter that has been estimated. Thus, when comparing any two estimates of interest it is important to determine whether the confidence intervals overlap. When the confidence intervals overlap we cannot be 95% certain that the two estimates being compared are different. Thus, we conclude that in this case there is no statistically significant difference between the two estimates ($p>0.05$). Conversely, when the confidence intervals do not overlap we can be 95% certain that the two estimates are different. Thus, we can conclude that a statistically significant difference exists ($p<0.05$) between the two estimates.

3.7. Indicators of recreational fishing quality

An assessment of a recreational fishery can be improved if reliable indicators of fishing quality are available. We present two indicators of recreational fishing quality for the boat-based and shore-based fisheries in the Lake Macquarie fishery so that comparisons can be made between survey periods. The indicators are: (1) recreational harvest rates for the main species of recreational importance as determined by their relative harvest sizes in each survey year; and (2) size-frequency distributions for these same species. The harvest rates 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 season and for each of the three Lake areas in units of number of fish per fisher hour. 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. Size frequency distributions are presented for the entire fishery (boat and shore fisheries combined) during each of the two survey years.

4. RESULTS

4.1. Recreational fishing effort

We estimated that about 970,500 and 993,300 fisher hours of daytime recreational effort (boat and shore fisheries combined) was expended in the Lake Macquarie fishery during the first and second survey years respectively (Table 2). This represents an overall increase in recreational fishing effort of about 2.3% (no significant difference, $p>0.05$) since the first survey (Table 2).

We estimated that about 681,800 and 769,300 fisher hours of daytime recreational boat-based effort was expended in the Lake Macquarie fishery during the first and second survey years respectively (Table 2). This represents an overall increase in boat-based recreational fishing effort of about 12.8% (significant difference, $p<0.05$) since the first survey (Table 2). The boat-based effort accounted for 70.3% and 77.4% of the annual effort for the total fishery (boat and shore combined) during the first and second survey years respectively (Table 2).

We estimated that about 288,700 and 224,000 fisher hours of daytime recreational shore-based effort was expended in the Lake Macquarie fishery during the first and second survey years respectively (Table 2). This represents an overall decrease in shore-based recreational fishing effort of about 22.4% (significant difference, $p<0.05$) since the first survey (Table 2). The shore-based effort accounted for 29.7% and 22.6% of the annual effort for the total fishery (boat and shore combined) during the first and second survey years respectively (Table 2).

4.2. Recreational harvest

4.2.1. Whole fishery

We recorded 60 taxa in the retained catch of recreational fishers (boat and shore combined) during the first survey year and 62 taxa during the second survey year (Table 3, Appendix 2). We estimated that about 543,700 fish, crabs and cephalopods (472,174 to 615,148 individuals - approximate 95% Confidence Limits) were harvested by daytime recreational fishers from the Lake Macquarie fishery during the first survey year and about 497,500 fish, crabs and cephalopods (461,356 to 533,548 individuals - approximate 95% Confidence Limits) were harvested during the second survey year (Table 3). The crab and cephalopod component of the harvest was quite large, accounting for 36.1% of the harvest (about 196,200 individuals – 147,294 to 245,192 approximate 95% Confidence Limits) during the first survey year and 19.8% of the harvest (about 98,600 individuals – 84,796 to 112,426 approximate 95% Confidence Limits) during the second survey year (Table 3). The finfish component of the harvest accounted for 63.9% of the harvest (about 347,400 individuals – 295,317 to 399,519 approximate 95% Confidence Limits) during the first survey year and 80.2% of the harvest (about 398,800 individuals – 365,493 to 432,189 approximate 95% Confidence Limits) during the second survey year (Table 3). In both survey years the recreational harvest was dominated by relatively few taxa (Table 3). The ten most commonly harvested taxa, by number, accounted for 88.0% and 93.2% of the daytime recreational harvest during the first and second survey years respectively (Table 3). However, the composition and relative contribution of these dominant taxa changed markedly between survey years (Table 3). For example, the total harvest (by number) of trumpeter whiting, dusky flathead, tailor and sand whiting, increased significantly since the first survey period (Table 3). In contrast, the total harvest (by number) of common squid, yellow-finned leatherjacket, and sand mullet decreased significantly since the first survey period (Table 3). Changes in total harvest (increases or decreases) were also observed for luderick, blue swimmer crab, yellowfin bream, large-toothed flounder and flat-tail mullet but these observed changes were not statistically different ($p>0.05$) between the survey periods (Table 3).

We estimated that about 178 tonnes of fish, crabs and cephalopods (152 to 205 tonnes - approximate 95% Confidence Limits) were harvested by daytime recreational fishers from the Lake Macquarie fishery during the first survey year and about 224 tonnes of fish, crabs and cephalopods (203 to 244 tonnes - approximate 95% Confidence Limits) were harvested during the second survey year (Table 4). The crab and cephalopod component of the harvest was quite large, accounting for 37.4% of the harvest (about 67 tonnes – 44 to 89 tonnes approximate 95% Confidence Limits) during the first survey year and 20.0% of the harvest (about 45 tonnes – 37 to 53 tonnes approximate 95% Confidence Limits) during the second survey year (Table 4). The finfish component of the harvest accounted for 62.6% of the harvest (about 112 tonnes – 97 to 126 tonnes approximate 95% Confidence Limits) during the first survey year and 80.0% of the harvest (about 179 tonnes – 160 to 197 tonnes approximate 95% Confidence Limits) during the second survey year (Table 4). In both survey years the recreational harvest was dominated by relatively few taxa (Table 4). The ten most commonly harvested taxa, by weight, accounted for 90.1% and 93.5% of the daytime recreational harvest during the first and second survey years respectively (Table 4). However, the composition and relative contribution of these dominant taxa changed markedly between survey years (Table 4). For example, the total harvest (by weight) of dusky flathead, tailor, trumpeter whiting and sand whiting, increased significantly since the first survey period (Table 4). In contrast, the total harvest (by weight) of common squid, yellow-finned leatherjacket, and sand mullet was significantly less in the second survey period (Table 4). Changes in total harvest (increases or decreases) were also observed for luderick, blue swimmer crab, yellowfin bream, snapper and Australian salmon but these observed changes were not statistically different ($p>0.05$) between the survey periods (Table 4).

4.2.2. Boat fishery

We recorded 46 taxa in the retained catch of boat-based recreational fishers during the first survey year and 55 taxa during the second survey year (Table 5, Appendix 3). We estimated that about 369,100 fish, crabs and cephalopods (304,983 to 433,279 individuals - approximate 95% Confidence Limits) were harvested by daytime recreational fishers from the Lake Macquarie fishery during the first survey year and about 378,200 fish, crabs and cephalopods (348,390 to 407,972 individuals - approximate 95% Confidence Limits) were harvested during the second survey year (Table 5). The crab and cephalopod component of the harvest was quite large, accounting for 49.8% of the harvest (about 183,900 individuals – 135,321 to 232,399 approximate 95% Confidence Limits) during the first survey year and 23.7% of the harvest (about 89,500 individuals – 76,735 to 102,337 approximate 95% Confidence Limits) during the second survey year (Table 5). The finfish component of the harvest accounted for 50.2% of the harvest (about 185,300 individuals – 143,332 to 227,210 approximate 95% Confidence Limits) during the first survey year and 76.3% of the harvest (about 288,600 individuals – 261,744 to 315,546 approximate 95% Confidence Limits) during the second survey year (Table 5). In both survey years the boat-based recreational harvest was dominated by relatively few taxa (Table 5). The ten most commonly harvested taxa, by number, accounted for 90.0% and 95.1% of the daytime recreational harvest during the first and second survey years respectively (Table 4). However, the composition and relative contribution of these dominant taxa changed markedly between survey years (Table 5). For example, the total boat-based harvest (by number) of trumpeter whiting, yellowfin bream, dusky flathead and tailor have increased significantly since the first survey period (Table 5). In contrast, the total boat-based harvest (by number) of common squid and yellow-finned leatherjacket has decreased significantly since the first survey period (Table 5). Changes in total harvest (increases or decreases) were also observed for blue swimmer crab, sand whiting, luderick, large-toothed flounder, snapper and river garfish but these observed changes were not statistically different ($p>0.05$) between the survey periods (Table 5).

We estimated that about 116 tonnes of fish, crabs and cephalopods (92 to 141 tonnes - approximate 95% Confidence Limits) were harvested by daytime boat-based recreational fishers from the Lake Macquarie fishery during the first survey year and about 161 tonnes of fish, crabs and cephalopods (148 to 175 tonnes - approximate 95% Confidence Limits) were harvested during the second survey year (Table 6). The crab and cephalopod component of the harvest was quite large, accounting for 54.1% of the harvest (about 63 tonnes – 41 to 85 tonnes approximate 95% Confidence Limits) during the first survey year and 26.2% of the harvest (about 42 tonnes – 35 to 50 tonnes approximate 95% Confidence Limits) during the second survey year (Table 6). The finfish component of the harvest accounted for 45.9% of the harvest (about 53 tonnes – 43 to 64 tonnes approximate 95% Confidence Limits) during the first survey year and 73.8% of the harvest (about 119 tonnes – 108 to 130 tonnes approximate 95% Confidence Limits) during the second survey year (Table 6). In both survey years the recreational boat-based harvest was dominated by relatively few taxa (Table 6). The ten most commonly harvested taxa, by weight, accounted for 92.7% and 93.8% of the daytime recreational harvest during the first and second survey years respectively (Table 6). However, the composition and relative contribution of these dominant taxa changed markedly between survey years (Table 6). For example, the total boat-based harvest (by weight) of dusky flathead, tailor, yellowfin bream, trumpeter whiting and sand whiting, have increased significantly since the first survey period (Table 6). In contrast, the total boat-based harvest (by weight) of common squid decreased significantly since the first survey period (Table 6). Changes in total harvest (increases or decreases) were also observed for blue swimmer crab, luderick, snapper, Australian salmon, yellow-finned leatherjacket and sand mullet but these observed changes were not statistically different ($p>0.05$) between the survey periods (Table 6).

4.2.3. Shore fishery

We recorded 38 taxa in the retained catch of shore-based recreational fishers during the first survey year and 44 taxa during the second survey year (Table 7, Appendix 4). We estimated that about 174,500 fish, crabs and cephalopods (142,978 to 206,082 individuals - approximate 95% Confidence Limits) were harvested by daytime recreational fishers from the Lake Macquarie fishery during the first survey year and about 119,300 fish, crabs and cephalopods (98,889 to 139,653 individuals - approximate 95% Confidence Limits) were harvested during the second survey year (Table 7). The crab and cephalopod component of the shore-based harvest was quite small, accounting for 7.1% of the harvest (about 12,400 individuals – 6,061 to 18,705 approximate 95% Confidence Limits) during the first survey year and 7.6% of the harvest (about 9,100 individuals – 3,879 to 14,271 approximate 95% Confidence Limits) during the second survey year (Table 7). The finfish component of the shore-based harvest accounted for 92.9% of the harvest (about 162,100 individuals – 131,235 to 193,059 approximate 95% Confidence Limits) during the first survey year and 92.4% of the harvest (about 110,200 individuals – 90,488 to 129,904 approximate 95% Confidence Limits) during the second survey year (Table 7). In both survey years the shore-based recreational harvest was dominated by relatively few taxa (Table 7). The ten most commonly harvested taxa, by number, accounted for 91.2% and 92.6% of the daytime recreational harvest during the first and second survey years respectively (Table 7). However, the composition and relative contribution of these dominant taxa changed markedly between survey years (Table 7). For example, the total shore-based harvest (by number) of trumpeter whiting and dusky flathead have increased significantly since the first survey period (Table 7). In contrast, the total shore-based harvest (by number) of sand mullet, six-spined leatherjacket and fan-bellied leatherjacket has decreased significantly since the first survey period (Table 7). Changes in total harvest (increases or decreases) were also observed for luderick, yellowfin bream, common squid, tailor, flat-tail mullet, yellow-finned leatherjacket, sand whiting, and tarwhine but these observed changes were not statistically different ($p>0.05$) between the survey periods (Table 7).

We estimated that about 62 tonnes of fish, crabs and cephalopods (51 to 73 tonnes - approximate 95% Confidence Limits) were harvested by daytime shore-based recreational fishers from the Lake Macquarie fishery during the first survey year and about 62 tonnes of fish, crabs and cephalopods (47 to 77 tonnes - approximate 95% Confidence Limits) were harvested during the second survey year (Table 8). The crab and cephalopod component of the harvest was relatively small, accounting for 6.2% of the shore-based harvest (about 4 tonnes – 1 to 7 tonnes approximate 95% Confidence Limits) during the first survey year and 4.1% of the shore-based harvest (about 3 tonnes – 1 to 4 tonnes approximate 95% Confidence Limits) during the second survey year (Table 8). The finfish component of the harvest accounted for 93.8% of the shore-based harvest (about 58 tonnes – 48 to 69 tonnes approximate 95% Confidence Limits) during the first survey year and 95.9% of the harvest (about 60 tonnes – 45 to 75 tonnes approximate 95% Confidence Limits) during the second survey year (Table 8). In both survey years the recreational shore-based harvest was dominated by relatively few taxa (Table 8). The ten most commonly harvested taxa, by weight, accounted for 95.3% and 95.6% of the daytime recreational shore-based harvest during the first and second survey years respectively (Table 8). However, the composition and relative contribution of these dominant taxa changed markedly between survey years (Table 8). For example, the total shore-based harvest (by weight) of trumpeter whiting was significantly greater in the second survey period (Table 8). In contrast, the total shore-based harvest (by weight) of yellow-finned leatherjacket and sand mullet decreased significantly since the first survey period (Table 8). Changes in total harvest (increases or decreases) were also observed for luderick, yellowfin bream, dusky flathead, tailor, flat-tail mullet, common squid, blue swimmer crab, tarwhine, sand whiting, southern calamari and fan-bellied leatherjacket but these observed changes were not statistically different ($p>0.05$) between the survey periods (Table 8).

Table 2. Estimates of daytime recreational fishing effort (fisher hours) with 95% confidence intervals for the boat-based, shore-based and total fisheries for in Lake Macquarie for each survey year. The proportional changes between survey years and their statistical significance are presented.

	SURVEY YEAR 1 (March 1999 to February 2000)			SURVEY YEAR 2 (December 2003 to November 2004)			COMPARISON BETWEEN SURVEY YEARS	
Fishery	Effort (fisher hours)	95% Confidence Intervals	% total	Effort (fisher hours)	95% Confidence Intervals	% total	% Change (fisher hours)	Statistical Significance
Boat	681,822	621,875 to 741,769	70.3%	769,251	730,293 to 808,209	77.4%	12.8%	ns
Shore	288,662	260,326 to 316,988	29.7%	224,029	205,156 to 242,902	22.6%	-22.4%	*
Total Fishery	**970,484**	**904,181 to 1,036,787**	**100%**	**993,280**	**949,991 to 1,036,569**	**100%**	**2.3%**	**ns**

* Significantly different, $p<0.05$.
ns No significant difference, $p>0.05$

Table 3. Annual harvest estimates (number of individuals) with 95% confidence intervals for taxa taken by recreational fishers (boat-based and shore-based fishers combined) in the Lake Macquarie fishery for each survey year. The proportional changes between survey years and their statistical significance are presented.

COMMON NAME	TOTAL HARVEST FOR WHOLE FISHERY						COMPARISON BETWEEN SURVEY YEARS	
	SURVEY YEAR 1 (March 1999 to February 2000)			SURVEY YEAR 2 (December 2003 to November 2004)				
	Total Fish (number)	95% Confidence Intervals	% Total	Total Fish (number)	95% Confidence Intervals	% Total	% Change (number)	Statistical Significance
Trumpeter Whiting	63,413	27,709 to 99,117	11.7%	139,382	115,353 to 163,411	28.0%	119.8%	*
Luderick	62,278	46,983 to 77,573	11.5%	62,492	44,336 to 80,648	12.6%	0.3%	ns
Blue Swimmer Crab	111,472	71,885 to 151,059	20.5%	61,451	50,455 to 72,447	12.4%	-44.9%	ns
Yellowfin Bream	48,874	32,497 to 65,251	9.0%	56,792	49,903 to 63,681	11.4%	16.2%	ns
Dusky Flathead	18,886	13,191 to 24,581	3.5%	41,424	36,035 to 46,813	8.3%	119.3%	*
Tailor	12,890	6,794 to 18,986	2.4%	39,415	31,093 to 47,737	7.9%	205.8%	*
Common Squid	79,869	51,434 to 108,304	14.7%	34,724	26,447 to 43,001	7.0%	-56.5%	*
Sand Whiting	5,341	1,241 to 9,441	1.0%	13,806	9,883 to 17,729	2.8%	158.5%	*
Large-Toothed Flounder	4,948	2,436 to 7,460	0.9%	7,400	5,971 to 8,829	1.5%	49.6%	ns
Flat-Tail Mullet	12,554	2,315 to 22,793	2.3%	6,392	2,456 to 10,328	1.3%	-49.1%	ns
Snapper	6,499	4,264 to 8,734	1.2%	5,174	3,987 to 6,361	1.0%	-20.4%	ns
Yellow-Finned Leatherjacket	32,475	15,500 to 49,450	6.0%	4,708	1,584 to 7,832	0.9%	-85.5%	*
Small-Toothed Flounder	3,693	2,237 to 5,149	0.7%	3,148	2,249 to 4,047	0.6%	-14.8%	ns
River Garfish	6,393	0 to 14,238	1.2%	3,001	1,440 to 4,562	0.6%	-53.1%	ns
Sand Mullet	35,063	17,921 to 52,205	6.4%	2,270	750 to 3,790	0.5%	-93.5%	*
Tarwhine	5,793	1,169 to 10,417	1.1%	2,085	1,240 to 2,930	0.4%	-64.0%	ns
Yellowtail	#1	-	<0.1%	1,677	177 to 3,177	0.3%	-	-
Fan-Bellied Leatherjacket	7,877	3,607 to 12,147	1.4%	1,556	251 to 2,861	0.3%	-80.2%	*
Six-Spined Leatherjacket	9826	4,645 to 15,007	1.8%	1,495	344 to 2,646	0.3%	-84.8%	*
Southern Calamari	2470	0 to 5,772	0.5%	1,264	299 to 2,229	0.3%	-48.8%	ns
Silver Trevally	319	26 to 612	<0.1%	1,118	431 to 1,805	0.2%	250.5%	ns
Sea Garfish	2,072	0 to 5,224	0.4%	840	0 to 1,915	0.2%	-59.5%	ns

Table 3, continued.

COMMON NAME	TOTAL HARVEST FOR WHOLE FISHERY: SURVEY YEAR 1 (March 1999 to February 2000) Total Fish (number)	95% Confidence Intervals	% Total	SURVEY YEAR 2 (December 2003 to November 2004) Total Fish (number)	95% Confidence Intervals	% Total	COMPARISON BETWEEN SURVEY YEARS % Change (number)	Statistical Significance
Octopus †	-	-	-	755	85 to 1,425	0.2%	-	-
Sea Mullet	#2	-	<0.1%	755	86 to 1,424	0.2%	-	-
Southern Herring	3,990	1,351 to 6,629	0.7%	701	0 to 1,409	0.1%	-82.4%	ns
Australian Salmon	#1	-	<0.1%	604	34 to 1,174	0.1%	-	-
Chinaman Leatherjacket	-	-	-	497	69 to 925	<0.1%	-	-
Stout Longtom †	480	62 to 898	<0.1%	455	117 to 793	<0.1%	-5.2%	ns
Mud Crab	2,430	0 to 5,492	0.4%	402	158 to 646	<0.1%	-83.5%	ns
Slimy Mackerel	-	-	-	282	0 to 696	<0.1%	-	-
Rough Leatherjacket	300	0 to 666	<0.1%	271	59 to 483	<0.1%	-9.7%	ns
Silver Batfish †	#1	-	<0.1%	223	0 to 514	<0.1%	-	-
Striped Seapike	#1	-	<0.1%	218	0 to 444	<0.1%	-	-
Kingfish	#3	-	<0.1%	164	40 to 288	<0.1%	-	-
Mulloway	#6	-	<0.1%	149	0 to 321	<0.1%	-	-
School Whiting	583	0 to 1,234	0.1%	141	0 to 304	<0.1%	-75.8%	ns
Marbled Flathead	#1	-	<0.1%	130	0 to 286	<0.1%	-	-
Eastern Blue-Spotted Flathead	688	11 to 1,365	0.1%	#2	-	<0.1%	-	-
Black Trevally (Spinefoot) †	2,107	0 to 4,279	0.4%	#1	-	<0.1%	-	-
Other Taxa^	#62	-	<0.1%	#88	-	<0.1%	-	-
Grand Total	**543,661**	**472,174 to 615,148**	**100.0%**	**497,452**	**461,356 to 533,548**	**100.0%**	**-8.5%**	**n.s.**

Key:
\# 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.
\- Not recorded or not calculated for rare event occurrences.
† Associated estimates of expanded weight (kg) are not provided for this taxon in Tables 6, 7and 8 because a suitable length to weight conversion key was not available
^ Other taxa details are provided in Appendix 2.
* Significantly different, p<0.05.
ns No significant difference, p>0.05

Table 4. Annual harvest estimates (kilograms) with 95% confidence intervals for taxa taken by recreational fishers (boat-based and shore-based combined) in the Lake Macquarie fishery for each survey year. The proportional changes between survey years and their associated statistical significance are presented.

COMMON NAME	TOTAL HARVEST FOR WHOLE FISHERY						COMPARISON BETWEEN SURVEY YEARS	
	SURVEY YEAR 1 (March 1999 to February 2000)			SURVEY YEAR 2 (December 2003 to November 2004)				
	Total Fish (kg)	95% Confidence Intervals	% Total	Total Fish (kg)	95% Confidence Intervals	% Total	% Change (number)	Statistical Significance
Luderick	32,740	23,784 to 41,696	18.3%	42,768	28,083 to 57,453	19.1%	30.6%	ns
Dusky Flathead	12,088	8,760 to 15,416	6.8%	40,189	33,681 to 46,697	18.0%	232.5%	*
Blue Swimmer Crab	51,429	29,546 to 73,312	28.8%	37,707	30,053 to 45,361	16.9%	-26.7%	ns
Yellowfin Bream	22,313	15,273 to 29,353	12.5%	32,994	28,761 to 37,227	14.8%	47.9%	ns
Tailor	4,082	2,116 to 6,048	2.3%	26,089	19,425 to 32,753	11.7%	539.2%	*
Trumpeter Whiting	5,985	2,887 to 9,083	3.4%	14,254	11,752 to 16,756	6.4%	138.2%	*
Common Squid	11,654	7,386 to 15,922	6.5%	5,653	4,254 to 7,052	2.5%	-51.5%	*
Sand Whiting	1,344	448 to 2,240	0.8%	3,624	2,641 to 4,607	1.6%	169.7%	*
Snapper	4,341	1,265 to 7,417	2.4%	2,880	2,199 to 3,561	1.3%	-33.6%	ns
Australian Salmon	#3	-	<0.1%	2,641	0 to 5,937	1.2%	-	-
Flat-Tail Mullet	3,829	1,155 to 6,503	2.1%	2,609	1,044 to 4,174	1.2%	-31.9%	ns
Large-Toothed Flounder	915	444 to 1,386	0.5%	1,793	1,444 to 2,142	0.8%	96.0%	*
Silver Trevally	184	0 to 384	0.1%	1,158	133 to 2,183	0.5%	528.6%	ns
Mulloway	#25	-	<0.1%	1,129	0 to 2,417	0.5%	-	-
Yellow-Finned Leatherjacket	6,457	3,475 to 9,439	3.6%	1,116	427 to 1,805	0.5%	-82.7%	*
Southern Calamari	2,052	0 to 5,081	1.2%	1,041	335 to 1,747	0.5%	-49.3%	ns
Tarwhine	2,006	299 to 3,713	1.1%	962	525 to 1,399	0.4%	-52.0%	ns
Small-Toothed Flounder	806	462 to 1,150	0.5%	835	581 to 1,089	0.4%	3.6%	ns
Sand Mullet	9,777	4,629 to 14,925	5.5%	629	145 to 1,113	0.3%	-93.6%	*
Sea Mullet	#1	-	<0.1%	587	0 to 1,304	0.3%	-	-
Fan-Bellied Leatherjacket	2,351	686 to 4,016	1.3%	566	248 to 884	0.3%	-75.9%	ns
Yellowtail	-	-	-	468	0 to 953	0.2%	-	-

Table 4, continued.

COMMON NAME	TOTAL HARVEST FOR WHOLE FISHERY: SURVEY YEAR 1 (March 1999 to February 2000)			SURVEY YEAR 2 (December 2003 to November 2004)			COMPARISON BETWEEN SURVEY YEARS	
	Total Fish (kg)	95% Confidence Intervals	% Total	Total Fish (kg)	95% Confidence Intervals	% Total	% Change (number)	Statistical Significance
Mud Crab	1,583	0 to 3,401	0.9%	358	148 to 568	0.2%	-77.4%	ns
Kingfish	#7	-	<0.1%	340	88 to 592	0.2%	-	-
Six-Spined Leatherjacket	1,493	526 to 2,460	0.8%	324	109 to 539	0.1%	-78.3%	ns
River Garfish	293	0 to 634	0.2%	180	72 to 288	<0.1%	-38.5%	ns
Rough Leatherjacket	104	0 to 245	<0.1%	166	35 to 297	<0.1%	59.3%	ns
Chinaman Leatherjacket	-	-	-	119	20 to 218	<0.1%	-	-
Marbled Flathead	#1	-	<0.1%	117	0 to 250	<0.1%	-	-
Sea Garfish	107	0 to 276	<0.1%	92	0 to 240	<0.1%	-13.6%	ns
Striped Seapike	-	-	-	78	0 to 167	<0.1%	-	-
Cobia	#4	-	<0.1%	60	60 to 60	<0.1%	-	-
Slimy Mackerel	-	-	-	31	0 to 72	<0.1%	-	-
School Whiting	83	0 to 176	<0.1%	20	0 to 43	<0.1%	-75.9%	ns
Southern Herring	123	40 to 206	<0.1%	8	0 to 16	<0.1%	-93.4%	*
Eastern Blue-Spotted Flathead	236	0 to 485	0.1%	-	-	-	-	-
Other Taxa^	#12	-	<0.1%	#9	-	<0.1%	-	-
Grand Total	**178,426**	**151,520 to 205,332**	**100.0%**	**223,594**	**203,413 to 243,775**	**100.0%**	**25.3%**	**ns**

Key:

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.

- Not recorded or not calculated for rare event occurrences.

^ Other taxa details are provided in Appendix 2.

* Significantly different, $p<0.05$.

ns No significant difference, $p>0.05$

Table 5. Annual harvest estimates (number of individuals) with 95% confidence intervals for taxa taken by boat-based recreational fishers in the Lake Macquarie fishery for each survey year. The proportional changes between survey years and their associated statistical significance are presented.

COMMON NAME	BOAT-BASED HARVEST FOR WHOLE FISHERY						COMPARISON BETWEEN SURVEY YEARS	
	SURVEY YEAR 1 (March 1999 to February 2000)			SURVEY YEAR 2 (December 2003 to November 2004)				
	Total Fish (number)	95% Confidence Intervals	% Total	Total Fish (number)	95% Confidence Intervals	% Total	% Change (number)	Statistical Significance
Trumpeter Whiting	61,113	25,521 to 96,705	16.6%	129,580	105,802 to 153,358	34.3%	112.0%	*
Blue Swimmer Crab	110,069	70,514 to 149,624	29.8%	60,770	49,792 to 71,748	16.1%	-44.8%	ns
Yellowfin Bream	24,560	16,296 to 32,824	6.7%	39,946	34,500 to 45,392	10.6%	62.6%	*
Dusky Flathead	16,934	11,363 to 22,505	4.6%	35,390	30,492 to 40,288	9.4%	109.0%	*
Tailor	8,675	4,375 to 12,975	2.4%	34,462	26,736 to 42,188	9.1%	297.3%	*
Common Squid	71,358	43,393 to 99,323	19.3%	27,151	20,616 to 33,686	7.2%	-62.0%	*
Sand Whiting	4,963	884 to 9,042	1.3%	11,676	8,005 to 15,347	3.1%	135.3%	ns
Luderick	8,015	0 to 16,969	2.2%	8,180	4,363 to 11,997	2.2%	2.1%	ns
Large-Toothed Flounder	4,947	2,435 to 7,459	1.3%	6,960	5,579 to 8,341	1.8%	40.7%	ns
Snapper	6,233	4,035 to 8,431	1.7%	5,011	3,839 to 6,183	1.3%	-19.6%	ns
Small-Toothed Flounder	3,692	2,236 to 5,148	1.0%	2,728	2,003 to 3,453	0.7%	-26.1%	ns
Flat-Tail Mullet	3,884	786 to 6,982	1.1%	2,462	966 to 3,958	0.7%	-36.6%	ns
Yellow-Finned Leatherjacket	11,568	5,225 to 17,911	3.1%	1,891	175 to 3,607	0.5%	-83.7%	*
Yellowtail	#1	-	<0.1%	1,674	174 to 3,174	0.4%	-	-
River Garfish	6,393	0 to 14,238	1.7%	1,376	355 to 2,397	0.4%	-78.5%	ns
Fan-Bellied Leatherjacket	3,823	1,456 to 6,190	1.0%	1,361	84 to 2,638	0.4%	-64.4%	ns
Sea Garfish	2,072	0 to 5,224	0.6%	830	0 to 1,905	0.2%	-59.9%	ns
Tarwhine	#6	-	<0.1%	804	316 to 1,292	0.2%	-	-
Silver Trevally	-	-	-	780	186 to 1,374	0.2%	-	-
Octopus †	-	-	-	628	0 to 1,282	0.2%	-	-
Australian Salmon	-	-	-	604	34 to 1,174	0.2%	-	-
Southern Calamari	#2	-	<0.1%	576	182 to 970	0.2%	-	-

Table 5, continued.

COMMON NAME	BOAT-BASED HARVEST FOR WHOLE FISHERY						COMPARISON BETWEEN SURVEY YEARS	
	SURVEY YEAR 1 (March 1999 to February 2000)			SURVEY YEAR 2 (December 2003 to November 2004)				
	Total Fish (number)	95% Confidence Intervals	% Total	Total Fish (number)	95% Confidence Intervals	% Total	% Change (number)	Statistical Significance
Chinaman Leatherjacket	-	-	-	494	66 to 922	0.1%	-	-
Mud Crab	2,430	0 to 5,492	0.7%	399	155 to 643	0.1%	-83.6%	ns
Six-Spined Leatherjacket	3,221	0 to 6,687	0.9%	383	100 to 666	0.1%	-88.1%	ns
Slimy Mackerel	-	-	-	282	0 to 696	<0.1%	-	-
Sea Mullet	-	-	-	272	0 to 742	<0.1%	-	-
Stout Longtom †	226	0 to 509	<0.1%	233	76 to 390	<0.1%	3.1%	ns
Sand Mullet	13,333	2,188 to 24,478	3.6%	228	5 to 451	<0.1%	-98.3%	*
Striped Seapike	#1	-	<0.1%	217	0 to 443	<0.1%	-	-
Rough Leatherjacket	299	0 to 665	<0.1%	195	27 to 363	<0.1%	-	-
Kingfish	#2	-	<0.1%	161	37 to 285	<0.1%	-	-
Mulloway	#5	-	<0.1%	149	0 to 321	<0.1%	-	-
School Whiting	583	0 to 1,234	0.2%	141	0 to 304	<0.1%	-75.8%	ns
Marbled Flathead	-	-	-	130	0 to 286	<0.1%	-	-
Eastern Blue-Spotted Flathead	688	11 to 1,365	0.2%	#2	-	<0.1%	-	-
Other Taxa^	#35	-	<0.1%	#55	-	<0.1%	-	-
Grand Total	**369,131**	**304,983 to 433,279**	**100.0%**	**378,181**	**348,390 to 407,972**	**100.0%**	**2.5%**	**ns**

Key:
\# 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.
\- Not recorded or not calculated for rare event occurrences.
† Associated estimates of expanded weight (kg) are not provided for this taxon in Tables 6 and 7 because a suitable length to weight conversion key was not available
^ Other taxa details are provided in Appendix 3.
* Significantly different, $p<0.05$.
ns No significant difference, $p>0.05$

Table 6. Annual harvest estimates (kilograms) with 95% confidence intervals for taxa taken by boat-based recreational fishers in the Lake Macquarie fishery for each survey year. The proportional changes between survey years and their associated statistical significance are presented.

COMMON NAME	BOAT-BASED HARVEST FOR WHOLE FISHERY: SURVEY YEAR 1 (March 1999 to February 2000)			SURVEY YEAR 2 (December 2003 to November 2004)			COMPARISON BETWEEN SURVEY YEARS	
	Total Fish (kg)	95% Confidence Intervals	% Total	Total Fish (kg)	95% Confidence Intervals	% Total	% Change (number)	Statistical Significance
Blue Swimmer Crab	50,913	29,038 to 72,788	43.8%	36,952	29,367 to 44,537	22.9%	-27.4%	ns
Dusky Flathead	10,581	7,428 to 13,734	9.1%	36,508	30,239 to 42,777	22.6%	245.0%	*
Tailor	3,439	1,546 to 5,332	3.0%	24,384	17,852 to 30,916	15.1%	609.1%	*
Yellowfin Bream	11,406	6,996 to 15,816	9.8%	22,426	19,194 to 25,658	13.9%	96.6%	*
Trumpeter Whiting	5,730	2,650 to 8,810	4.9%	13,318	10,836 to 15,800	8.2%	132.4%	*
Luderick	4,623	0 to 10,512	4.0%	5,064	2,611 to 7,517	3.1%	9.5%	ns
Common Squid	10,354	6,184 to 14,524	8.9%	4,373	3,381 to 5,365	2.7%	-57.8%	*
Sand Whiting	1,252	363 to 2,141	1.1%	3,079	2,165 to 3,993	1.9%	145.9%	*
Snapper	4,311	1,236 to 7,386	3.7%	2,840	2,161 to 3,519	1.8%	-34.1%	ns
Australian Salmon	-	-	-	2,641	0 to 5,937	1.6%	-	-
Large-Toothed Flounder	915	444 to 1,386	0.8%	1,680	1,344 to 2,016	1.0%	83.7%	ns
Mulloway	#21	-	-	1,129	0 to 2,417	0.7%	-	-
Flat-Tail Mullet	1,664	212 to 3,116	1.4%	1,062	412 to 1,712	0.7%	-36.2%	ns
Small-Toothed Flounder	806	462 to 1,150	0.7%	750	513 to 987	0.5%	-7.0%	ns
Silver Trevally	-	-	-	697	0 to 1,601	0.4%	-	-
Yellow-Finned Leatherjacket	2,383	986 to 3,780	2.1%	602	46 to 1,158	0.4%	-74.7%	ns
Southern Calamari	#2	-	-	555	130 to 980	0.3%	-	-
Fan-Bellied Leatherjacket	894	390 to 1,398	0.8%	526	213 to 839	0.3%	-41.1%	ns
Yellowtail	-	-	-	468	0 to 953	0.3%	-	-
Sea Mullet	-	-	-	395	0 to 1,087	0.2%	-	-
Mud Crab	1,583	0 to 3,401	1.4%	355	145 to 565	0.2%	-77.6%	ns
Kingfish	#2	-	-	330	78 to 582	0.2%	-	-

Table 6, continued.

COMMON NAME	BOAT-BASED HARVEST FOR WHOLE FISHERY						COMPARISON BETWEEN SURVEY YEARS	
	SURVEY YEAR 1 (March 1999 to February 2000)			SURVEY YEAR 2 (December 2003 to November 2004)				
	Total Fish (kg)	95% Confidence Intervals	% Total	Total Fish (kg)	95% Confidence Intervals	% Total	% Change (number)	Statistical Significance
Tarwhine	#1	-	-	294	119 to 469	0.2%	-	-
Sand Mullet	3,963	0 to 7,958	3.4%	163	0 to 335	0.1%	-95.9%	ns
Six-Spined Leatherjacket	523	0 to 1,090	0.4%	151	42 to 260	<0.1%	-71.0%	ns
Rough Leatherjacket	104	0 to 245	<0.1%	131	14 to 248	<0.1%	25.9%	ns
Chinaman Leatherjacket	-	-	-	119	20 to 218	<0.1%	-	-
Marbled Flathead	-	-	-	117	0 to 250	<0.1%	-	-
Sea Garfish	107	0 to 276	<0.1%	91	0 to 239	<0.1%	-14.6%	ns
Striped Seapike	-	-	-	77	0 to 166	<0.1%	-	-
River Garfish	293	0 to 634	0.3%	73	19 to 127	<0.1%	-75.2%	ns
Slimy Mackerel	-	-	-	31	0 to 72	<0.1%	-	-
School Whiting	83	0 to 176	<0.1%	20	0 to 43	<0.1%	-75.9%	ns
Eastern Blue-Spotted Flathead	236	0 to 485	0.2%	-	-	-	-	-
Other Taxa^	#12	-	<0.1%	#66	-	<0.1%	-	-
Grand Total	**116,198**	**91,545 to 140,851**	**100.0%**	**161,467**	**148,055 to 174,87**	**100.0%**	**39.0%**	*

Key:
\# 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.
\- Not recorded or not calculated for rare event occurrences.
^ Other taxa details are provided in Appendix 3.
* Significantly different, p<0.05.
ns No significant difference, p>0.05

Table 7. Annual harvest estimates (number of individuals) and 95% confidence intervals for taxa taken by shore-based recreational fishers in the Lake Macquarie fishery for each survey year. The proportional changes between survey years and their associated statistical significance are presented.

COMMON NAME	SHORE-BASED HARVEST FOR WHOLE FISHERY						COMPARISON BETWEEN SURVEY YEARS	
	SURVEY YEAR 1 (March 1999 to February 2000)			SURVEY YEAR 2 (December 2003 to November 2004)				
	Total Fish (number)	95% Confidence Intervals	% Total	Total Fish (number)	95% Confidence Intervals	% Total	% Change (number)	Statistical Significance
Luderick	54,263	41,863 to 66,663	31.1%	54,312	36,562 to 72,062	45.5%	0.1%	ns
Yellowfin Bream	24,314	10,175 to 38,453	13.9%	16,846	12,628 to 21,064	14.1%	-30.7%	ns
Trumpeter Whiting	2,300	0 to 5,123	1.3%	9,802	6,334 to 13,270	8.2%	326.2%	*
Common Squid	8,511	3,358 to 13,664	4.9%	7,573	2,493 to 12,653	6.3%	-11.0%	ns
Dusky Flathead	1,952	765 to 3,139	1.1%	6,034	3,786 to 8,282	5.1%	209.1%	*
Tailor	4,215	0 to 8,536	2.4%	4,953	1,861 to 8,045	4.2%	17.5%	ns
Flat-Tail Mullet	8,670	0 to 18,429	5.0%	3,930	289 to 7,571	3.3%	-54.7%	ns
Yellow-Finned Leatherjacket	20,907	5,162 to 36,652	12.0%	2,817	206 to 5,428	2.4%	-86.5%	ns
Sand Whiting	378	0 to 797	0.2%	2,130	745 to 3,515	1.8%	463.5%	ns
Sand Mullet	21,730	8,705 to 34,755	12.5%	2,042	538 to 3,546	1.7%	-90.6%	*
River Garfish	-	-	-	1,625	444 to 2,806	1.4%	-	-
Tarwhine	5,787	1,163 to 10,411	3.3%	1,281	591 to 1,971	1.1%	-77.9%	ns
Six-Spined Leatherjacket	6,605	2,754 to 10,456	3.8%	1,112	0 to 2,228	0.9%	-83.2%	*
Southern Herring	3,990	1,351 to 6,629	2.3%	701	0 to 1,409	0.6%	-82.4%	ns
Southern Calamari	2,468	0 to 5,770	1.4%	688	0 to 1,569	0.6%	-72.1%	ns
Blue Swimmer Crab	1,403	0 to 2,989	0.8%	681	52 to 1,310	0.6%	-51.5%	ns
Sea Mullet	#2	-	<0.1%	483	7 to 959	0.4%	-	-
Large-Toothed Flounder	#1	-	<0.1%	440	75 to 805	0.4%	-	-
Small-Toothed Flounder	#1	-	<0.1%	420	0 to 951	0.4%	-	-
Silver Trevally	319	26 to 612	0.2%	338	0 to 684	0.3%	6.0%	ns
Silver Batfish †	#1	-	<0.1%	223	0 to 514	0.2%	-	-
Stout Longtom †	254	0 to 563	0.1%	222	0 to 522	0.2%	-12.6%	ns

Table 7, continued.

COMMON NAME	SHORE-BASED HARVEST FOR WHOLE FISHERY SURVEY YEAR 1 (March 1999 to February 2000)			SURVEY YEAR 2 (December 2003 to November 2004)			COMPARISON BETWEEN SURVEY YEARS	
	Total Fish (number)	95% Confidence Intervals	% Total	Total Fish (number)	95% Confidence Intervals	% Total	% Change (number)	Statistical Significance
Fan-Bellied Leatherjacket	4054	500 to 7,608	2.3%	195	0 to 463	0.2%	-95.2%	*
Snapper	266	0 to 674	0.2%	163	0 to 352	0.1%	-38.7%	ns
Octopus †	-	-	-	127	0 to 275	0.1%	-	-
Rough Leatherjacket	#1	-	<0.1%	76	0 to 205	<0.1%	-	-
Black Trevally (Spinefoot) †	2,107	0 to 4,279	1.2%	#1	-	<0.1%	-	-
Other Taxa^	#31	-	<0.1%	#56	-	<0.1%	-	-
Grand Total	**174,530**	**142,978 to 206,082**	**100.0%**	**119,271**	**98,889 to 139,653**	**100.0%**	**-31.7%**	**ns**

Key:

\# 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.

\- Not recorded or not calculated for rare event occurrences.

† Associated estimates of expanded weight (kg) are not provided for this taxon in Tables 6 and 8 because a suitable length to weight conversion key was not available

^ Other taxa details are provided in Appendix 4.

* Significantly different, p<0.05.

ns No significant difference, p>0.05

Table 8. Annual harvest estimates (kilograms) with 95% confidence intervals for taxa taken by shore-based recreational fishers in the Lake Macquarie fishery for each survey year. The proportional changes between survey years and their associated statistical significance are presented.

COMMON NAME	SHORE-BASED HARVEST FOR WHOLE FISHERY						COMPARISON BETWEEN SURVEY YEARS	
	SURVEY YEAR 1 (March 1999 to February 2000)			SURVEY YEAR 2 (December 2003 to November 2004)				
	Total Fish (kg)	95% Confidence Intervals	% Total	Total Fish (kg)	95% Confidence Intervals	% Total	% Change (number)	Statistical Significance
Luderick	28,117	21,370 to 34,864	45.2%	37,704	23,225 to 52,183	60.7%	34.1%	ns
Yellowfin Bream	10,907	5,420 to 16,394	17.5%	10,568	7,834 to 13,302	17.0%	-3.1%	ns
Dusky Flathead	1,507	443 to 2,571	2.4%	3,682	1,932 to 5,432	5.9%	144.3%	ns
Tailor	643	114 to 1,172	1.0%	1,705	388 to 3,022	2.7%	165.1%	ns
Flat-Tail Mullet	2,165	0 to 4,410	3.5%	1,548	124 to 2,972	2.5%	-28.5%	ns
Common Squid	1,300	388 to 2,212	2.1%	1,280	293 to 2,267	2.1%	-1.6%	ns
Trumpeter Whiting	255	0 to 588	0.4%	937	622 to 1,252	1.5%	267.7%	*
Blue Swimmer Crab	516	0 to 1,111	0.8%	755	0 to 1,782	1.2%	46.4%	ns
Tarwhine	2,005	298 to 3,712	3.2%	668	267 to 1,069	1.1%	-66.7%	ns
Sand Whiting	92	0 to 203	0.1%	545	185 to 905	0.9%	494.6%	ns
Yellow-Finned Leatherjacket	4,074	1,440 to 6,708	6.5%	514	108 to 920	0.8%	-87.4%	*
Southern Calamari	2,050	0 to 5,079	3.3%	486	0 to 1,049	0.8%	-76.3%	ns
Sand Mullet	5,814	2,567 to 9,061	9.3%	466	13 to 919	0.7%	-92.0%	*
Silver Trevally	184	0 to 384	0.3%	461	0 to 944	0.7%	150.2%	ns
Sea Mullet	#1	-	<0.1%	192	5 to 379	0.3%	-	-
Six-Spined Leatherjacket	970	186 to 1,754	1.6%	173	0 to 358	0.3%	-82.2%	ns
Large-Toothed Flounder	-	-	-	113	19 to 207	0.2%	-	-
River Garfish	-	-	-	108	15 to 201	0.2%	-	-
Small-Toothed Flounder	-	-	-	85	0 to 177	0.1%	-	-
Snapper	30	0 to 80	<0.1%	41	0 to 90	<0.1%	35.9%	ns
Fan-Bellied Leatherjacket	1,457	0 to 3,044	2.3%	39	0 to 95	<0.1%	-97.3%	ns
Rough Leatherjacket	-	-	-	35	0 to 95	<0.1%	-	-

Table 8, continued.

COMMON NAME	SHORE-BASED HARVEST FOR WHOLE FISHERY: SURVEY YEAR 1 (March 1999 to February 2000)			SURVEY YEAR 2 (December 2003 to November 2004)			COMPARISON BETWEEN SURVEY YEARS	
	Total Fish (kg)	95% Confidence Intervals	% Total	Total Fish (kg)	95% Confidence Intervals	% Total	% Change (number)	Statistical Significance
Southern Herring	123	40 to 206	0.2%	8	0 to 16	<0.1%	-93.4%	*
Other Taxa^	#17	-	<0.1%	#17	-	<0.1%	-	-
Grand Total	**62,228**	**51,451 to 73,005**	**100.0%**	**62,128**	**47,049 to 77,207**	**100.0%**	**-0.2%**	**ns**

Key:
\# 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.
* Significantly different, $p<0.05$.
ns No significant difference, $p>0.05$
\- Not recorded or not calculated for rare event occurrences.
^ Other taxa details are provided in Appendix 4.

4.3. Indicators of Recreational Fishing Quality

4.3.1. Recreational harvest rates

Seasonal trends are evident in the harvest rate information, however, these data are highly variable which means that estimates of seasonal harvest rates are usually imprecise. Thus, most comparisons of harvest rates among seasons within a survey year or between survey years are not statistically significantly different (see Figs 2 to 23). A brief description of the harvest rate data that focuses on statistically detectable differences between survey periods is provided below for the main species of recreational importance.

4.3.1.1. Trumpeter whiting

In the Southern Lake area, the boat-based harvest rate observed during the Summer of the second survey year was significantly greater ($p<0.05$) than that measured during the Summer of the first survey year (Fig. 2). In the Southern Lake area, the shore-based harvest rates observed during all seasons of the second survey were found to be significantly higher than those measured during the corresponding seasons during the first survey year (Fig. 3).

4.3.1.2. Luderick

There were no statistically significant differences in seasonal harvest rates between survey periods for boat-based fishers (Fig. 4). In the Southern Lake area, the Spring harvest rate of shore-based fishers in the first survey year was significantly higher ($p<0.05$) than the corresponding season during the second survey year (Fig. 5).

4.3.1.3. Blue swimmer crab

There were no statistically significant differences in seasonal harvest rates between survey periods for boat-based fishers or shore-based fishers (Figs.6 & 7).

4.3.1.4. Yellowfin bream

In the Swansea Channel and the Southern Lake area, the boat-based harvest rates observed during Autumn of the second survey year were significantly greater ($p<0.05$) than those measured during the corresponding season in the same areas of the Lake during the first survey year (Fig. 8). In the Southern Lake area, the Winter harvest rate of boat-based fishers was significantly higher during the second survey year (Fig. 8). Also, in the Southern Lake area, the Summer harvest rate of shore-based fishers was significantly higher during the second survey year (Fig. 9).

4.3.1.5. Dusky flathead

In the Southern Lake area, the boat-based and shore-based harvest rates observed during Winter and Spring of the second survey year were significantly greater ($p<0.05$) than those measured during the corresponding seasons during the first survey year (Figs. 10 & 11). Also, the Summer harvest rate of boat-based fishers was significantly higher in the Southern Lake area during the second survey year (Fig. 10).

4.3.1.6. Tailor

In the Northern Lake area, the boat-based harvest rate observed during the Autumn of the second survey year was significantly greater ($p<0.05$) than that measured during the Autumn of the first survey year (Fig. 12). In the Southern Lake area, the boat-based harvest rates observed during the Autumn, Winter and Spring seasons of the second survey year were found to be significantly higher than those measured during the corresponding seasons during the first survey year (Fig. 12). There were no statistically significant differences in seasonal harvest rates between survey periods for shore-based fishers (Fig. 13).

4.3.1.7. Common squid

In the Southern Lake area, the boat-based harvest rates observed during Autumn and Winter of the first survey year were significantly greater ($p<0.05$) than those measured during the corresponding seasons of the second survey year (Fig. 14). For the shore-based fishery, harvest rates were significantly greater ($p<0.05$) in the Southern Lake area for Summer in the first survey year (Fig. 15).

4.3.1.8. Sand whiting

In the Northern Lake area, the boat-based harvest rates observed during Summer of the second survey year were significantly greater ($p<0.05$) than those measured during the Summer of the first survey year (Fig. 16). There were no statistically significant differences in seasonal harvest rates between survey periods for shore-based fishers (Fig.17).

4.3.1.9. Large-toothed flounder

In the Swansea Channel, the boat-based harvest rates observed during Summer of the second survey year were significantly greater ($p<0.05$) than those measured during the Summer of the first survey year (Fig. 18). There were no statistically significant differences in seasonal harvest rates between survey periods for shore-based fishers (Fig 19).

4.3.1.10. Yellow-finned leatherjacket

In the Northern Lake area, the boat-based harvest rates observed during Summer of the first survey year were significantly greater ($p<0.05$) than those measured during the Summer of the second survey year (Fig. 20). For the shore-based fishery, harvest rates were significantly greater ($p<0.05$) in the Northern Lake area for Autumn, Winter and Spring in the first survey year (Fig. 21).

4.3.1.11. Sand mullet

There were no statistically significant differences in seasonal harvest rates between survey periods for boat-based fishers or shore-based fishers (Figs.22 & 23).

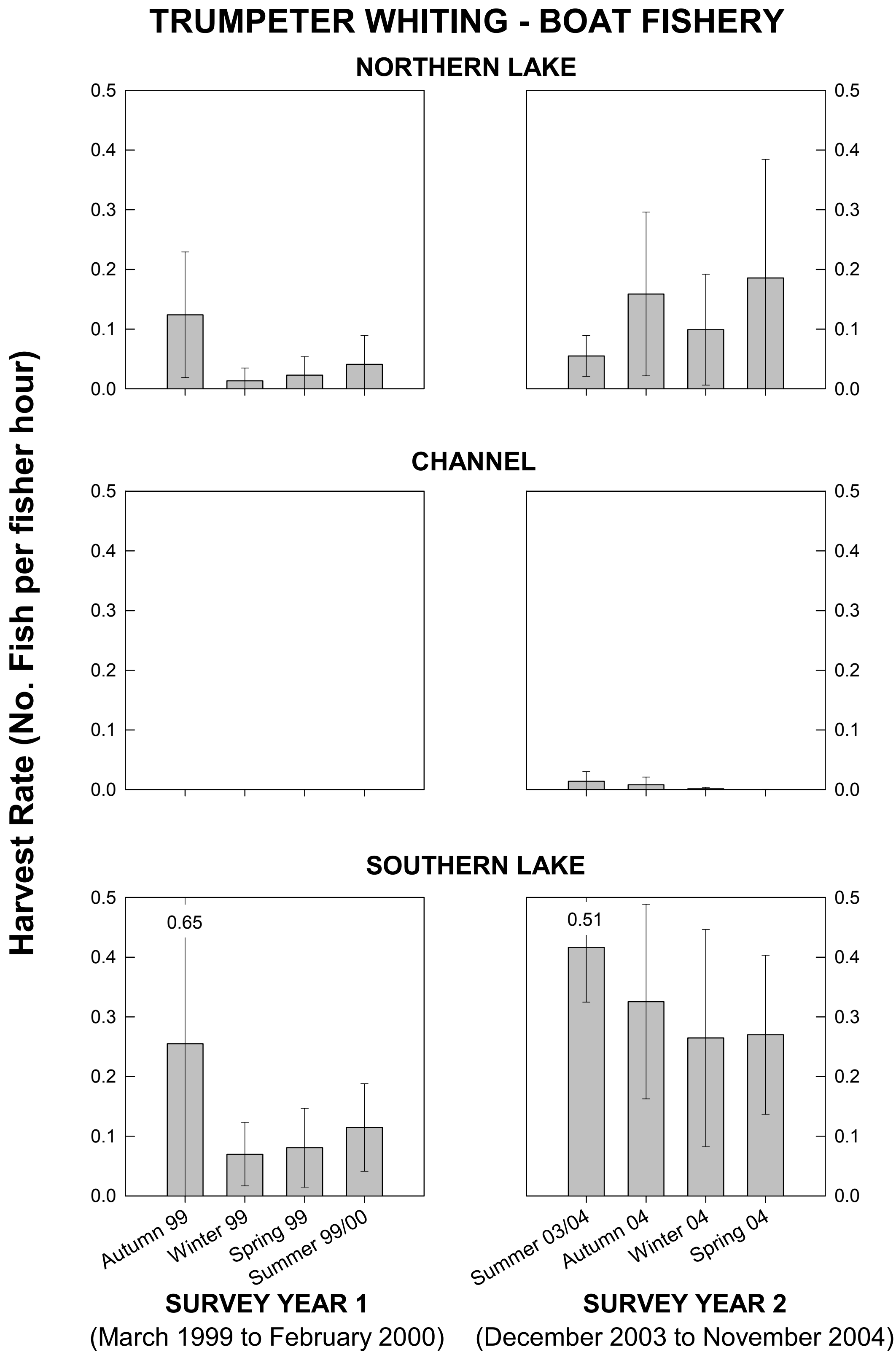

Figure 2. Recreational harvest rate estimates (fish per fisher hour) with 95% confidence intervals for trumpeter whiting taken by boat-based fishers in the Northern Lake, Swansea Channel and Southern Lake for each survey year.

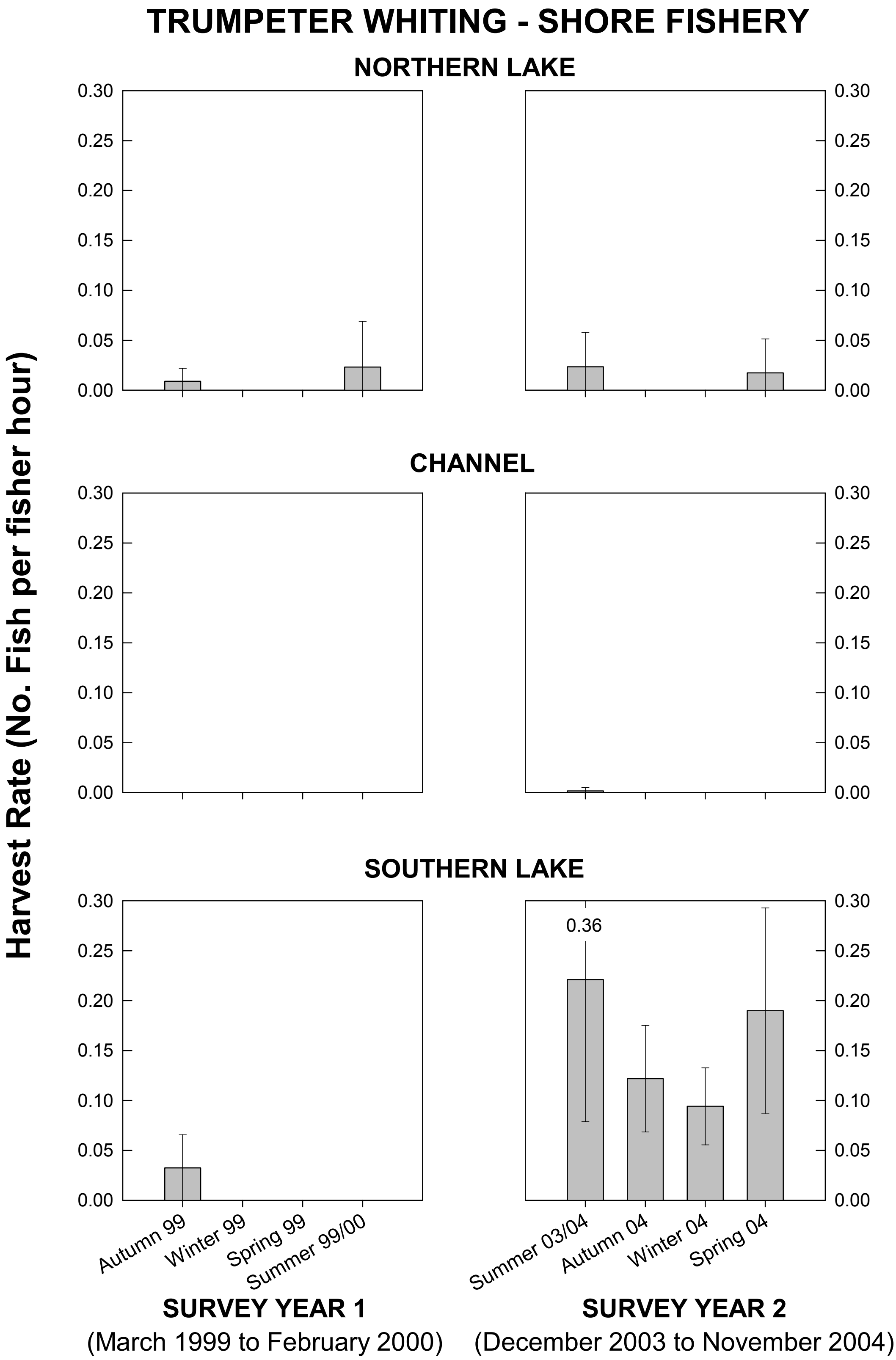

Figure 3. Recreational harvest rate estimates (fish per fisher hour) with 95% confidence intervals for trumpeter whiting taken by shore-based fishers in the Northern Lake, Swansea Channel and Southern Lake areas for each survey year.

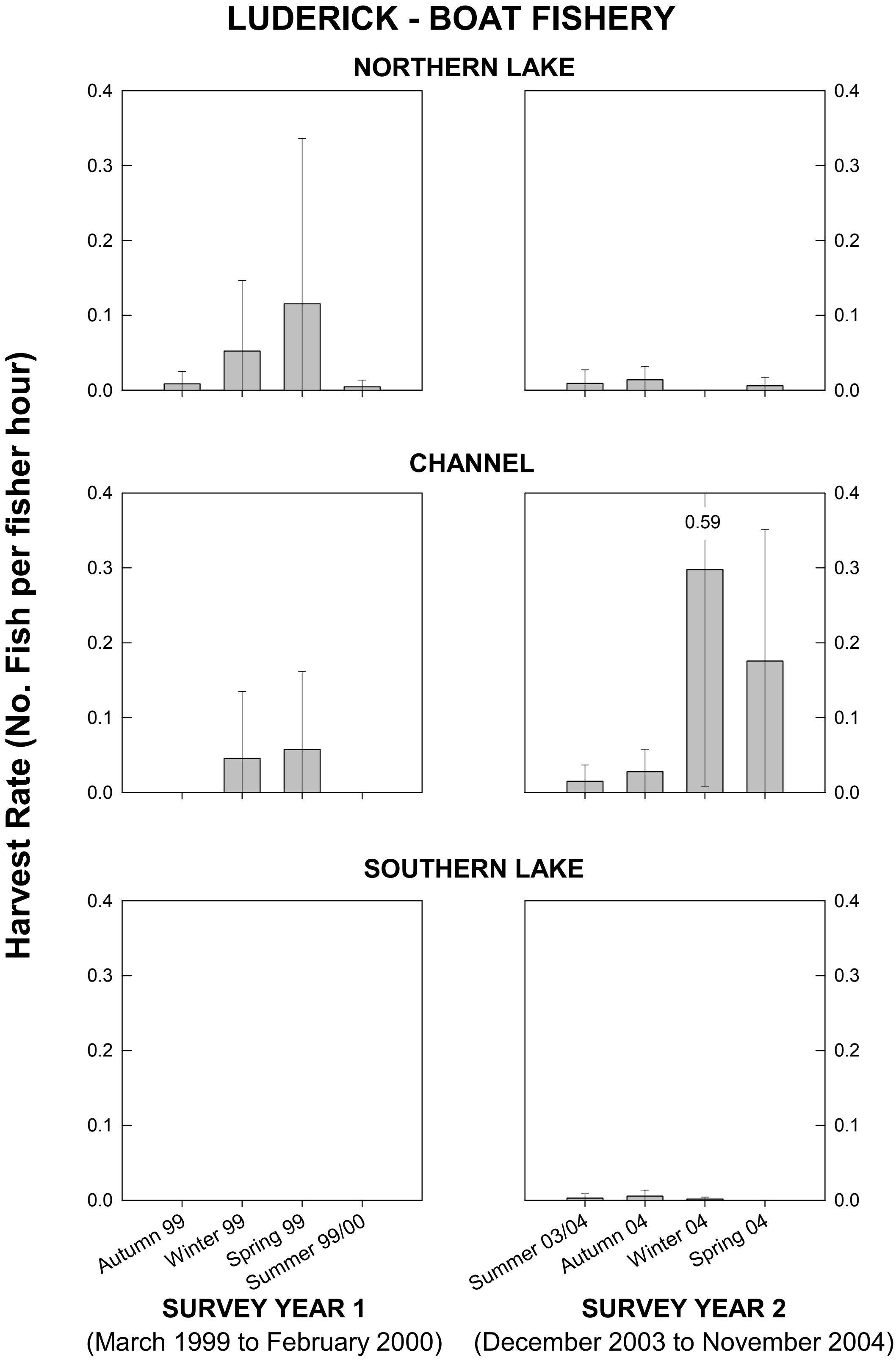

Figure 4. Recreational harvest rate estimates (fish per fisher hour) with 95% confidence intervals for luderick taken by boat-based fishers in the Northern Lake, Swansea Channel and Southern Lake areas for each survey year.

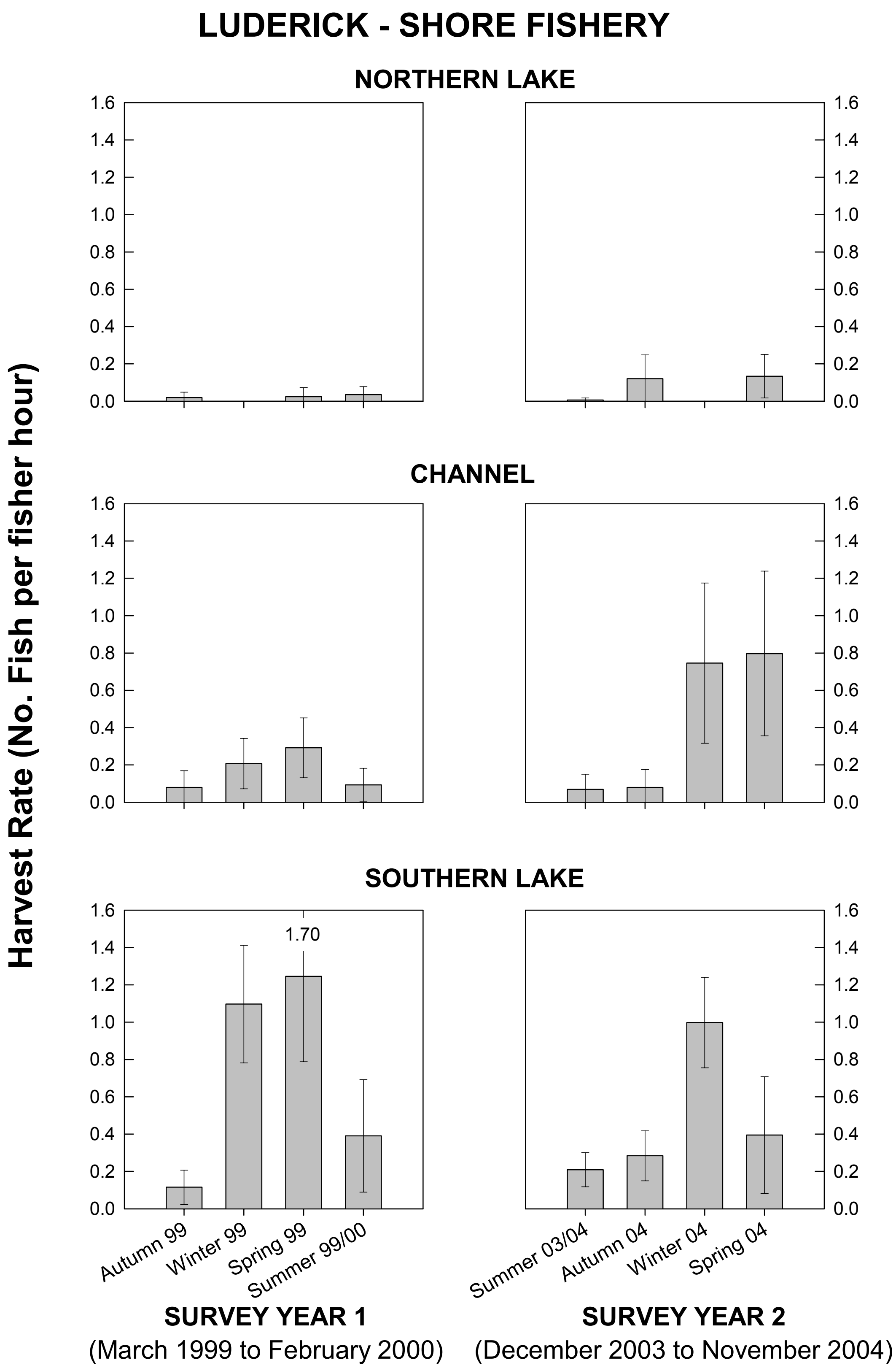

Figure 5. Recreational harvest rate estimates (fish per fisher hour) with 95% confidence intervals for luderick taken by shore-based fishers in the Northern Lake, Swansea Channel and Southern Lake areas for each survey year.

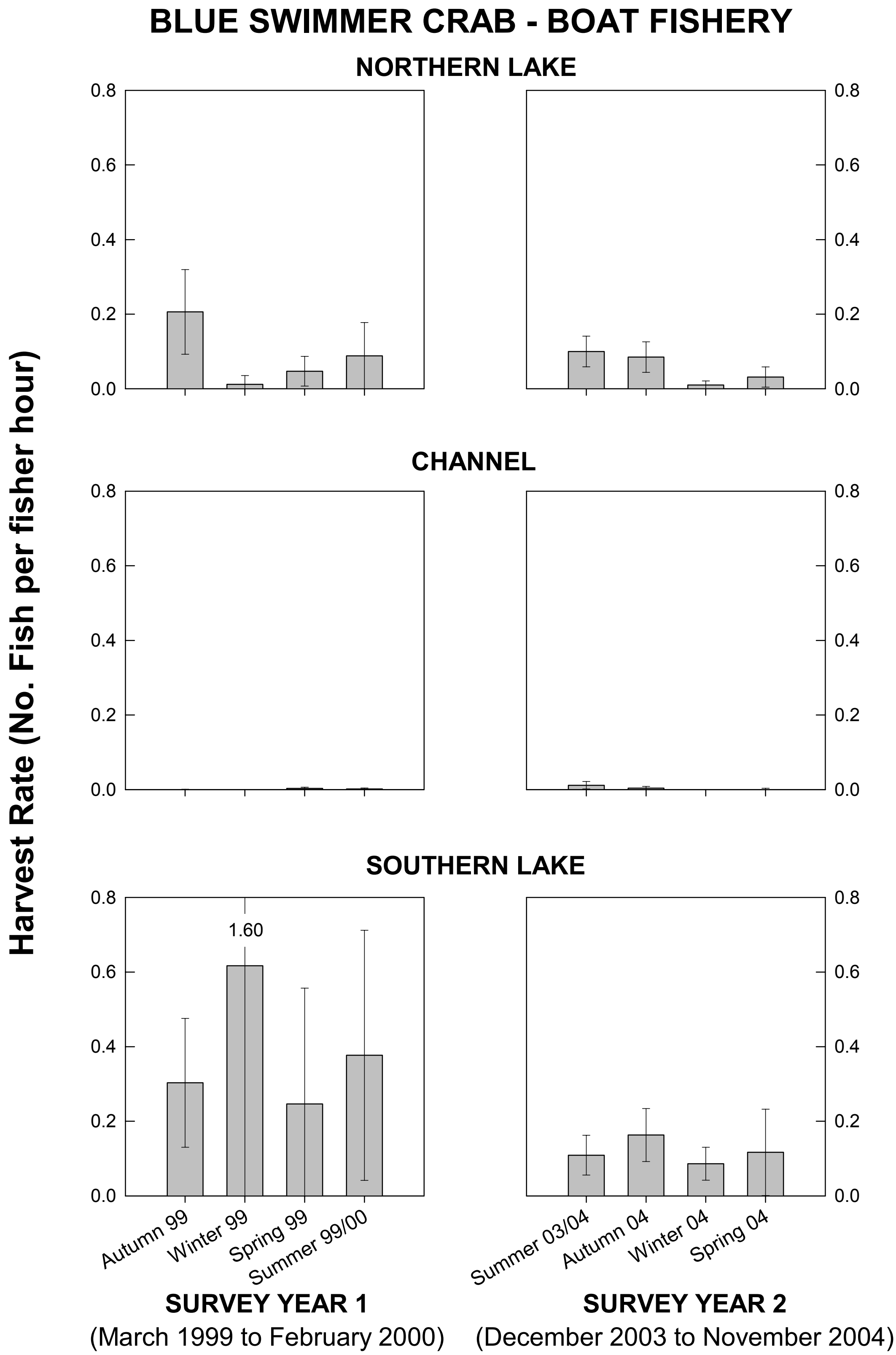

Figure 6. Recreational harvest rate estimates (fish per fisher hour) with 95% confidence intervals for blue swimmer crab taken by boat-based fishers in the Northern Lake, Swansea Channel and Southern Lake areas for each survey year.

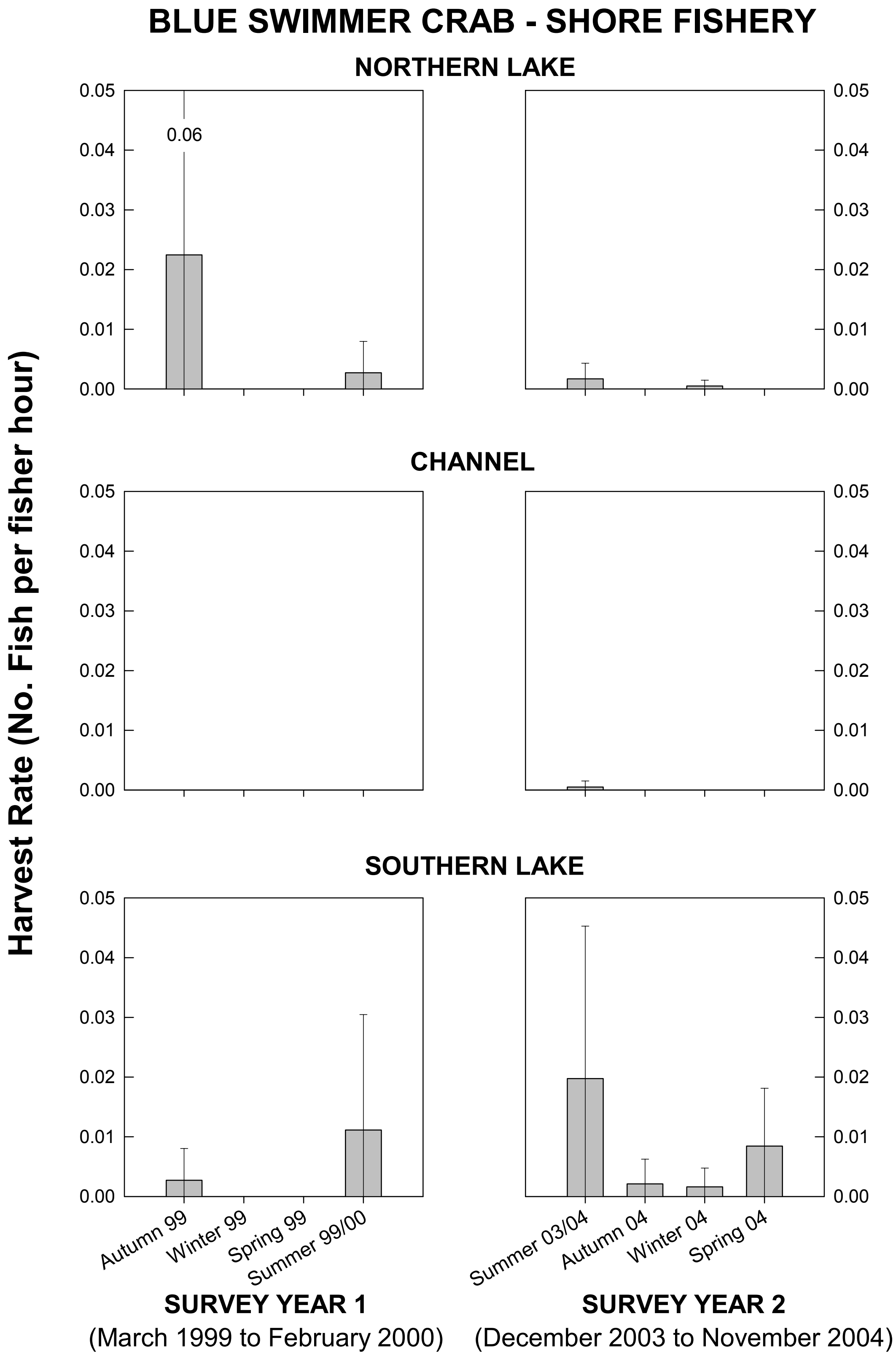

Figure 7. Recreational harvest rate estimates (fish per fisher hour) and 95% confidence intervals for blue-swimmer crab taken by shore-based fishers in the Northern Lake, Swansea Channel and Southern Lake areas for each survey year.

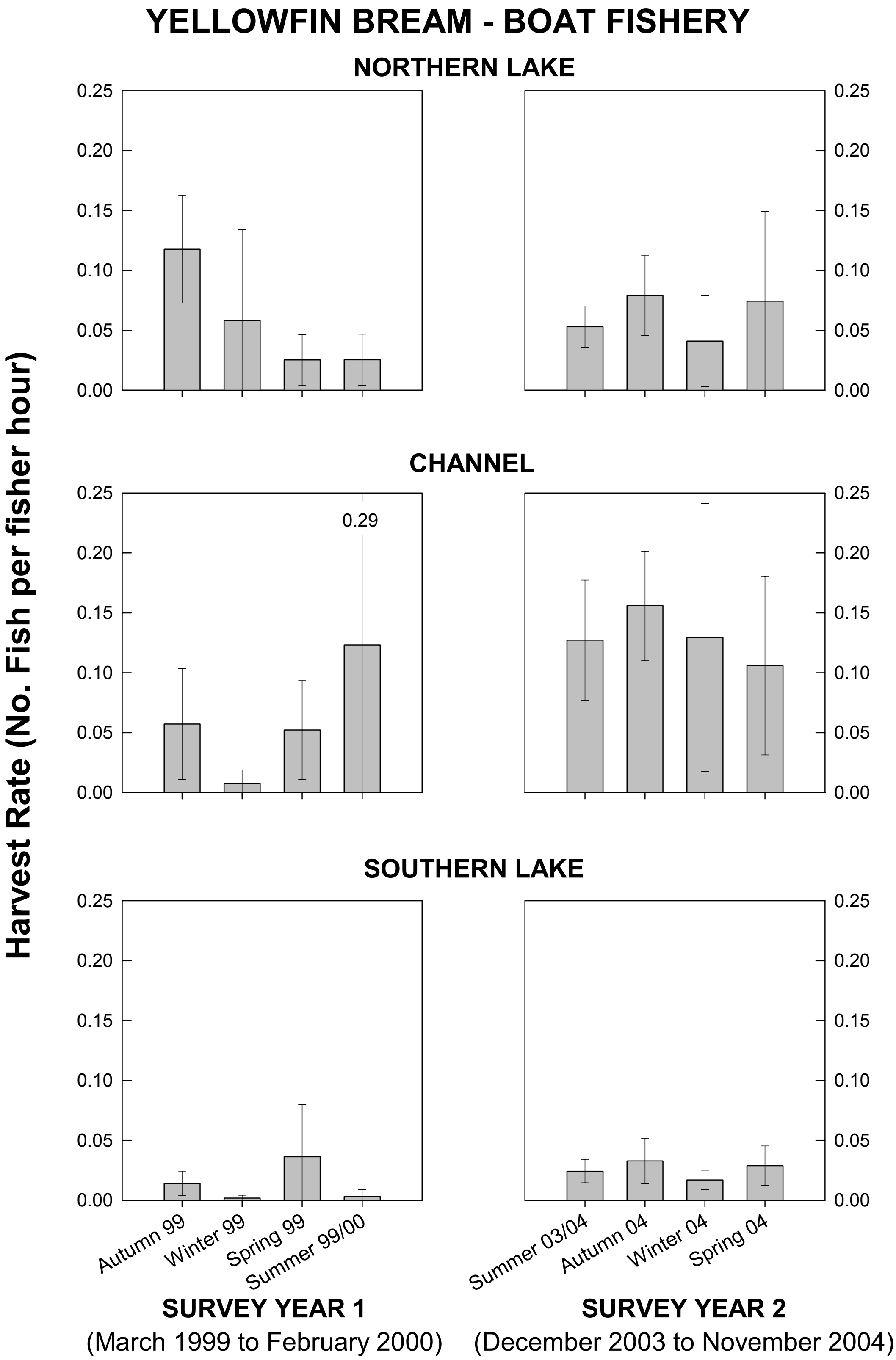

Figure 8. Recreational harvest rate estimates (fish per fisher hour) with 95% confidence intervals for yellowfin bream taken by boat-based fishers in the Northern Lake, Swansea Channel and Southern Lake areas for each survey year.

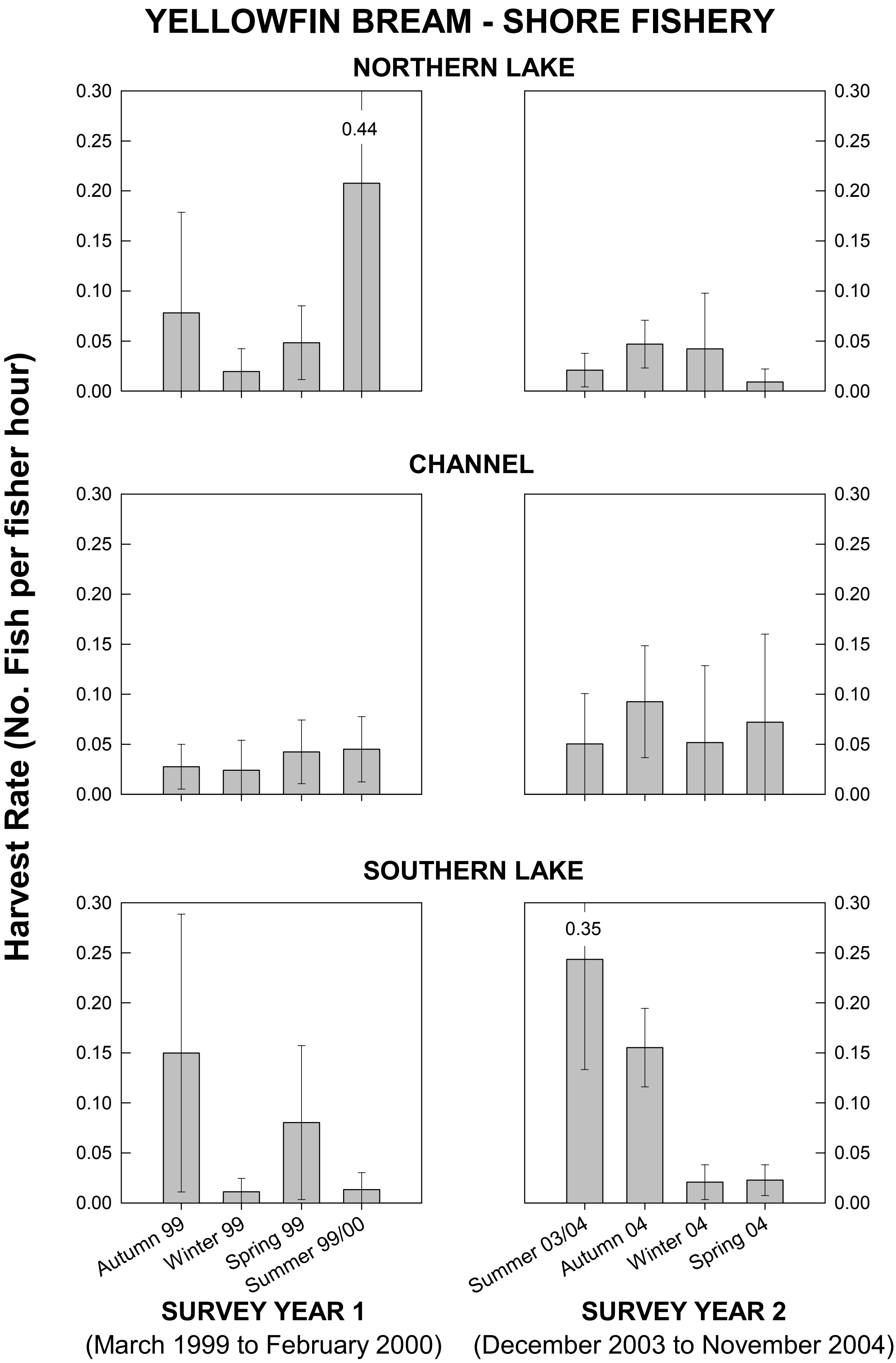

Figure 9. Recreational harvest rate estimates (fish per fisher hour) with 95% confidence intervals for yellowfin bream taken by shore-based fishers in the Northern Lake, Swansea Channel and Southern Lake areas for each survey year.

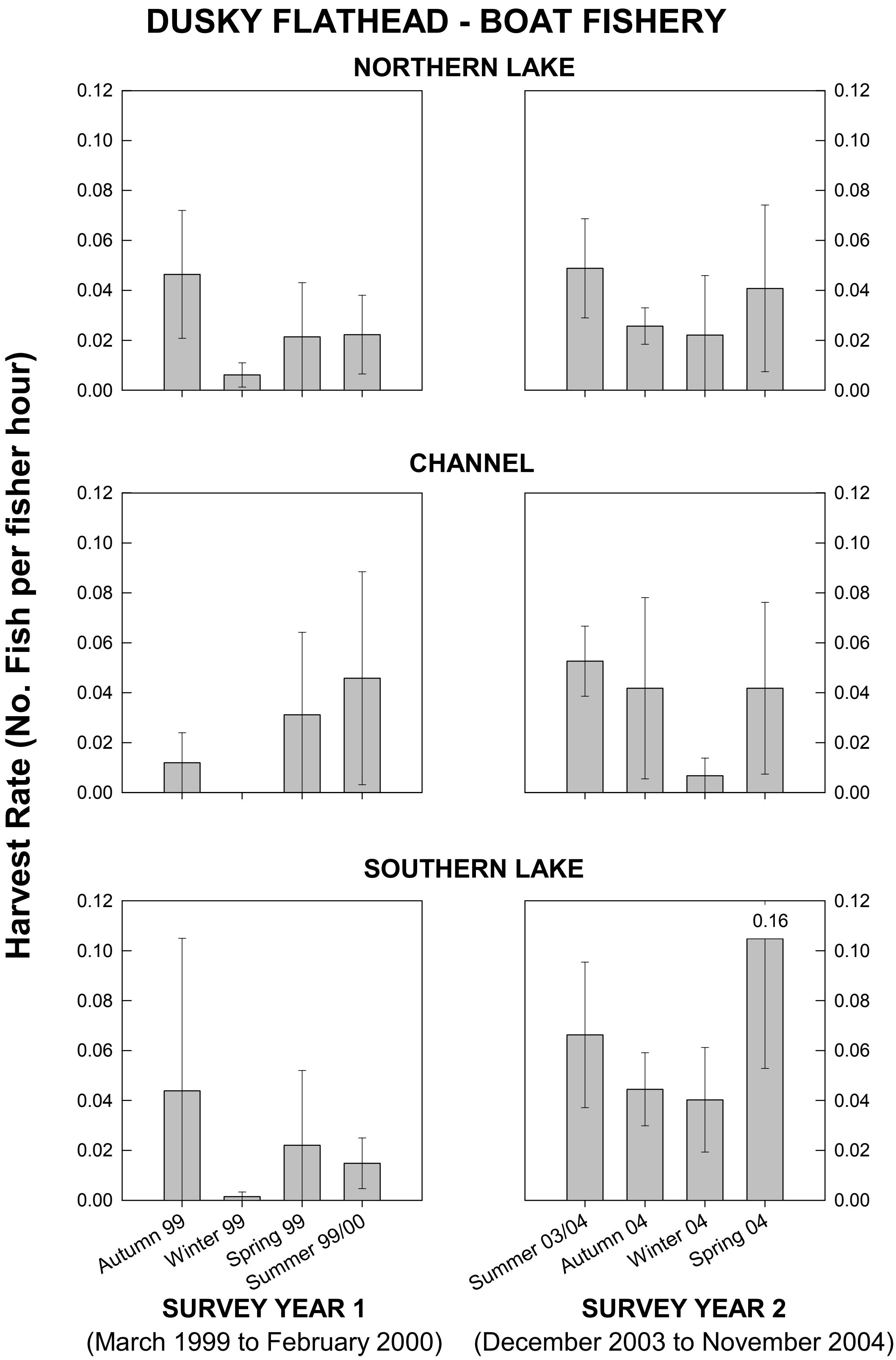

Figure 10. Recreational harvest rate estimates (fish per fisher hour) with 95% confidence intervals for dusky flathead taken by boat-based fishers in the Northern Lake, Swansea Channel and Southern Lake areas for each survey year.

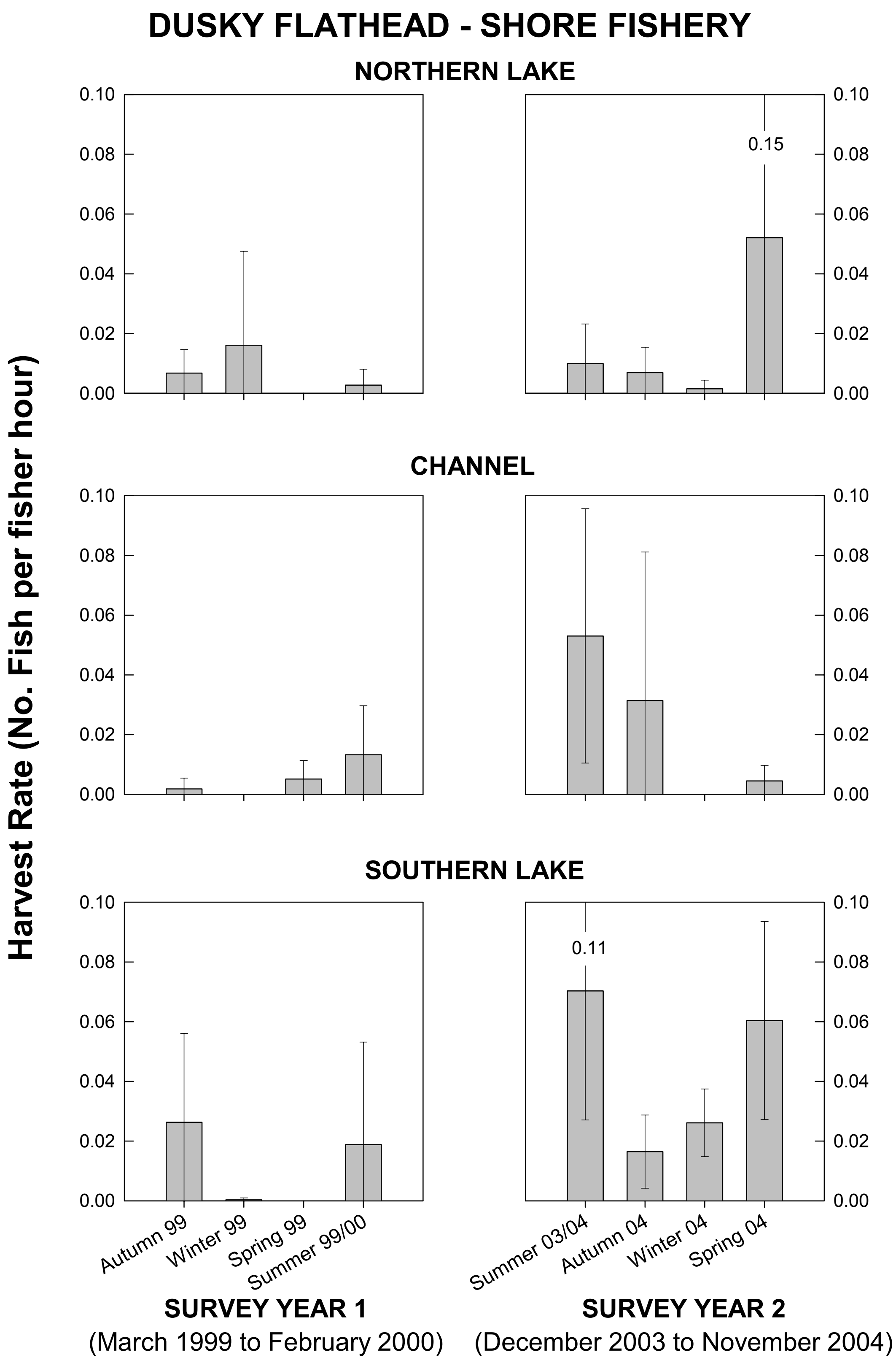

Figure 11. Recreational harvest rate estimates (fish per fisher hour) with 95% confidence intervals for dusky flathead taken by shore-based fishers in the Northern Lake, Swansea Channel and Southern Lake areas for each survey year.

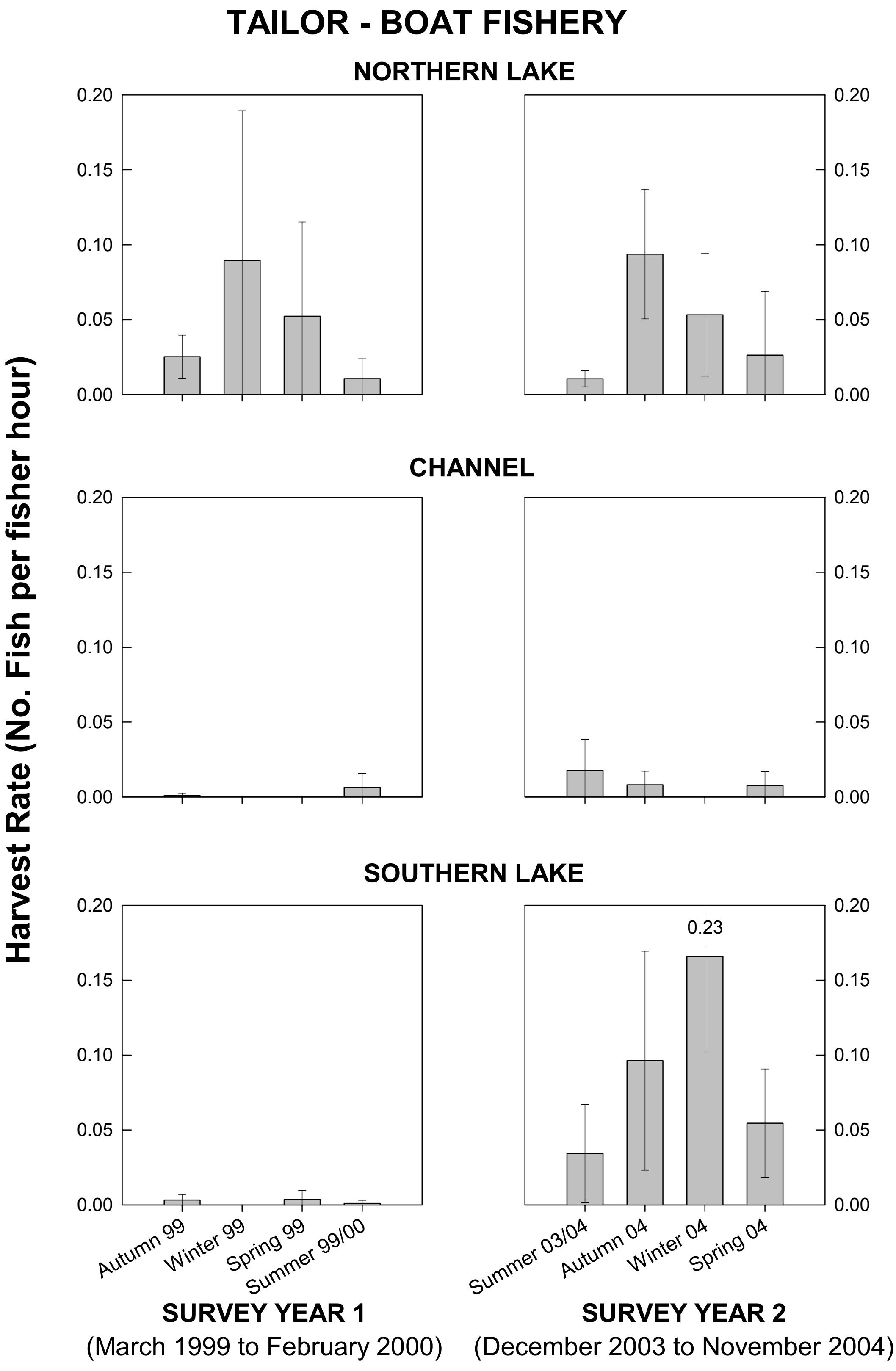

Figure 12. Recreational harvest rate estimates (fish per fisher hour) with 95% confidence intervals for tailor taken by boat-based fishers in the Northern Lake, Swansea Channel and Southern Lake areas for each survey year.

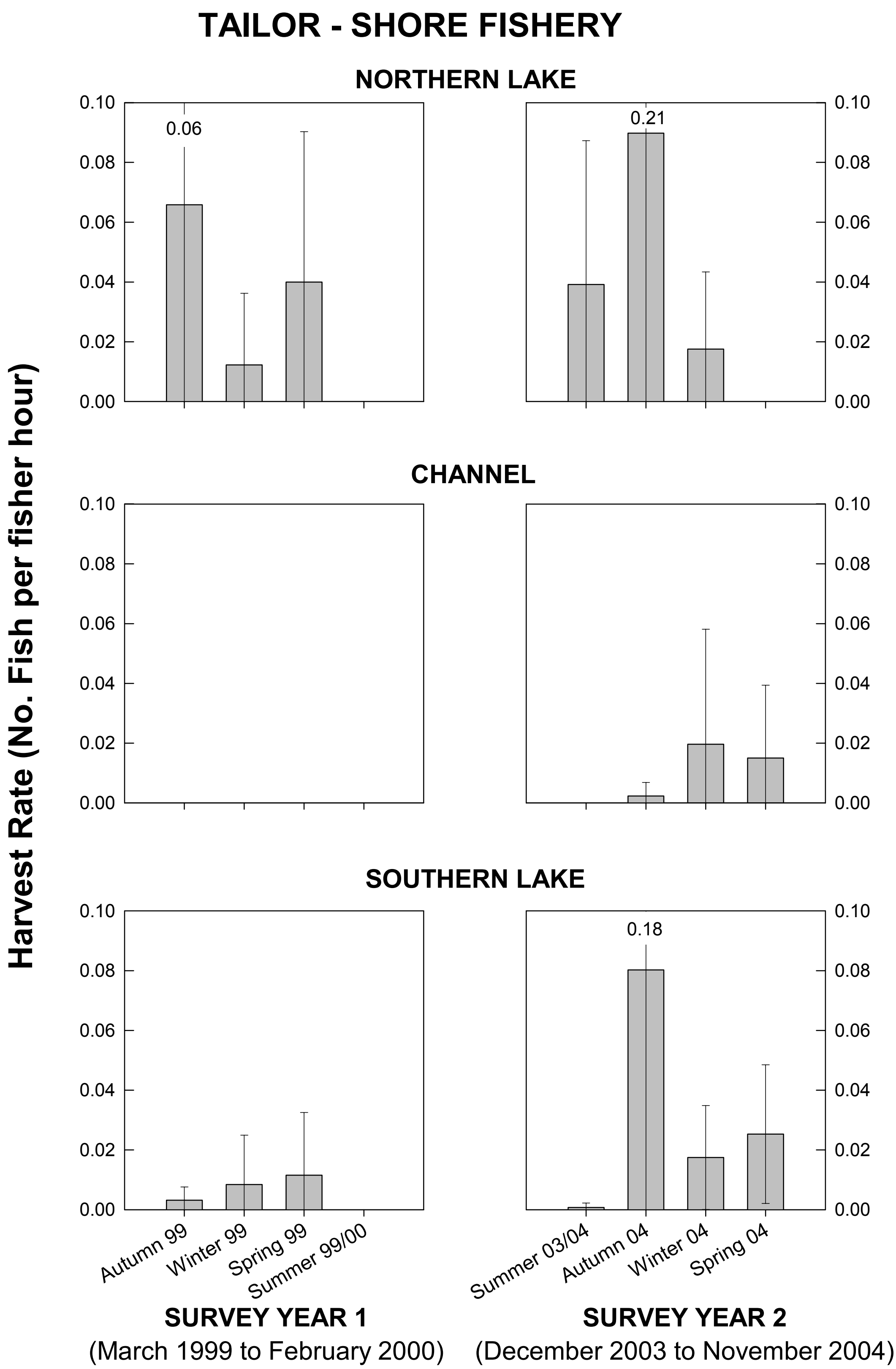

Figure 13. Recreational harvest rate estimates (fish per fisher hour) with 95% confidence intervals for tailor taken by shore-based fishers in the Northern Lake, Swansea Channel and Southern Lake areas for each survey year.

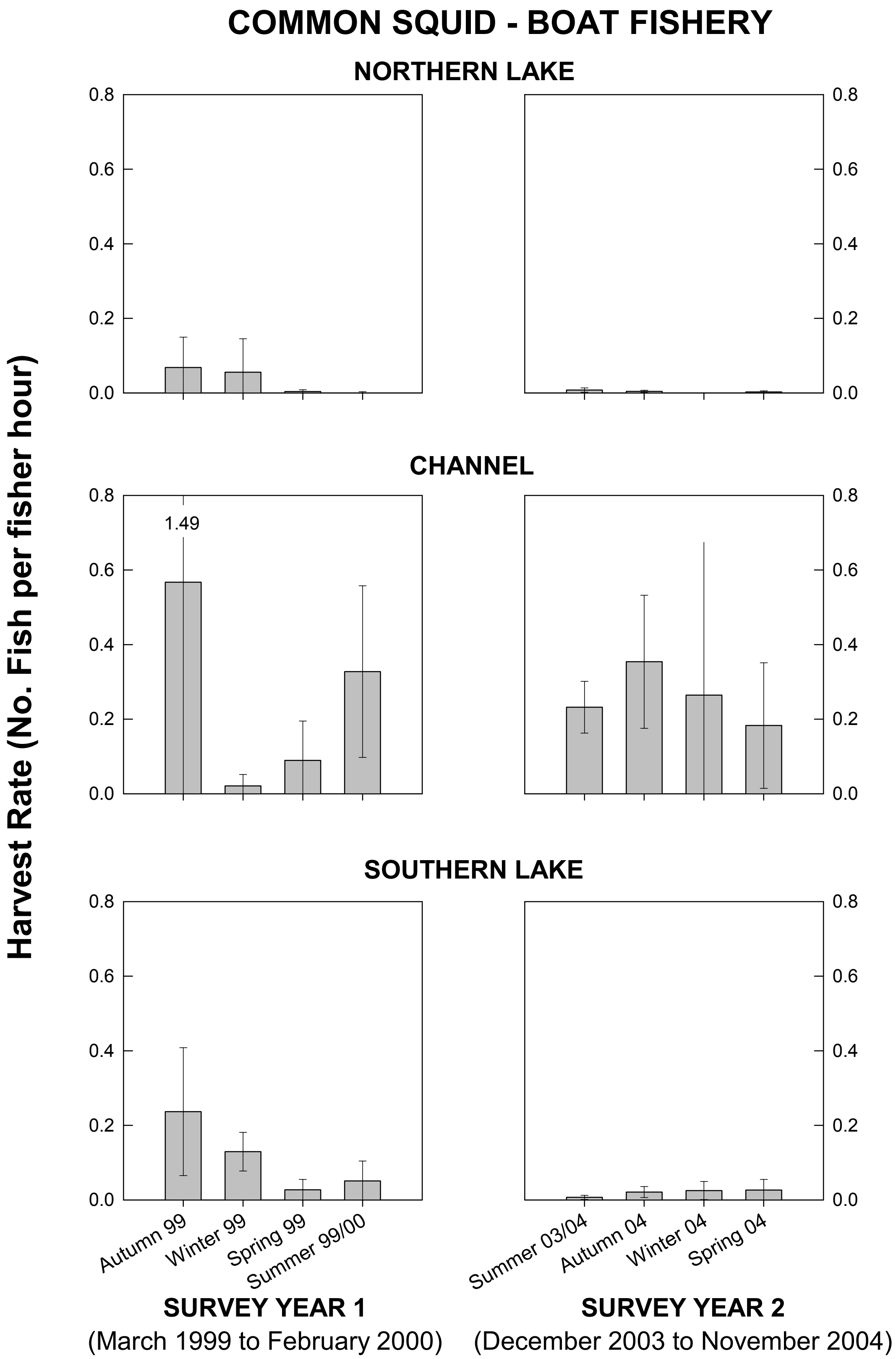

Figure 14. Recreational harvest rate estimates (fish per fisher hour) with 95% confidence intervals for common squid taken by boat-based fishers in the Northern Lake, Swansea Channel and Southern Lake areas for each survey year.

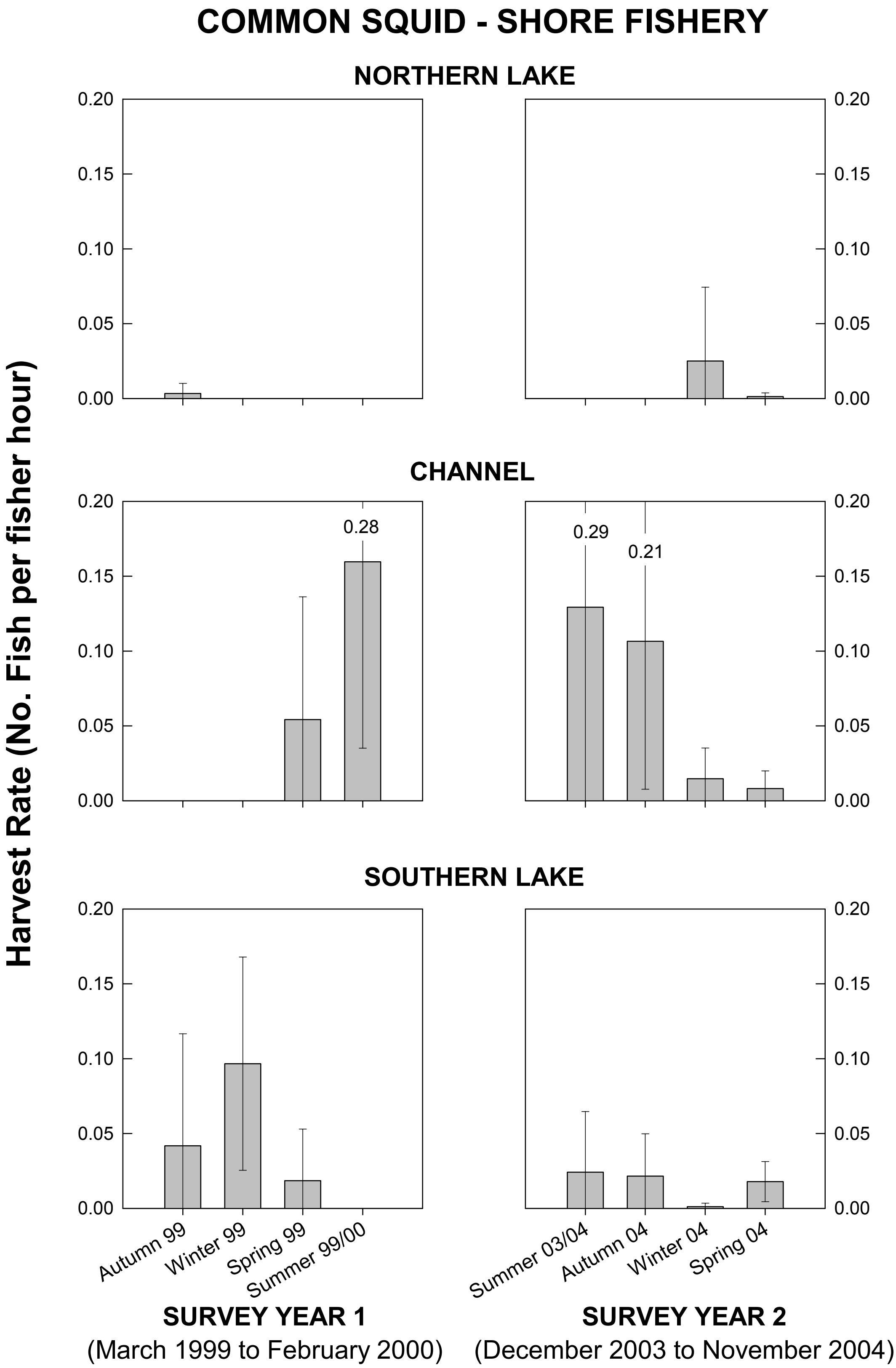

Figure 15. Recreational harvest rate estimates (fish per fisher hour) with 95% confidence intervals for common squid taken by shore-based fishers in the Northern Lake, Swansea Channel and Southern Lake areas for each survey year.

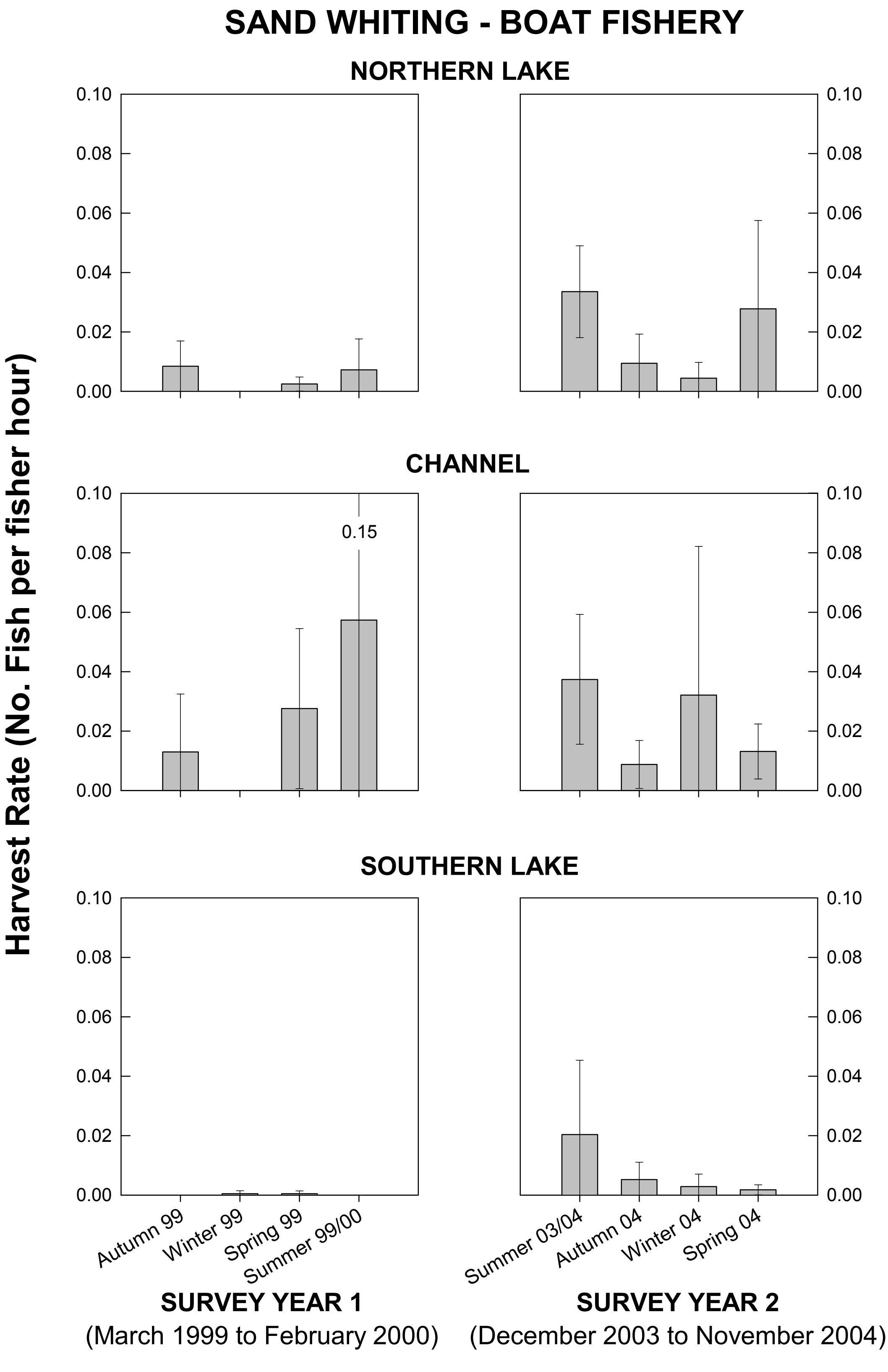

Figure 16. Recreational harvest rate estimates (fish per fisher hour) with 95% confidence intervals for sand whiting taken by boat-based fishers in the Northern Lake, Swansea Channel and Southern Lake areas for each survey year.

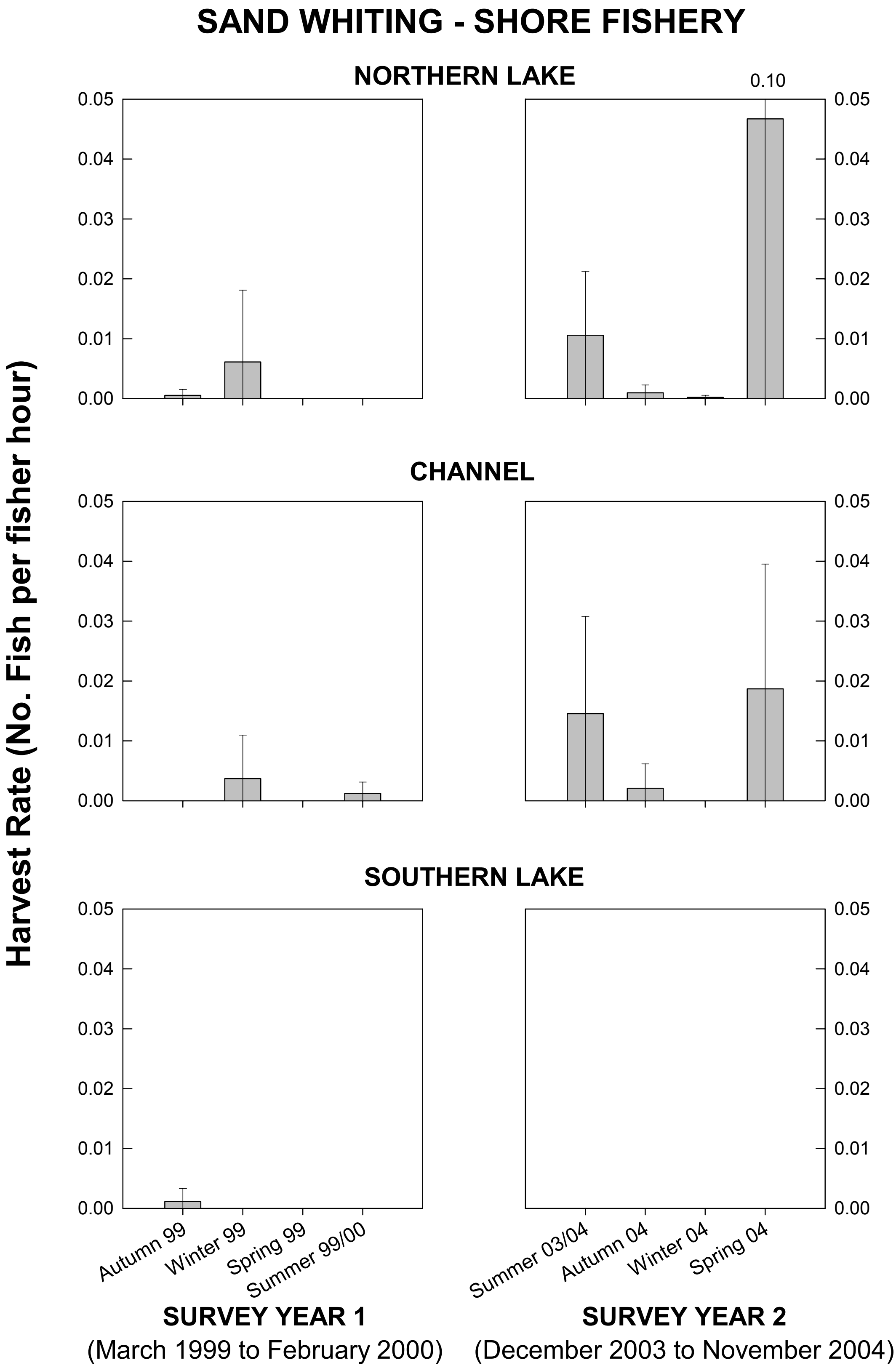

Figure 17. Recreational harvest rate estimates (fish per fisher hour) with 95% confidence intervals for sand whiting taken by shore-based fishers in the Northern Lake, Swansea Channel and Southern Lake areas for each survey year.

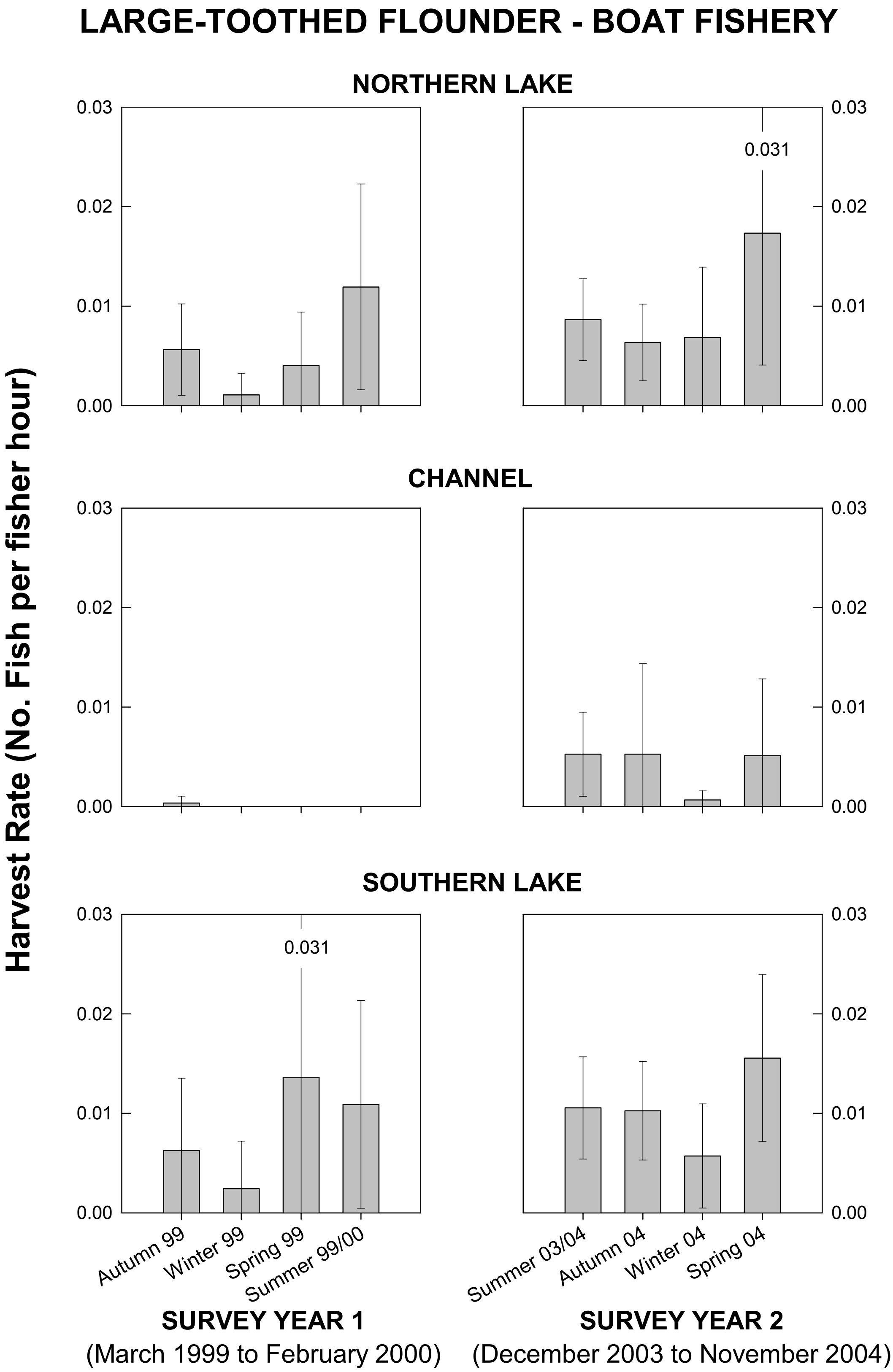

Figure 18. Recreational harvest rate estimates (fish per fisher hour) with 95% confidence intervals for large-toothed flounder taken by boat-based fishers in the Northern Lake, Swansea Channel and Southern Lake areas for each survey year.

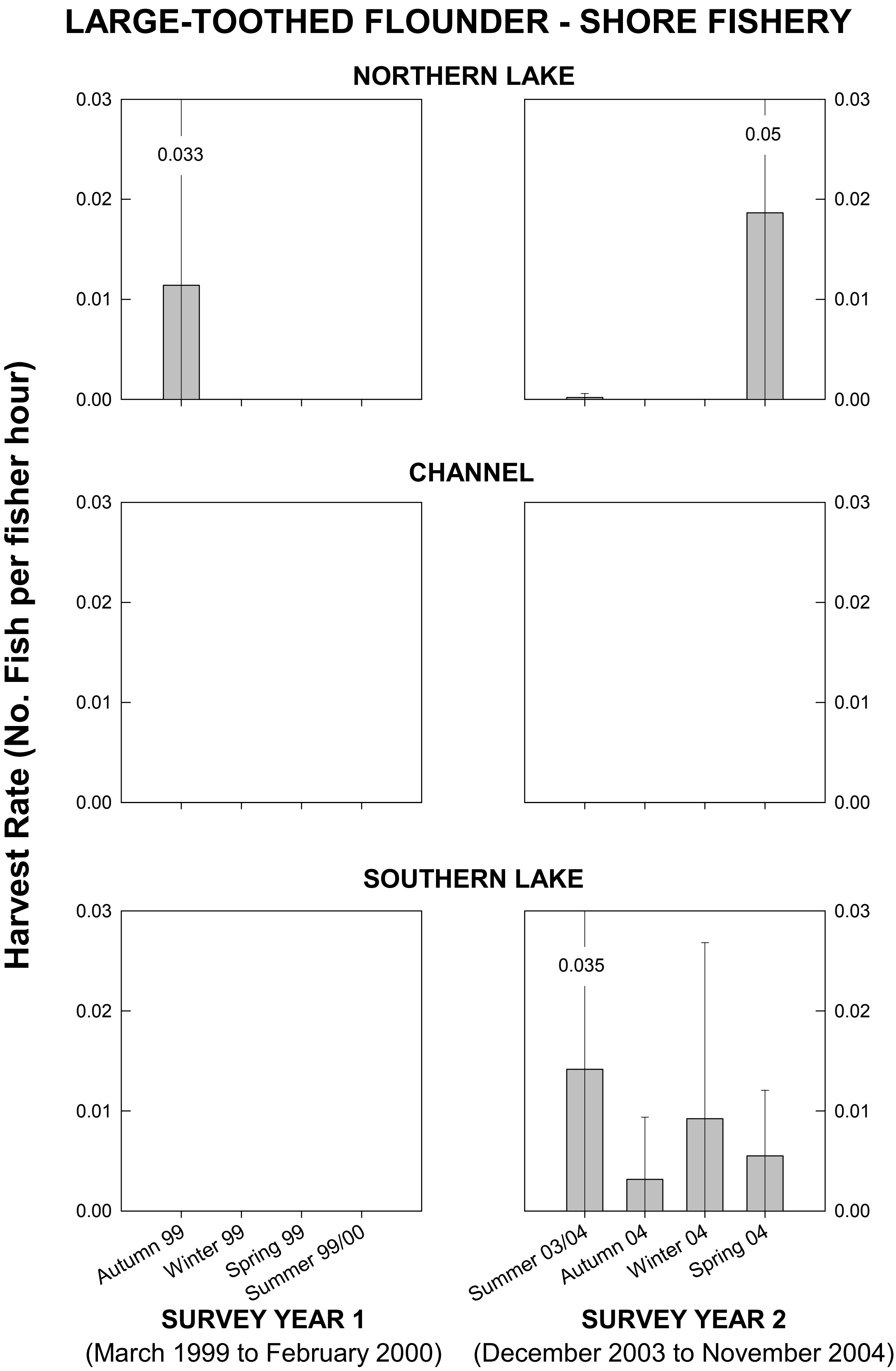

Figure 19. Recreational harvest rate estimates (fish per fisher hour) with 95% confidence intervals for large-toothed flounder taken by shore-based fishers in the Northern Lake, Swansea Channel and Southern Lake areas for each survey year.

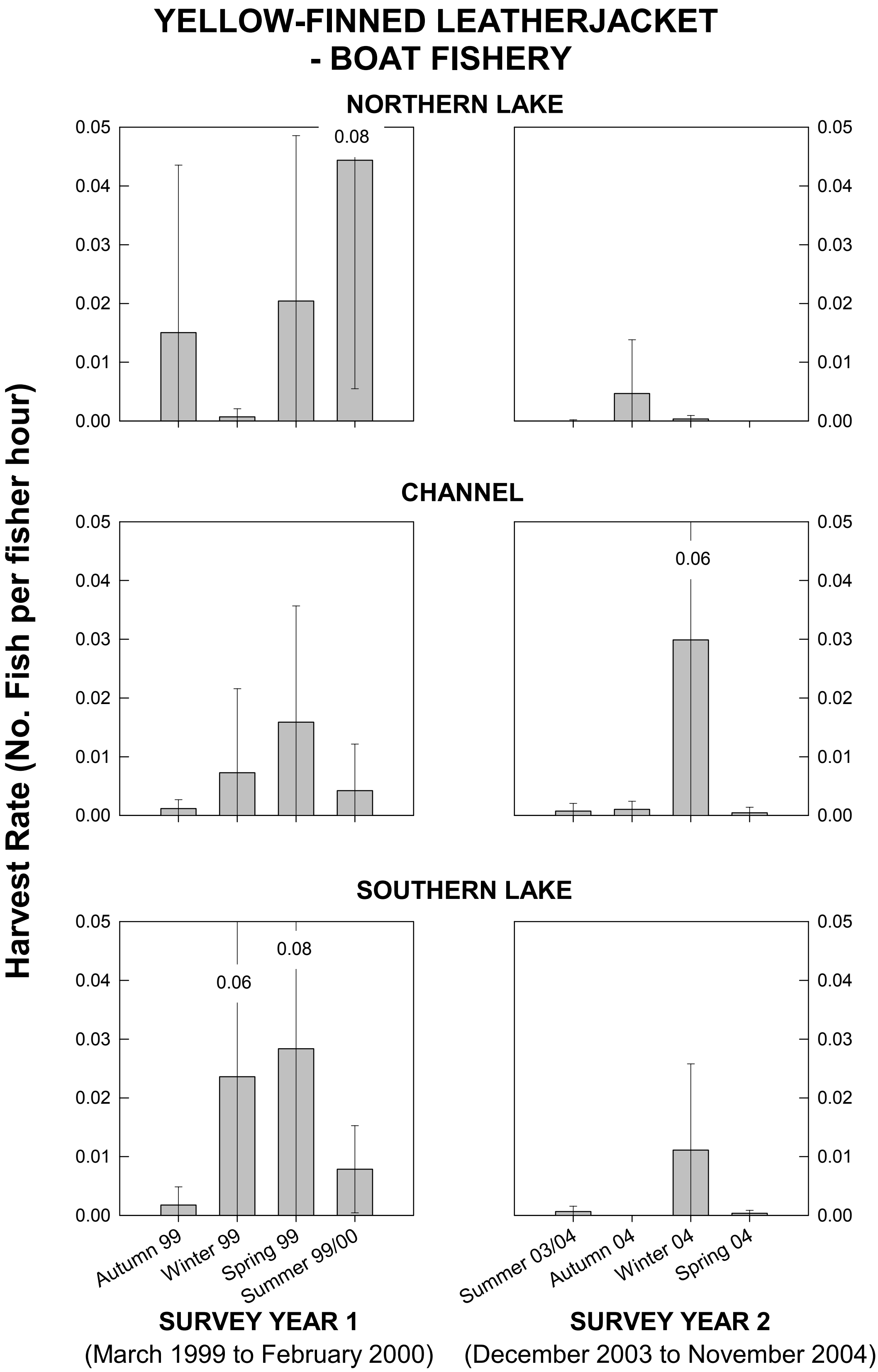

Figure 20. Recreational harvest rate estimates (fish per fisher hour) with 95% confidence intervals for yellow-finned leatherjacket taken by boat-based fishers in the Northern Lake, Swansea Channel and Southern Lake areas for each survey year.

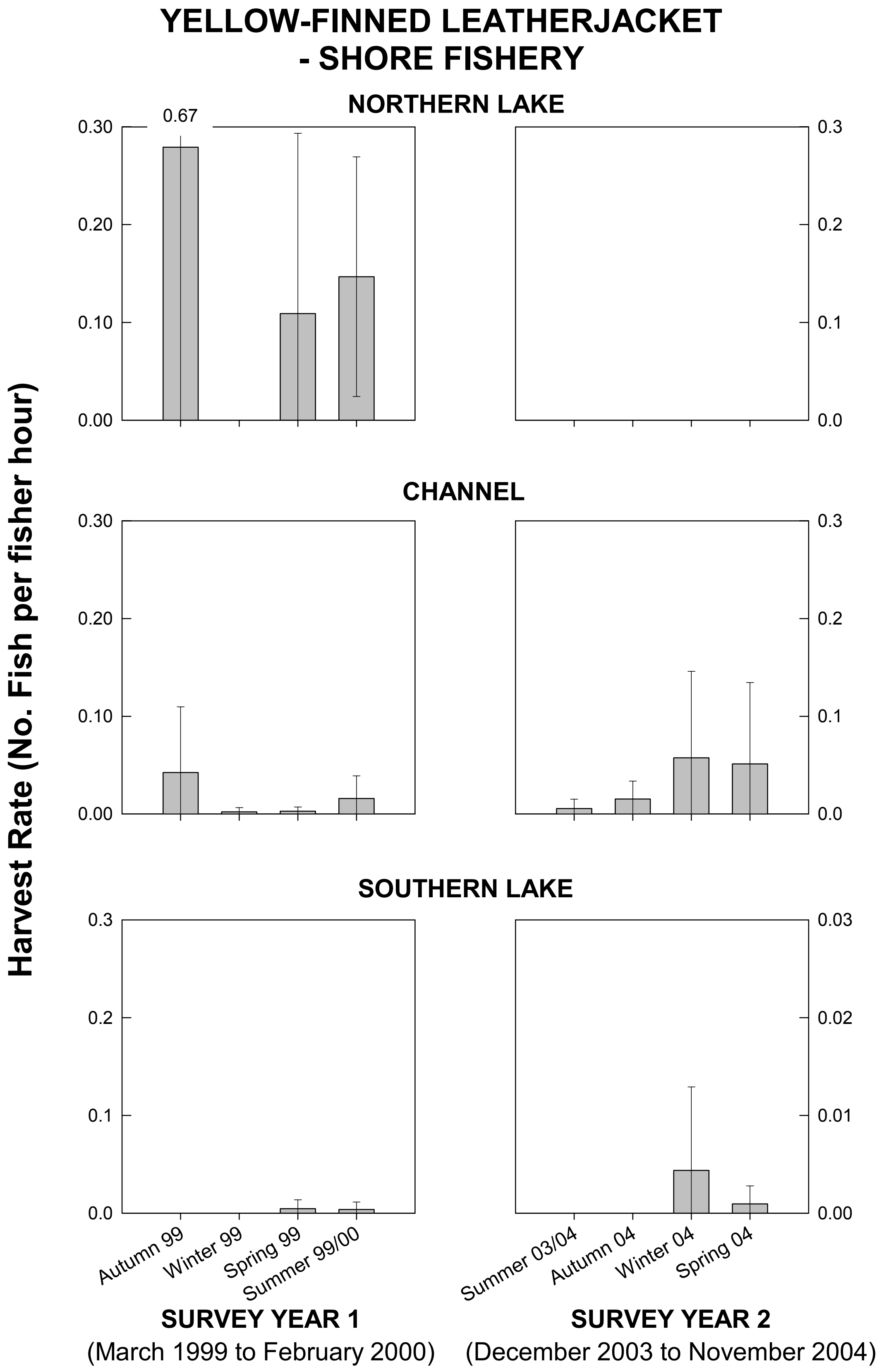

Figure 21. Recreational harvest rate estimates (fish per fisher hour) with 95% confidence intervals for yellow-finned leatherjacket taken by shore-based fishers in the Northern Lake, Swansea Channel and Southern Lake areas for each survey year.

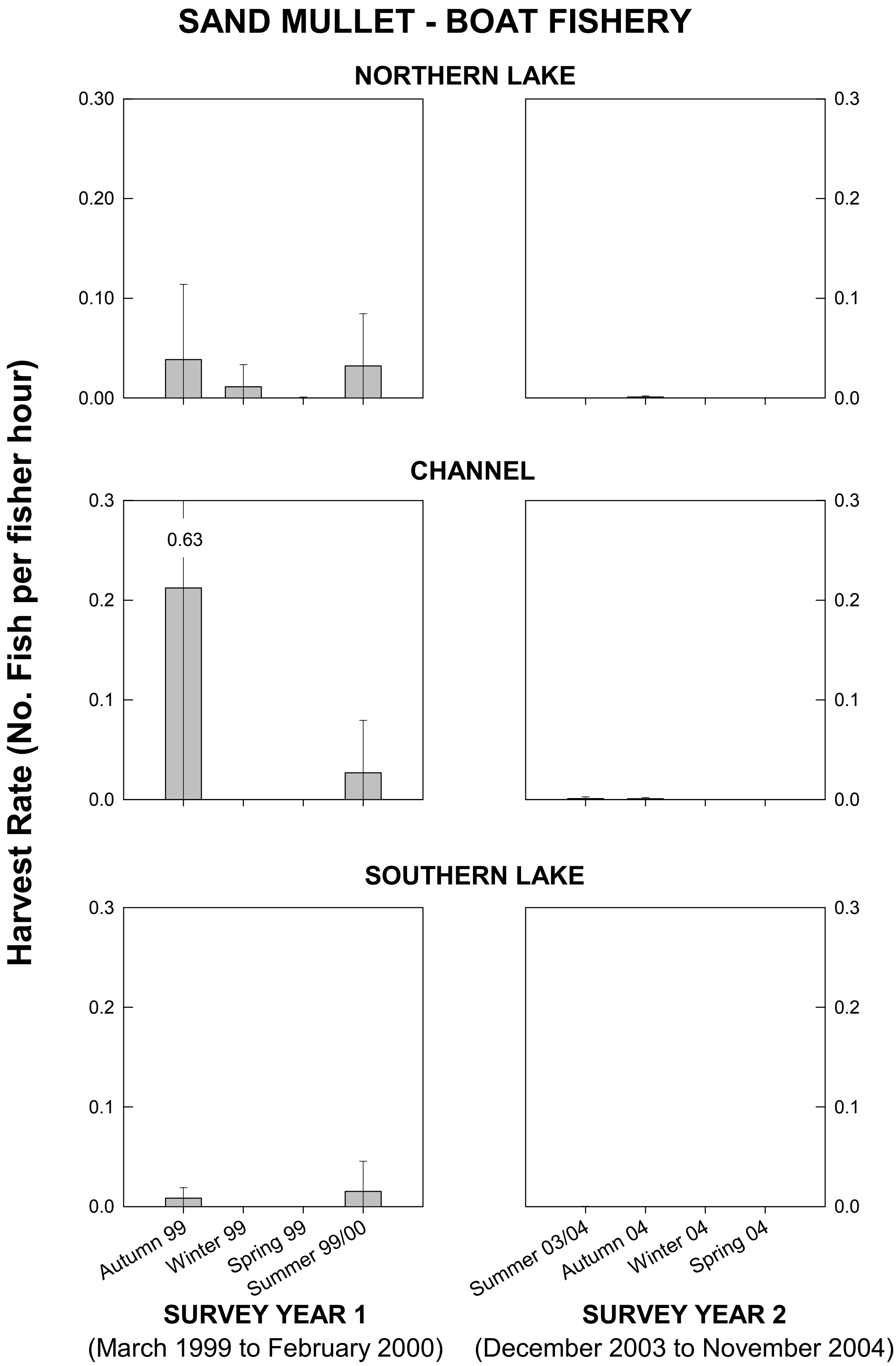

Figure 22. Recreational harvest rate estimates (fish per fisher hour) with 95% confidence intervals for sand mullet taken by boat-based fishers in the Northern Lake, Swansea Channel and Southern Lake areas for each survey year.

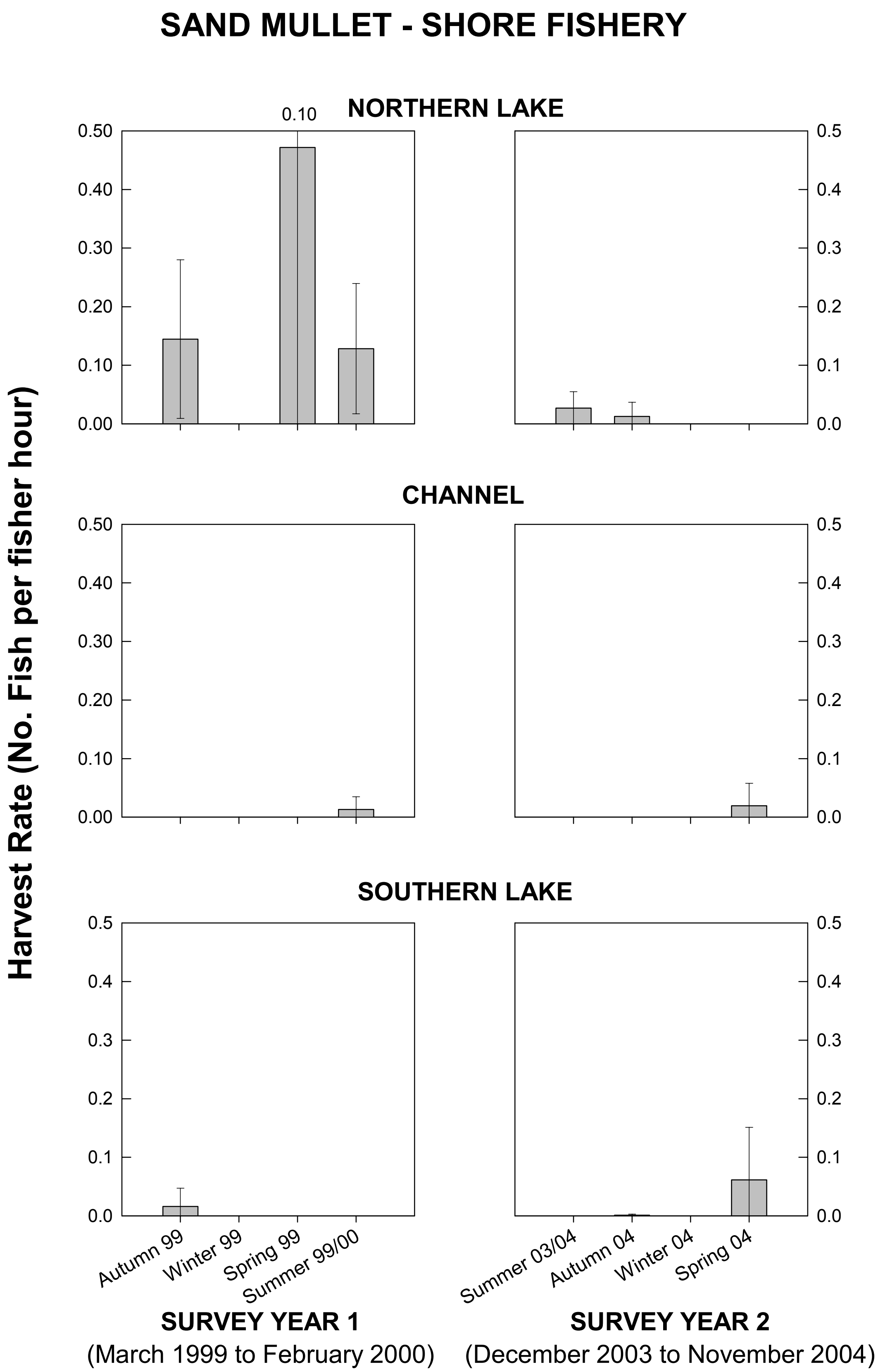

Figure 23. Recreational harvest rate estimates (fish per fisher hour) with 95% confidence intervals for sand mullet taken by shore-based fishers in the Northern Lake, Swansea Channel and Southern Lake areas for each survey year.

4.3.2. Size-frequency distributions

Descriptive statistics of all measurements taken for each taxon by boat-based and shore-based fishers during each survey period are presented in Appendices 2 - 4. Here, we present length frequency distributions and comparisons between survey periods (shore and boat fisheries combined) for the main species of recreational importance.

4.3.2.1. Trumpeter whiting

A comparison of the length frequency distributions between the two survey periods shows great similarity between survey years (Fig. 24). There was no change in the mean and median fork lengths of trumpeter whiting between survey years (Fig. 24).

4.3.2.2. Luderick

A comparison of the length frequency distributions between the two survey periods shows that luderick taken during the second survey year were, on average, larger than those harvested during the first survey year (Fig. 25). Luderick harvested during the second survey year had larger mean and median fork lengths (Fig. 25).

4.3.2.3. Blue swimmer crab

A comparison of the length frequency distributions between the two survey periods shows that the crabs taken during the second survey year were, on average, larger than those harvested during the first survey year (Fig. 26). Blue swimmer crabs harvested during the second survey year had larger mean and median carapace lengths (Fig. 26).

4.3.2.4. Yellowfin bream

A comparison of the length frequency distributions between the two survey periods shows that yellowfin bream taken during the second survey year were, on average, larger than those harvested during the first survey year (Fig. 27). Yellowfin bream harvested during the second survey year had larger mean and median fork lengths (Fig. 27).

4.3.2.5. Dusky flathead

A comparison of the length frequency distributions between the two survey periods shows that dusky flathead taken during the second survey year were, on average, larger than those harvested during the first survey year (Fig. 28). Dusky flathead harvested during the second survey year had larger mean and median fork lengths but it should be noted that the minimum legal length for this species was increased from 33 cm TL to 36 cm TL in the period between the surveys (Fig. 28).

4.3.2.6. Tailor

A comparison of the length frequency distributions between the two survey periods shows that tailor taken during the second survey year were, on average, larger than those harvested during the first survey year (Fig. 29). Tailor harvested during the second survey year had larger mean and median fork lengths (Fig. 29).

4.3.2.7. Common Squid

A comparison of the length frequency distributions between the two survey periods shows that common squid taken during the second survey year were, on average, larger than those harvested during the first survey year (Fig. 30). Squid harvested during the second survey year had larger mean and median mantle lengths (Fig. 30).

4.3.2.8. Sand whiting

A comparison of the length frequency distributions between the two survey periods shows that sand whiting taken during the second survey year were, on average, larger than those harvested during the first survey year (Fig. 31). Sand whiting harvested during the second survey year had larger mean and median fork lengths (Fig. 31).

4.3.2.9. Large-toothed flounder

A comparison of the length frequency distributions between the two survey periods shows that large-toothed flounder taken during the second survey year were, on average, larger than those harvested during the first survey year (Fig. 32). Large–toothed flounder harvested during the second survey year had larger mean and median total lengths (Fig. 32).

4.3.2.10. Yellow-finned leatherjacket

A comparison of the length frequency distributions between the two survey periods showed little similarity (Fig. 33). Yellow-finned leatherjackets harvested during the second survey year had the same mean length but smaller median total length indicating smaller fish were taken during the second survey year (Fig. 33).

4.3.2.11. Sand mullet

A comparison of the length frequency distributions between the two survey periods shows that sand mullet taken during the second survey year were, on average, larger than those harvested during the first survey year (Fig. 34). Sand mullet harvested during the second survey year had larger mean and median fork lengths (Fig. 34).

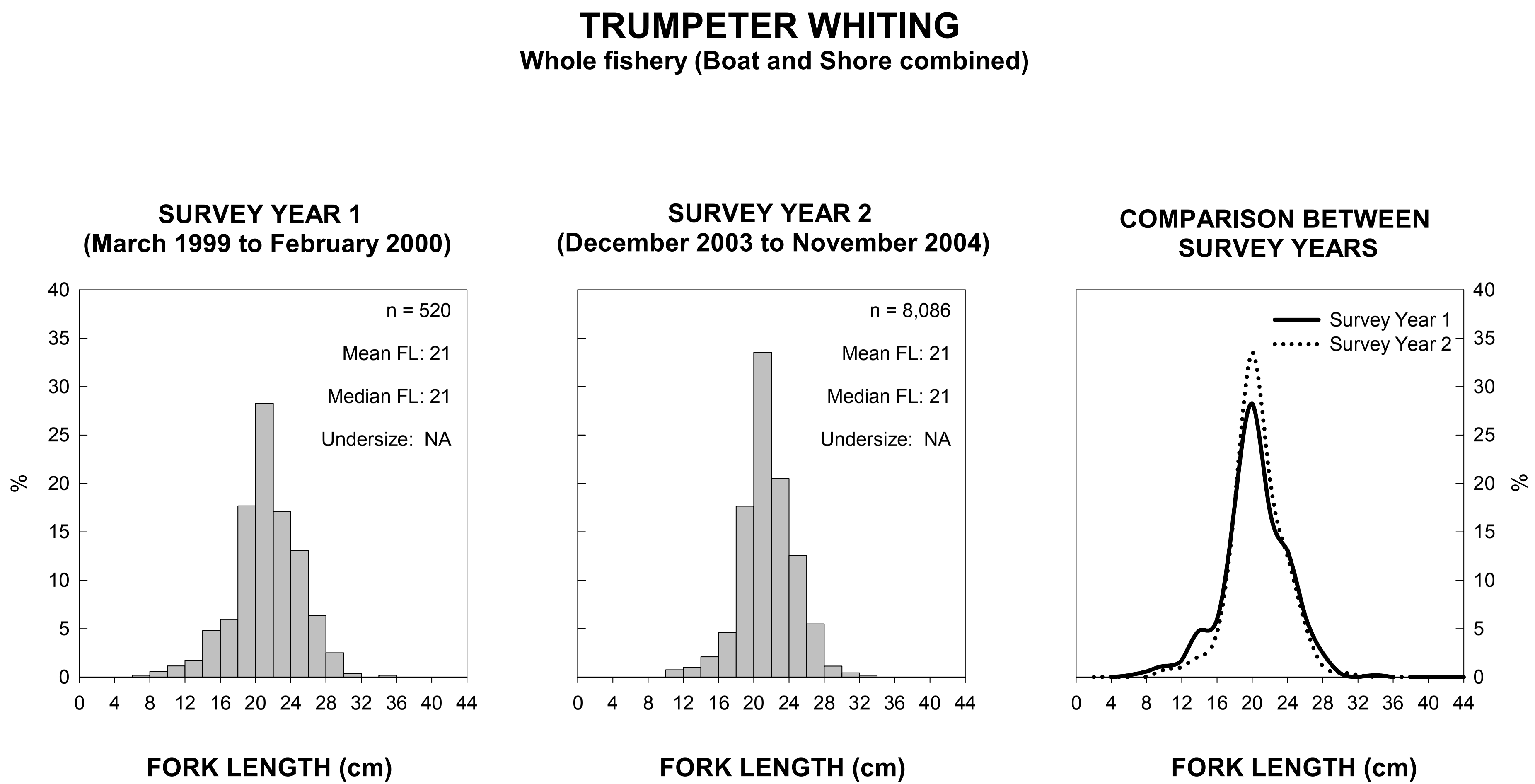

Figure 24. Trumpeter whiting – annual length frequency distributions and comparison between survey years for the whole recreational fishery in Lake Macquarie.

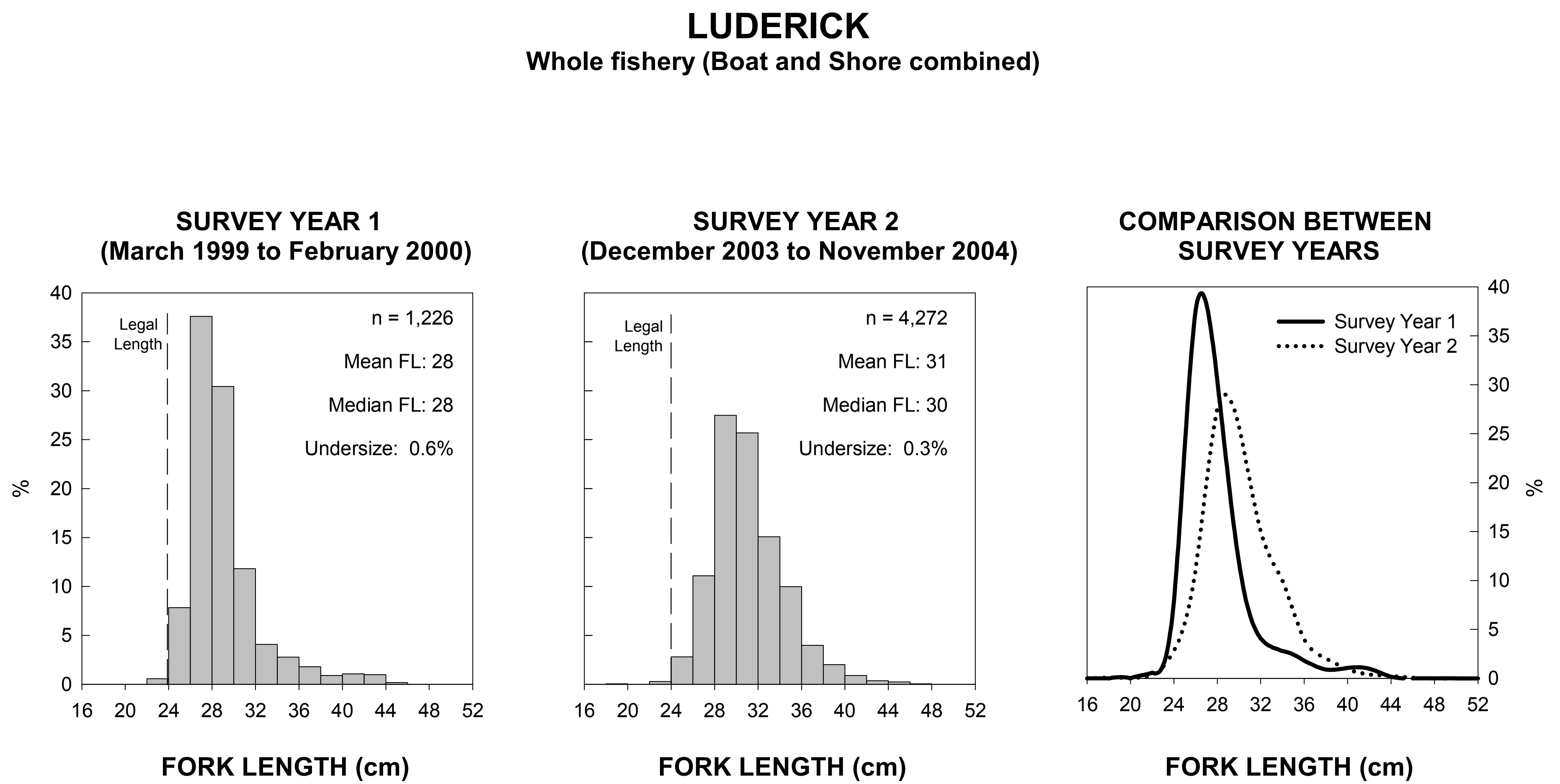

Figure 25. Luderick – annual length frequency distributions and comparison between survey years for the whole recreational fishery in Lake Macquarie.

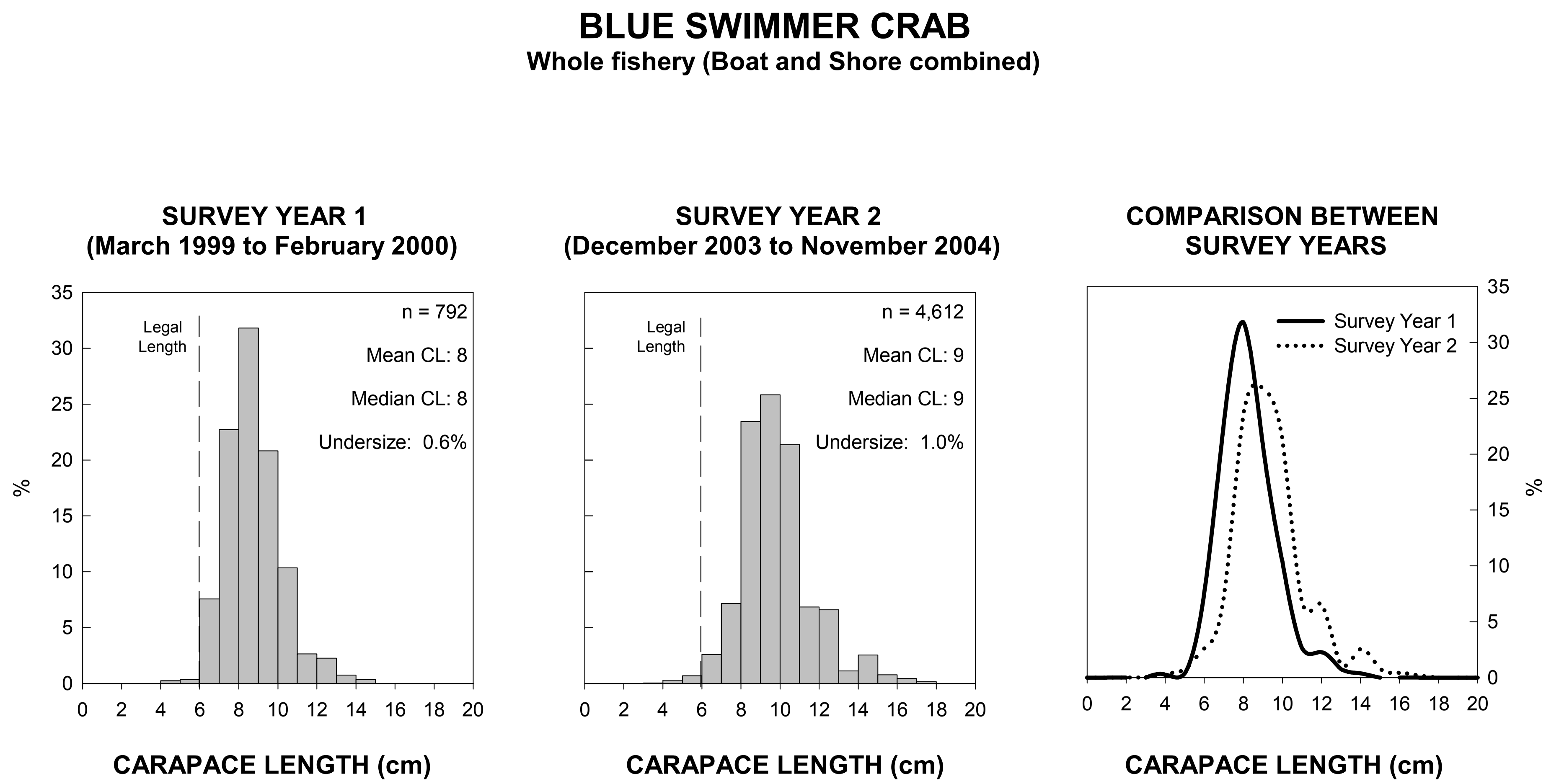

Figure 26. Blue swimmer crab – annual length frequency distributions and comparison between survey years for the whole recreational fishery in Lake Macquarie.

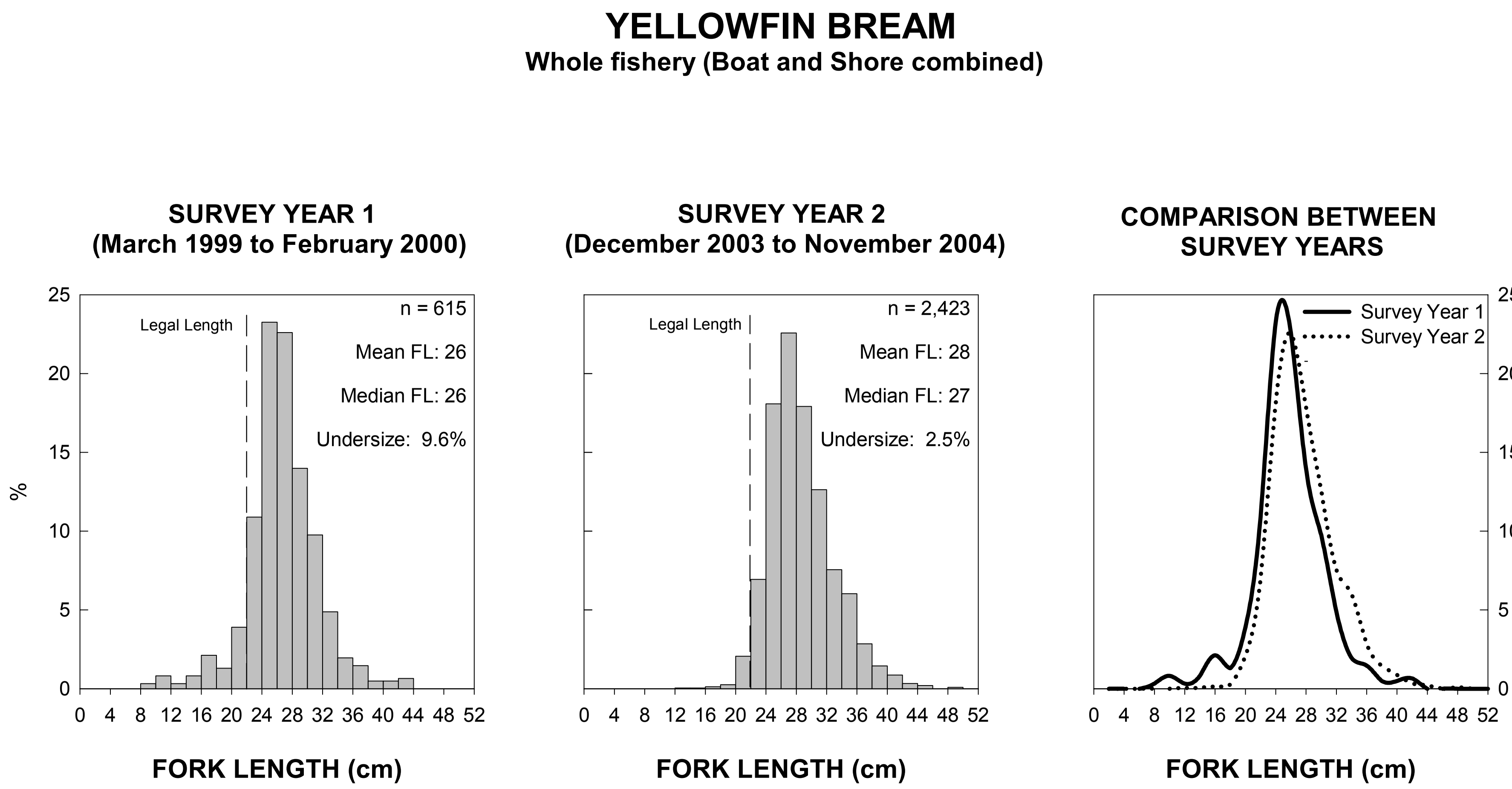

Figure 27. Yellowfin bream – annual length frequency distributions and comparison between survey years for the whole recreational fishery in Lake Macquarie.

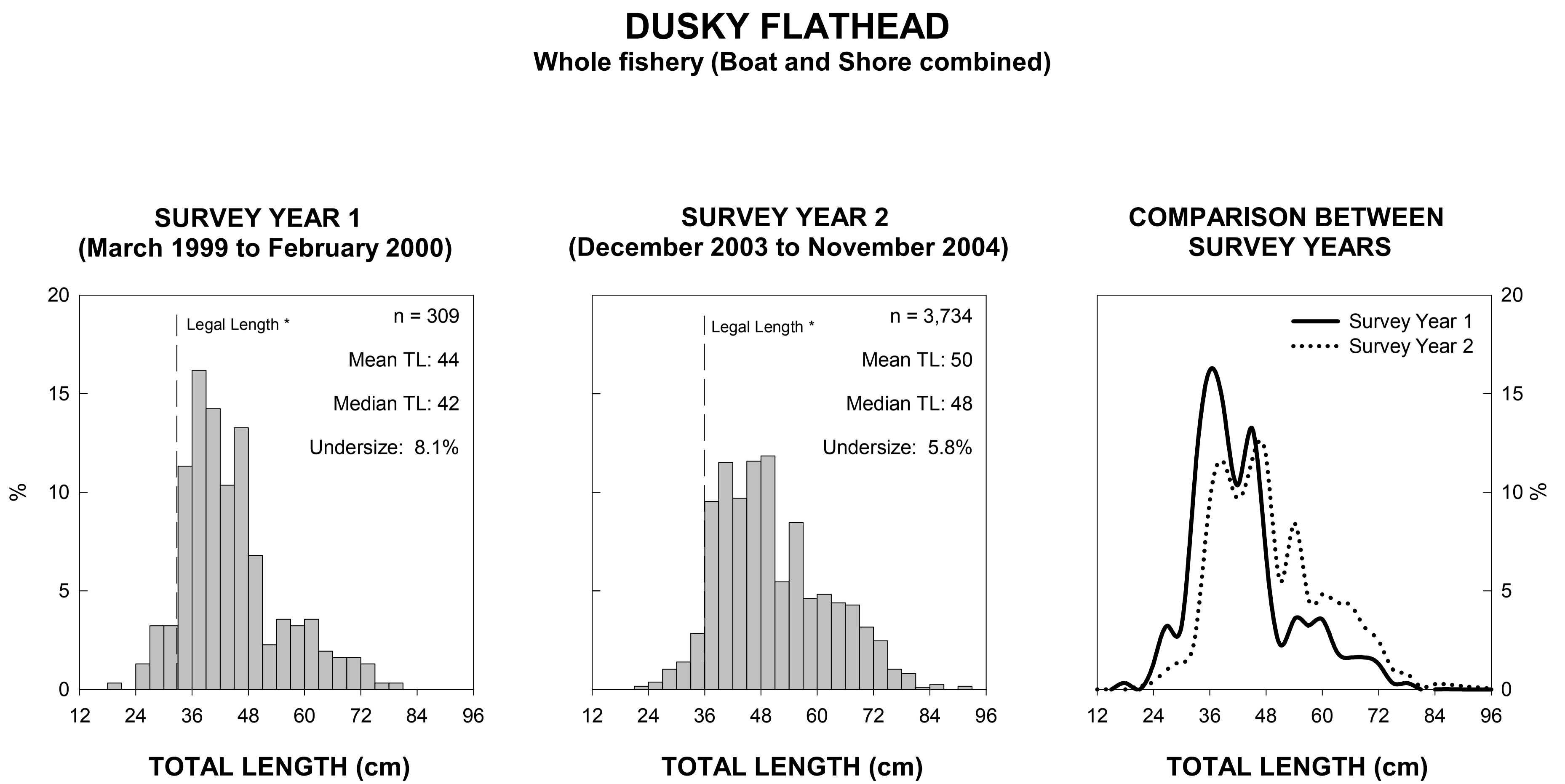

Figure 28. Dusky flathead – annual length frequency distributions and comparison between survey years for the whole recreational fishery in Lake Macquarie.

TAILOR

Whole fishery (Boat and Shore combined)

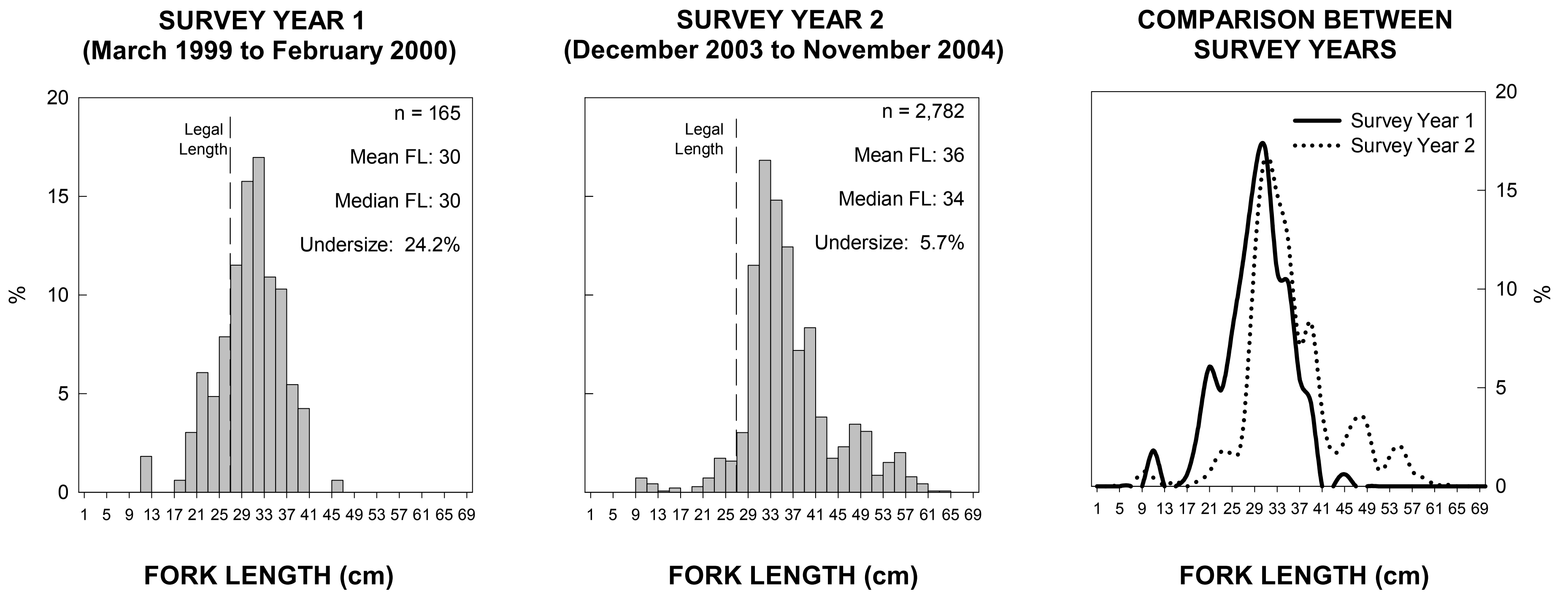

Figure 29. Tailor – annual length frequency distributions and comparison between survey years for the whole recreational fishery in Lake Macquarie.

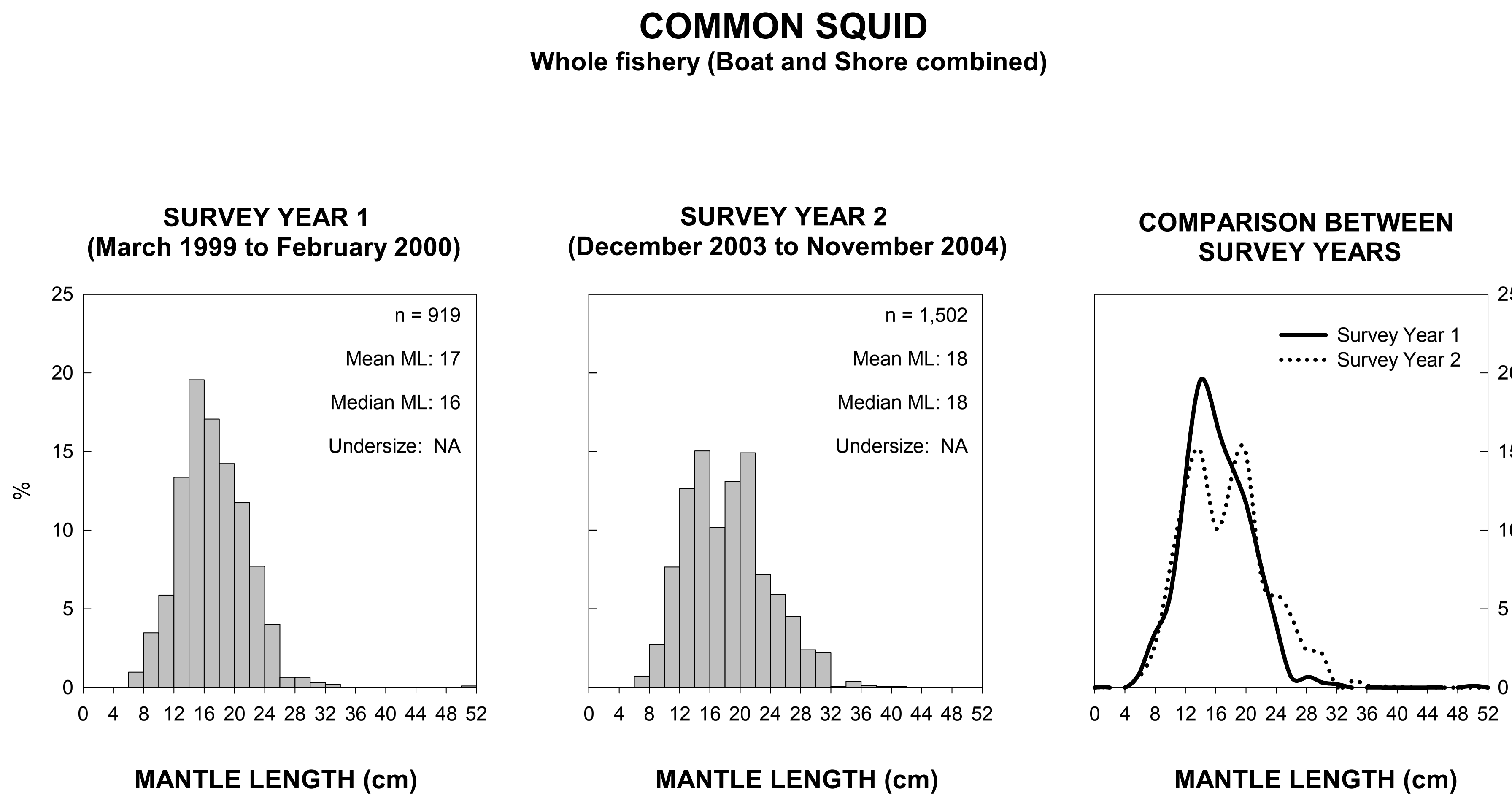

Figure 30. Common squid – annual length frequency distributions and comparison between survey years for the whole recreational fishery in Lake Macquarie.

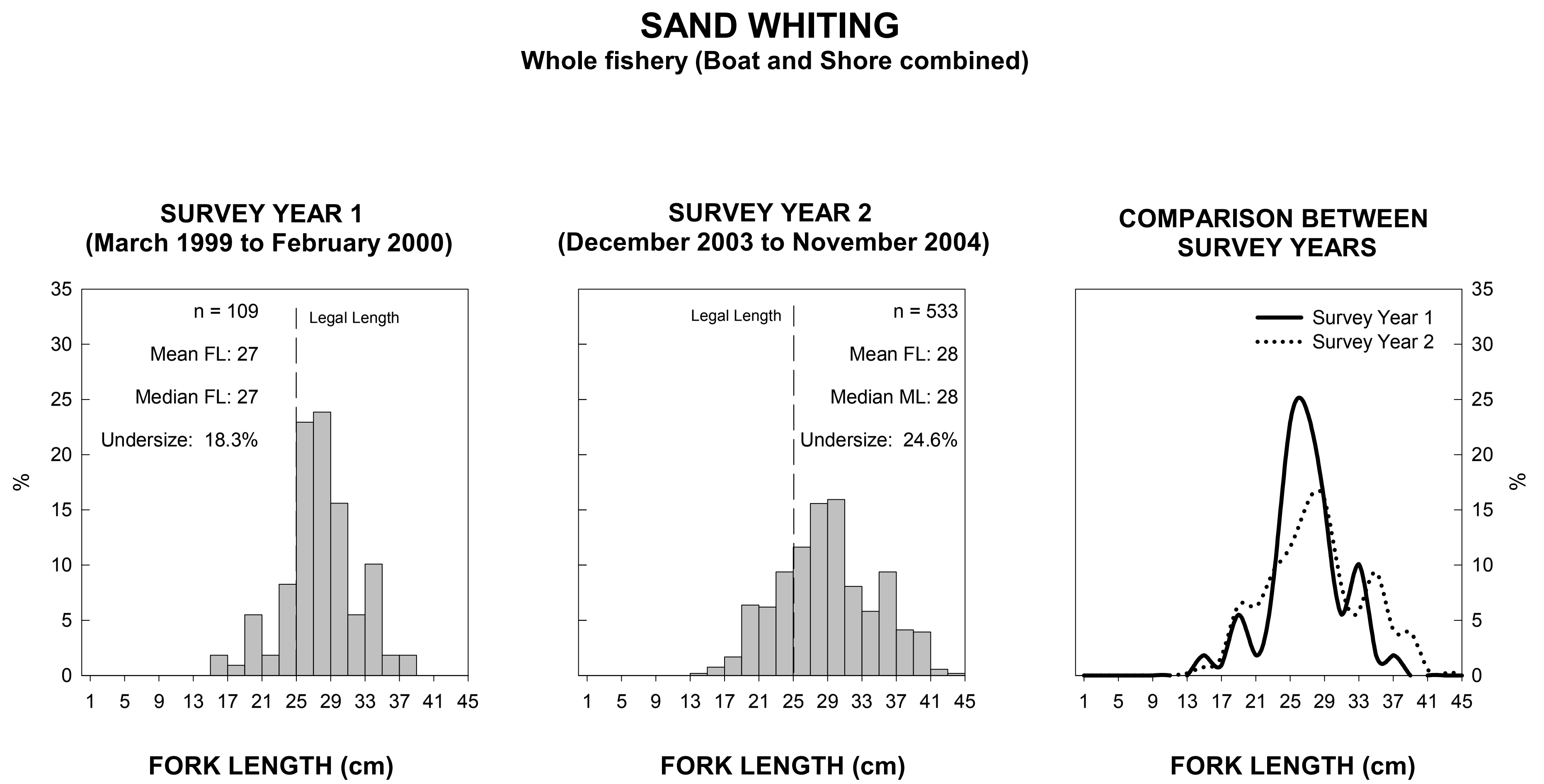

Figure 31. Sand whiting – annual length frequency distributions and comparison between survey years for the whole recreational fishery in Lake Macquarie.

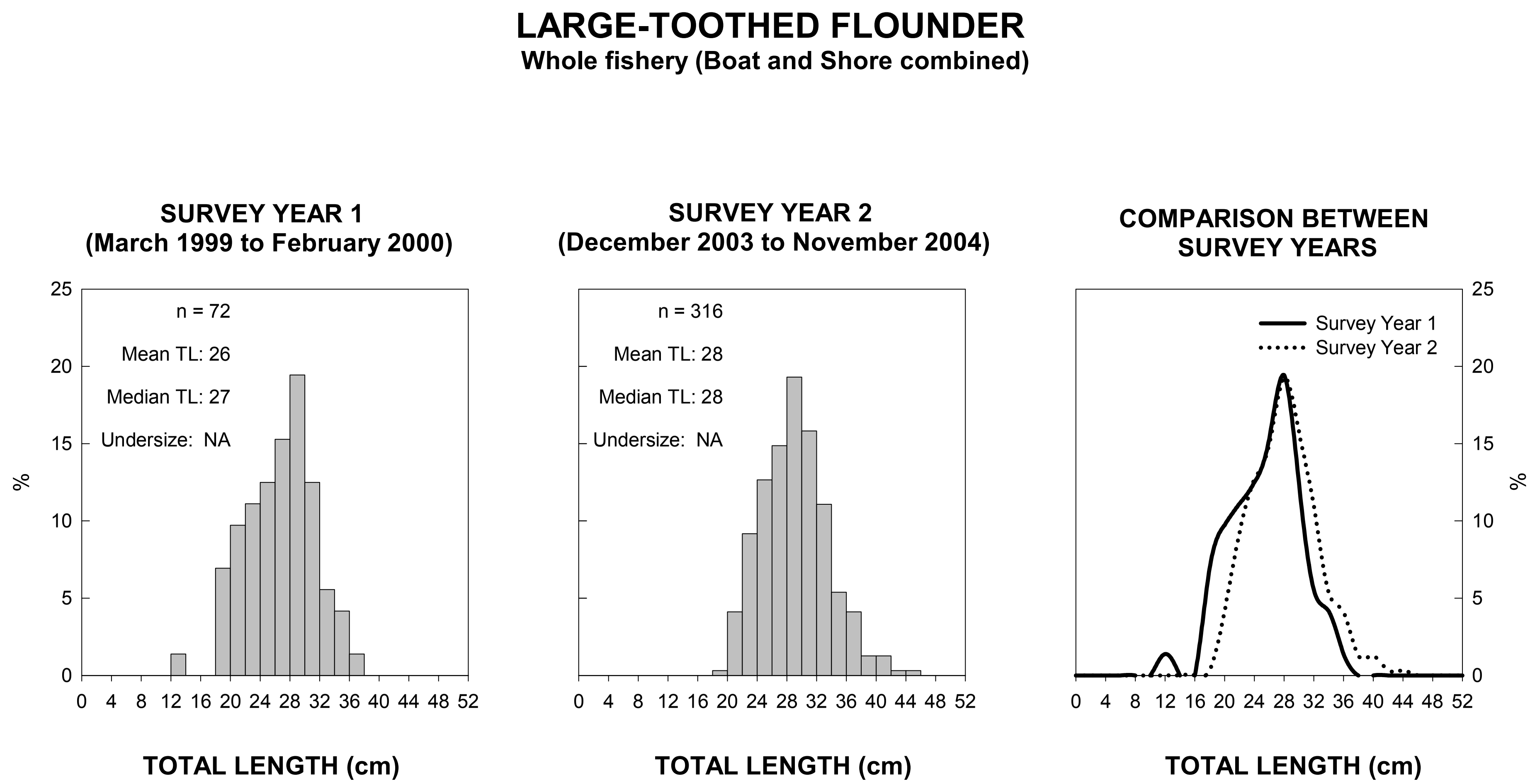

Figure 32. Large-toothed flounder – annual length frequency distributions and comparison between survey years for the whole recreational fishery in Lake Macquarie.

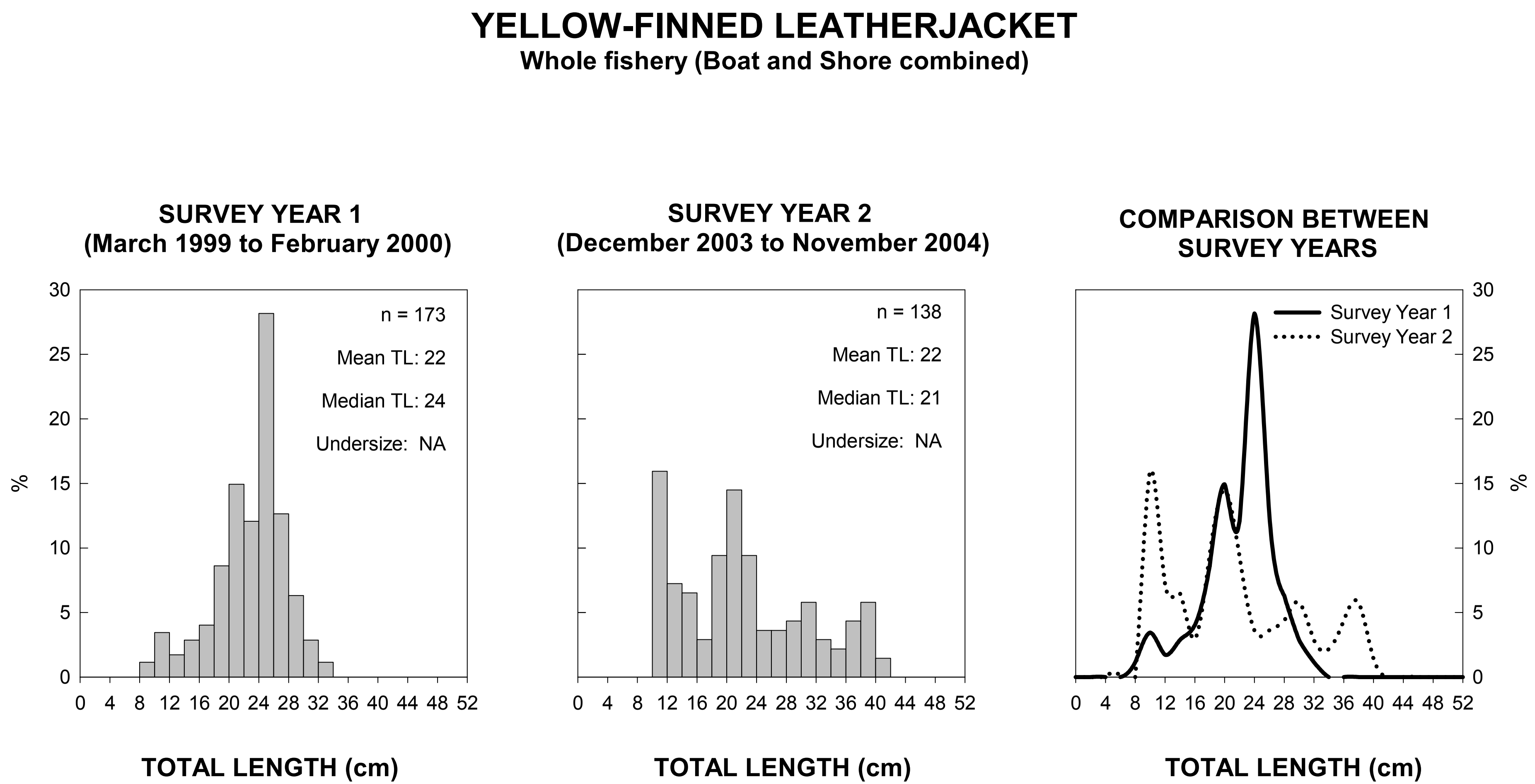

Figure 33. Yellow-finned leatherjacket – annual length frequency distributions and comparison between survey years for the whole recreational fishery in Lake Macquarie.

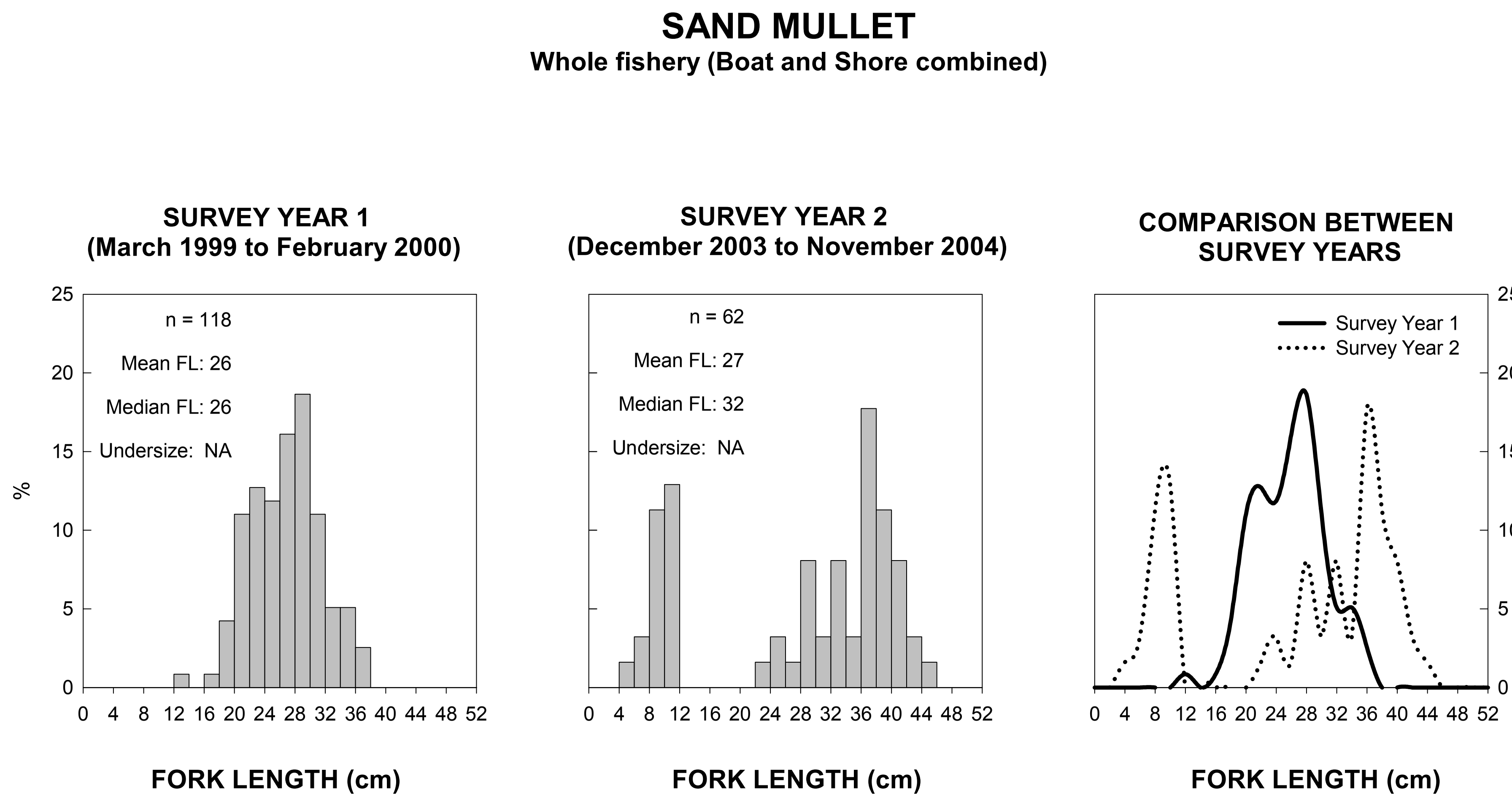

Figure 34. Sand mullet – annual length frequency distributions and comparison between survey years for the whole recreational fishery in Lake Macquarie.

5. DISCUSSION

The establishment of Lake Macquarie as a Recreational Fishing Haven (RFH) has changed the allocation of fisheries resources in this waterway between the recreational and commercial sectors. The removal of access for commercial fishers to Lake Macquarie occurred during May 2002 thereby creating additional recreational fishing opportunities. This report focuses on comparisons made between two separate daytime recreational fishing surveys of Lake Macquarie. The first annual survey was done during the pre-RFH period (March 1999 to February 2000) and the second annual survey was done during the post-RFH period (December 2003 to November 2004). These annual surveys provide a snapshot of the recreational fishery of Lake Macquarie before RFH implementation and after RFH implementation. However, the representativeness of these two unreplicated survey periods as measures of pre-RFH and post-RFH conditions within the recreational fishery of Lake Macquarie remains unknown.

The assessment of environmental disturbance or impacts arising from management interventions is made difficult because it is often uncertain whether a causal relationship exists between the management event (e.g. establishment of a RFH) that has occurred and any changes in fish populations or the recreational fishery that are measured at a later time. The changes in the recreational fishery that have been detected following the implementation of the RFH may be in part attributable to the impact of the management intervention and/or may be in part attributable to natural fluctuations in fish abundance and catchability. These can be large in an open system that allows migratory fish stocks to enter and leave the Lake. Nonetheless, the comparison between the two annual survey periods does show that real differences have occurred in the Lake Macquarie fishery since the first pre-RFH survey period.

Have there been changes in the recreational fishery since the exclusion of commercial fishing by the establishment of Lake Macquarie as a RFH? In an extractive fishery the estimation of harvest provides a direct measure of the impact of fishing. Thus, changes in the harvest (number and weight of fish, crabs and cephalopods) and the relative composition of the harvest between annual survey periods are important measures that were used to assess change in the recreational fishery through time. We found no significant difference in the total annual harvest of fish, crabs and cephalopods, by number or weight, between survey periods for the whole fishery (Tables 3 & 4). The recreational harvest in both survey years was dominated by relatively few taxa, however, the composition and relative contribution of these dominant taxa changed markedly between survey years (Tables 3 & 4). The recreational harvest of trumpeter whiting (119.8% by number, 138.2% by weight), dusky flathead (119.3% by number, 232.5% by weight), tailor (205.8% by number, 539.2% by weight) and sand whiting (158.5% by number, 169.7% by weight) was significantly greater ($p<0.05$) in the second survey year (Tables 3 & 4). In contrast, the recreational harvest of common squid (-56.5% by number, -51.5% by weight), yellow-finned leatherjacket (-85.5% by number, -82.7% by weight) and sand mullet (-93.5% by number, -93.6% by weight) was significantly less ($p<0.05$) in the second survey year (Tables 3 & 4). Increased harvest levels during the second survey year were recorded for yellowfin bream (16.2% by number, 47.9% by weight) and luderick (0.3% by number, 30.6% by weight) but these changes were not statistically significant (Tables 3 & 4). Blue swimmer crab (-44.9% by number, -26.7% by weight) and flat-tail mullet (-49.1% by number, -31.9% by weight) had lower harvest levels during the second survey period but these changes were not statistically significant (Tables 3 & 4). The harvest of large-toothed flounder was greater in the second survey period (49.6% by number but not statistically significant, 96.0% by weight $p<0.05$). These findings indicate that the post-RFH recreational fishery in Lake Macquarie was very different to the fishery that had existed prior to the implementation of the RFH.

A better understanding of these changes between survey periods in the Lake Macquarie recreational fishery can be achieved by considering the factors that influence the size of harvest levels and how they may have changed since the first survey year. The major factors that influence the size of the recreational harvest are fishing effort, harvest rates and the size of fish, crabs and cephalopods taken. A discussion of each of these main factors follows.

Fishing effort can influence the total harvest in two ways. Fishing effort can have a direct effect as measured by absolute changes in the time spent fishing (assuming harvest rate remains constant) and also an indirect effect which could be due to changes in the direction or targeting of fishing effort. The total fishing effort (boat and shore combined) in the fishery showed little change between survey periods (about 2.3% overall – not statistically significant – Table 2). However, different trends were evident in the boat-based and shore-based fisheries. The fishing effort expended in the larger boat-based fishery increased by about 12.8% during the second survey year but this change was not statistically significant. This additional boat-based fishing effort may have contributed to increases in the harvest of species that are targeted by boat-based drift fishing, such as, dusky flathead, large-toothed flounder and trumpeter whiting. Interestingly, there was a statistically significant reduction of about 22.4% in the level of fishing effort expended in the smaller shore-based fishery during the second survey year. This decreased fishing effort was mainly due to the exclusion of recreational fishers from the hot water outlet of the Eraring power station. This part of the Lake had been very popular with shore-based fishers during the Winter and Spring seasons of the first survey year. The hot water outlet site had been characterised previously by many large catches of luderick. The observed changes (increases or decreases) in harvest levels for different species cannot be explained by changes in effort alone. The proportional changes in recreational harvest between survey years are much larger than the corresponding proportional changes in fishing effort. This is true for both the boat-based and shore-based fisheries in Lake Macquarie.

Changes in targeting may also help explain changes in harvest between survey years. It is plausible that less favoured species are targeted by recreational fishers whenever it becomes difficult to catch their favoured species. This behaviour leads to the targeting of whatever is available at the time and usually occurs when favoured species are less accessible to the recreational fishery. For example, changes in targeting behaviour would be expected to shift away from favoured species during periods of low abundance, low catchability or when the available resource is being used heavily by many commercial and recreational users as in the case of the pre-RFH fishery in Lake Macquarie. Conversely, changes in targeting behaviour would be expected to shift towards favoured species during periods of high abundance, high catchability or when the fishing pressure on the available resource is reduced by excluding a large user-group (i.e. the commercial sector) as in the case of the post-RFH fishery in Lake Macquarie.

Do the seasonal harvest rate data for the boat-based and shore-based fisheries indicate any major changes in fishing quality since the first survey year? Seasonal trends are evident in the harvest rate data, however, these data are highly variable making it difficult to detect statistically significant differences between survey years (see Figs. 2 to 23). Trumpeter whiting, dusky flathead, tailor and sand whiting all had significant increases in recreational harvest, by number, during the second survey year. For these species, these observations were supported by the seasonal harvest rate comparisons made between the survey years. All of the significant harvest rate differences detected between corresponding seasons indicated that for these species the harvest rates were better during the post-RFH survey year. Common squid, yellow-finned leatherjacket and sand mullet all had significant decreases in recreational harvest, by number, during the second survey year. Seasonal harvest rate comparisons that were significantly different for common squid and yellow-finned leatherjacket indicated lower harvest rates during the post-RFH year, with the exception of a comparison between Autumn seasons which indicated that the harvest rate of common squid in the Swansea Channel area was better during the second year. The harvest rate data for sand mullet were too imprecise for the detection of any significant seasonal differences. Yellowfin bream and large-toothed flounder harvests were estimated to be greater during the second year but these trends were not statistically significantly different between years. Even so, all of the significant harvest rate differences detected between corresponding seasons indicated that for these two species, the harvest rates were better during the post-RFH survey year. The estimated harvest of blue swimmer crab had decreased since the first survey year but this trend was not statistically significant. Unfortunately, the harvest rate data for blue swimmer crab were too imprecise for the detection of any significant seasonal differences. The recreational harvest of luderick, by number, remained relatively constant between survey years. Interestingly, a comparison of the Spring seasons showed that the shore-based luderick harvest rate from the Southern Lake area had been significantly better during the first survey year. This was the only significant statistical difference detected for any seasonal harvest rate comparison involving luderick and may be explained by the exclusion of recreational fishers from the Eraring hot water outlet during the second survey year.

In summary, the harvest rate data have provided evidence of major changes in the Lake Macquarie fishery since the first survey year. These changes in seasonal harvest rates may be attributed to the effects of many inter-related factors, such as: (a) the availability of fish resulting from the removal of commercial fishing and/or natural fluctuations in abundance; (b) changes in targeting practices; and (c) increases in angler skill levels and technological improvements in fishing gear (e.g. the increased use of soft plastic lures may have led to increased harvest rates of dusky flathead).

Is there any evidence to indicate that the size of fish, crabs and cephalopods has changed since the first survey year? Changes in the size of fish can be assessed: (a) directly by comparing length frequency distributions, and their associated mean and median lengths; and (b) indirectly by comparing proportional changes in harvest levels (total number of individuals compared to total weight) between survey years. The change in size is inferred whenever the percentage change in harvest by number differs from the percentage change in harvest by weight. For example, when the percentage change by weight is greater than the percentage change by number, it can be inferred that the average size of fish has increased. Conversely, when the percentage change in harvest by weight is less than the percentage change by number, it can be inferred that the average size of fish has decreased.

An examination of comparative length frequency information, mean and median lengths between survey years indicated that most species were harvested at larger sizes during the post-RFH survey year. The mean and median sizes of dusky flathead, sand whiting, tailor, common squid, yellowfin bream, luderick, blue swimmer crab, large-toothed flounder and sand mullet were all larger during the second survey year (Figs. 24 to 34). The observed increase in mean size for dusky flathead was 6cm, which was 3cm more than the increase in minimum legal length that had been implemented since the first survey period. Interestingly, the increases in the mean and median size of common squid, blue swimmer crab and sand mullet occurred during the second survey year when their estimated harvests (number and weight) had decreased. Trumpeter whiting had identical mean and median lengths during each of the survey years. Yellow-finned leatherjacket taken during the second survey year had a smaller median length but identical mean length to fish taken during the first survey period (Fig.33).

Similar observations were made when comparing the relative changes in harvest (percentage number versus percentage weight) for these same species (Tables 3 and 4). Large increases in size during the second survey year were inferred for dusky flathead and tailor, moderate size increases were inferred for trumpeter whiting, sand whiting, yellowfin bream, luderick, blue swimmer crabs, common squid, large-toothed flounder and yellow-finned leatherjacket (Tables 3 and 4). No change in size was evident for sand mullet (Tables 3 and 4).

The removal of commercial fishing after the establishment of the RFH in 2002 meant that fish previously harvested by commercial fishers were now available to the recreational sector only. This management change may have led to an overall decrease in fishing pressure and a concomitant reduction in the rate of fishing mortality (commercial and recreational combined) on the fish, crab and squid stocks within Lake Macquarie. Any reduction in fishing effort or fishing mortality rate may allow the standing stocks of fish, crabs and squid some additional time to grow before they are harvested. If so, it would be expected that the mean and median sizes of many species should increase within the Lake Macquarie fishery. This is consistent with the increases in sizes observed during the post-RFH survey year.

6. CONCLUSIONS

This recreational fishing survey provides evidence of a relatively productive recreational fishery in Lake Macquarie and Swansea Channel. Comparisons made between two separate daytime recreational fishing surveys (the first done during the pre-RFH period and this second survey done during the post-RFH period) indicate that the post-RFH recreational fishery was very different to the fishery that existed prior to the implementation of the RFH. We documented statistically significant increases in recreational harvest for some prized recreational species and also some significant decreases for some other important recreational species. Overall, the indicators of recreational fishing quality that we examined indicated that the post-RFH fishery had improved in many ways since the pre-RFH survey period. A summary of the evidence provided in this report is that:

(a) the recreational harvest in both survey years was dominated by a relatively small number of taxa, however, the composition and relative contribution of these dominant taxa changed markedly between survey years. These changes occurred even though there was no significant difference between survey years in the total annual harvest, by number or weight, for the whole fishery;

(b) the recreational harvest of dusky flathead, tailor, sand whiting and trumpeter whiting (number and weight) and large-toothed flounder (weight only) had increased significantly during the post-RFH survey year;

(c) the recreational harvest of common squid, yellow-finned leatherjacket and sand mullet, by number and weight, had decreased significantly during the post-RFH survey year;

(d) total fishing effort (boat and shore combined) showed little change (about 2.3%), however, different trends were evident in the boat-based and shore-based fisheries. Fishing effort in the larger boat-based fishery increased by about 12.8% but this change was not statistically significant. In contrast, there was a statistically significant reduction of about 22.4% in the level of shore-based fishing.

(e) seasonal harvest rate comparisons between survey years tended to confirm the increasing or decreasing trends found in the annual recreational harvest estimates for the main species;

(f) comparisons of length frequency information, mean and median lengths between survey years indicated that most species were harvested at larger sizes during the post-RFH survey year. The mean and median sizes of dusky flathead, sand whiting, tailor, common squid, yellowfin bream, blue swimmer crab, large-toothed flounder and sand mullet were all larger during the second survey year.

7. RECOMMENDATIONS

1. This survey provides the first snapshot (point estimate) of the Lake Macquarie recreational fishery following the establishment of the waterway as a RFH. On-site surveys of recreational fishing are valuable tools for collecting information to describe the status of a fishery and any changes that may have occurred since previous survey periods. On-site surveys of the recreational fishery should be repeated regularly (every 3-5 years) to monitor the recreational fishery in Lake Macquarie.

2. It would be prudent and cost-effective to incorporate some biological sampling of key recreational species (e.g. age composition and reproductive biology) into any repeat survey work. Biological information will be invaluable for interpreting and understanding the factors that influence major changes in fish populations between survey periods.

3. Before future surveys or monitoring programmes are done in Lake Macquarie, it is recommended that statistical power analyses 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.

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9. APPENDICES

Appendix 1. Location of recognized boat ramps around Lake Macquarie.

Ramp No.	Ramp Location
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 - Fishermen's Co-op
37	Swansea - Coon Island 1 off Wallarah Street
38	Swansea - Coon Island 2 off Wallarah Street

Appendix 2. The number of individuals observed (N), the number of individuals measured (n), size range (cm), median length (cm), and mean lengths (cm) for all taxa recorded with recreational fishers (boat and shore-based fishers combined) in the Lake Macquarie fishery during each survey year.

		TOTAL FISHERY									
		SURVEY YEAR 1 (March 1999 to February 2000)					SURVEY YEAR 2 (December 2003 to November 2004)				
COMMON NAME	SCIENTIFIC NAME	N	n	Range	Median	Mean	N	n	Range	Median	Mean
Batfish, Silver	*Monodactylus argenteus*	1	1	14	14.0	14.0	23	14	8 to 14	11.0	11.2
Bigeye, Red	*Priacanthus spp.*	13	13	25 to 28	26.0	26.4	-	-	-	-	-
Blackfish, Rock	*Girella elevata*	2	2	25 to 26	25.5	25.5	3	3	24 to 30	29.0	27.7
Bream, Black	*Acanthopagrus butcheri*	3	3	25 to 27	26.0	26.0	-	-	-	-	-
Bream, Yellowfin	*Acanthopagrus australis*	646	615	8 to 43	26.0	26.2	2546	2423	13 to 48	27.0	28.2
Butterfish, Striped	*Scatophagus argus*	-	-	-	-	-	6	6	20 to 31	21.5	23.2
Calamari, Southern	*Sepioteuthis australis*	11	7	23 to 36	28.0	28.9	81	73	8 to 45	30.0	28.4
Cobia	*Rachycentron canadum*	1	1	71	71.0	71.0	2	2	120 to 146	133.0	133.0
Crab, Blue Swimmer	*Portunus pelagicus*	1064	792	4 to 14	8.0	8.2	2516	2306	2 to 17	9.0	9.3
Crab, Hairy-backed	*Charybdis natator*	1	-	-	-	-	-	-	-	-	-
Crab, Mud	*Scylla serrata*	32	31	7 to 15	9.0	9.5	23	19	9 to 15	12.0	11.9
Cuttlefish	*Sepia spp.*	-	-	-	-	-	15	15	10 to 22	20.0	17.9
Dolphin Fish	*Coryphaena hippurus*	4	3	44 to 58	58.0	53.3	-	-	-	-	-
Eel, Long-Finned	*Anguilla reinhardtii*	-	-	-	-	-	1	1	44	44.0	44.0
Eel, Short-Finned	*Anguilla australis*	-	-	-	-	-	10	10	40 to 51	46.0	46.0
Eels	*Anguilliformes*	1	1	65	65.0	65.0	-	-	-	-	-
Flathead, Dusky	*Platycephalus fuscus*	322	311	20 to 80	42.0	43.7	1922	1867	22 to 98	48.0	49.9

Appendix 2, continued.

		TOTAL FISHERY									
COMMON NAME	SCIENTIFIC NAME	SURVEY YEAR 1 (March 1999 to February 2000)					SURVEY YEAR 2 (December 2003 to November 2004)				
		N	n	Range	Median	Mean	N	n	Range	Median	Mean
Flathead, Eastern Blue-Spotted	*Platycephalus caeruleopunctatus*	13	13	30 to 45	38.0	37.8	2	2	30 to 45	37.5	37.5
Flathead, Long-Spined	*Platycephalus longispinis*	1	1	24	24.0	24.0	1	1	30	30.0	30.0
Flathead, Marbled	*Platycephalus marmoratus*	1	1	51	51.0	51.0	6	5	40 to 68	52.0	52.4
Flathead, Northern Sand	*Platycephalus arenarius*	1	1	44	44.0	44.0	1	1	32	32.0	32.0
Flathead, Tiger	*Neoplatycephalus richardsoni*	1	1	68	68.0	68.0	-	-	-	-	-
Flounder, Large-Toothed	*Pseudorhombus arsius*	74	72	13 to 36	27.0	26.1	352	316	19 to 44	28.0	28.4
Flounder, Small-Toothed	*Pseudorhombus jenynsii*	73	66	12 to 40	26.0	26.1	144	139	10 to 41	27.0	27.6
Garfish, River	*Hyporhamphus regularis*	72	27	19 to 29	24.0	23.9	144	88	18 to 34	25.0	25.3
Garfish, Sea	*Hyporhamphus australis*	25	24	17 to 29	24.0	23.8	56	45	19 to 37	30.0	29.5
Goatfish, Blue-Striped	*Upeneichthys lineatus*	1	-	-	-	-	-	-	-	-	-
Gurnard, Red	*Chelidonichthys kumu*	-	-	-	-	-	3	3	30 to 35	32.0	32.3
Herring, Giant	*Elops machnata*	1	1	62	62.0	62.0	-	-	-	-	-
Herring, Southern	*Herklotsichthys castelnaui*	125	125	5 to 20	10.0	10.7	31	28	7 to 13	8.0	8.7
Kingfish	*Seriola lalandi*	3	3	23 to 76	55.0	51.3	14	13	36 to 80	62.0	60.0
Leatherjacket, Chinaman	*Nelusetta ayraudi*	5	-	-	-	-	23	23	18 to 48	24.0	26.0
Leatherjacket, Fan-Bellied	*Monacanthus chinensis*	78	63	10 to 32	25.0	24.2	36	35	20 to 45	30.0	30.0
Leatherjacket, Rough	*Scobinichthys granulatus*	7	7	20 to 32	26.0	25.3	12	12	12 to 37	33.0	31.1

Appendix 2, continued.

COMMON NAME	SCIENTIFIC NAME	TOTAL FISHERY									
		SURVEY YEAR 1 (March 1999 to February 2000)					SURVEY YEAR 2 (December 2003 to November 2004)				
		N	n	Range	Median	Mean	N	n	Range	Median	Mean
Leatherjacket, Six-Spined	*Meuschenia freycineti*	154	116	7 to 33	18.0	17.7	57	43	8 to 38	23.0	23.2
Leatherjacket, Yellow-Finned	*Meuschenia trachylepis*	249	173	8 to 32	24.0	22.4	170	138	10 to 40	20.5	21.7
Longtom, Stout	*Tylosurus gavialoides*	9	8	29 to 105	61.0	60.1	20	18	39 to 106	68.5	67.5
Luderick	*Girella tricuspidata*	1293	1226	22 to 44	28.0	28.5	2432	2136	19 to 46	30.0	30.6
Mackerel, Frigate	*Auxis thazard*	-	-	-	-	-	1	1	36	36.0	36.0
Mackerel, Slimy	*Scomber australasicus*	-	-	-	-	-	14	14	25 to 36	27.0	27.6
Morwong, Red	*Cheilodactylus fuscus*	-	-	-	-	-	1	1	28	28.0	28.0
Mullet, Fan-Tail	*Mugil georgii*	8	3	25 to 28	26.0	26.3	9	9	22 to 27	24.0	24.7
Mullet, Flat-Tail	*Liza argentea*	121	80	17 to 38	28.0	27.3	231	210	18 to 49	30.0	31.5
Mullet, Sand	*Myxus elongatus*	297	118	13 to 37	26.0	26.1	96	62	5 to 45	32.0	27.4
Mullet, Sea	*Mugil cephalus*	2	2	32 to 33	32.5	32.5	32	30	21 to 46	24.5	28.8
Mulloway	*Argyrosomus hololepidotus*	6	6	58 to 99	68.0	70.8	7	7	57 to 146	73.0	93.1
Octopus	*Octopus spp.*	1	-	-	-	-	30	-	-	-	-
Perch, Butterfly	*Caesioperca lepidoptera*	-	-	-	-	-	1	1	35	35.0	35.0
Ray, Shovelnose	*Rhinobatidae*	1	1	75	75.0	75.0	2	2	57 to 85	71.0	71.0
Salmon, Australian	*Arripis trutta*	1	1	58	58.0	58.0	18	18	42 to 80	55.0	58.2
Scorpioncod, Red	*Scorpaena cardinalis*	-	-	-	-	-	1	1	28	28.0	28.0

Appendix 2, continued.

COMMON NAME	SCIENTIFIC NAME	TOTAL FISHERY									
		SURVEY YEAR 1 (March 1999 to February 2000)					SURVEY YEAR 2 (December 2003 to November 2004)				
		N	n	Range	Median	Mean	N	n	Range	Median	Mean
Seapike, Long-Finned	*Dinolestes lewini*	-	-	-	-	-	6	6	32 to 44	33.5	35.8
Seapike, Striped	*Sphyraena obtusata*	1	1	30	30.0	30.0	35	35	20 to 50	30.0	33.6
Shark, Wobbegong	*Orectolobus spp.*	-	-	-	-	-	1	1	58	58.0	58.0
Silver biddy	*Gerres subfasciatus*	-	-	-	-	-	3	3	28 to 32	30.0	30.0
Snapper	*Pagrus auratus*	101	95	8 to 54	27.0	26.3	253	250	11 to 45	29.0	28.8
Sole, Black	*Synaptura nigra*	1	-	-	-	-	-	-	-	-	-
Squid, Arrow	*Nototodarus gouldi*	1	1	12	12.0	12.0	-	-	-	-	-
Squid, Common	*Photololigo spp.*	1296	919	6 to 50	16.0	16.6	1963	1502	6 to 40	18.0	17.8
Stingarees & Black Stingrays	*Urolophidae & Dasyatididae*	-	-	-	-	-	3	-	-	-	-
Surgeon Fish	*Acanthuridae*	1	1	27	27.0	27.0	1	1	34	34.0	34.0
Sweep, Silver	*Scorpis lineolatus*	1	1	15	15.0	15.0	10	10	16 to 32	18.0	19.6
Tailor	*Pomatomus saltatrix*	206	165	11 to 45	30.0	30.0	1544	1391	10 to 64	34.0	35.9
Tarwhine	*Rhabdosargus sarba*	71	61	18 to 31	24.0	23.9	123	109	17 to 46	26.0	25.6
Teraglin	*Atractoscion aequidens*	5	5	40 to 45	42.0	41.8	-	-	-	-	-
Trevally, Black (Spinefoot)	*Siganus spp.*	74	33	10 to 19	14.0	14.5	1	1	12	12.0	12.0
Trevally, Silver	*Pseudocaranx dentex*	8	8	23 to 59	25.0	29.1	53	53	17 to 59	29.0	32.0
Trumpeter, Six-Lined	*Pelates quadrilineatus*	14	10	6 to 10	7.5	7.7	12	4	8 to 12	9.5	9.8

Appendix 2, continued.

COMMON NAME	SCIENTIFIC NAME	TOTAL FISHERY									
		SURVEY YEAR 1 (March 1999 to February 2000)					SURVEY YEAR 2 (December 2003 to November 2004)				
		N	n	Range	Median	Mean	N	n	Range	Median	Mean
Whiting, Sand	*Sillago ciliata*	111	109	15 to 38	27.0	27.3	645	533	14 to 45	28.0	28.5
Whiting, School	*Sillago flindersi*	7	7	21 to 26	25.0	24.3	9	9	21 to 26	24.0	23.8
Whiting, Trumpeter	*Sillago maculata*	696	520	7 to 34	21.0	20.7	5541	4043	9 to 33	21.0	21.0
Wirrah	*Acanthistius ocellatus*	3	3	28 to 30	28.0	28.7	-	-	-	-	-
Wrasse, Crimson-Banded	*Notolabrus gymnogenis*	2	2	24 to 31	27.5	27.5	3	3	22 to 30	30.0	27.3
Yellowtail	*Trachurus novaezelandiae*	1	1	27	27.0	27.0	78	43	15 to 36	24.0	24.2

- no observations or measurements made

Appendix 3. The number of individuals observed (N), the number of individuals measured (n), size range (cm), median length (cm), and mean lengths (cm) for all taxa recorded with boat-based recreational fishers in the Lake Macquarie fishery during each survey year.

		BOAT-BASED FISHERY													
COMMON NAME	SCIENTIFIC NAME	SURVEY YEAR 1 (March 1999 to February 2000)							SURVEY YEAR 2 (December 2003 to November 2004)						
		N	n	Min	Max	Range	Median	Mean	N	n	Min	Max	Range	Median	Mean
Bigeye, Red	*Priacanthus spp.*	13	13	25	28	25 to 28	26.0	26.4	-	-			-	-	-
Blackfish, Rock	*Girella elevata*	-	-			-	-	-	1	1	29	29	29	29.0	29.0
Bream, Black	*Acanthopagrus butcheri*	3	3	25	27	25 to 27	26.0	26.0	-	-			-	-	-
Bream, Yellowfin	*Acanthopagrus australis*	407	391	8	43	8 to 43	26.0	25.9	2131	2026	16	48	16 to 48	27.0	28.0
Calamari, Southern	*Sepioteuthis australis*	2	2	30	35	30 to 35	32.5	32.5	62	59	8	45	8 to 45	30.0	29.2
Cobia	*Rachycentron canadum*	1	1	71	71	71	71.0	71.0	2	2	120	146	120 to 146	133.0	133.0
Crab, Blue Swimmer	*Portunus pelagicus*	1039	784	4	14	4 to 14	8.0	8.3	2476	2266	2	17	2 to 17	9.0	9.3
Crab, Hairy-backed	*Charybdis natator*	1	-	0	0	-	-	-	-	-			-	-	-
Crab, Mud	*Scylla serrata*	32	31	7	15	7 to 15	9.0	9.5	20	16	9	15	9 to 15	11.0	11.6
Cuttlefish	*Sepia spp.*	-	-			-	-	-	12	12	16	22	16 to 22	20.0	19.3
Dolphin Fish	*Coryphaena hippurus*	4	3	44	58	44 to 58	58.0	53.3	-	-			-	-	-
Eel, Short-Finned	*Anguilla australis*	-	-			-	-	-	10	10	40	51	40 to 51	46.0	46.0
Flathead, Dusky	*Platycephalus fuscus*	289	278	20	80	20 to 80	41.0	43.2	1733	1681	22	98	22 to 98	48.0	50.7
Flathead, Eastern Blue-Spotted	*Platycephalus caeruleopunctatus*	13	13	30	45	30 to 45	38.0	37.8	2	2	30	45	30 to 45	37.5	37.5
Flathead, Long-Spined	*Platycephalus longispinis*	1	1	24	24	24	24.0	24.0	1	1	30	30	30	30.0	30.0
Flathead, Marbled	*Platycephalus marmoratus*	-	-			-	-	-	6	5	40	68	40 to 68	52.0	52.4
Flathead, Northern Sand	*Platycephalus arenarius*	1	1	44	44	44	44.0	44.0	1	1	32	32	32	32.0	32.0

Appendix 3, continued.

COMMON NAME	SCIENTIFIC NAME	BOAT-BASED FISHERY													
		SURVEY YEAR 1 (March 1999 to February 2000)							SURVEY YEAR 2 (December 2003 to November 2004)						
		N	n	Min	Max	Range	Median	Mean	N	n	Min	Max	Range	Median	Mean
Flounder, Large-Toothed	*Pseudorhombus arsius*	73	71	13	36	13 to 36	27.0	26.1	332	296	19	44	19 to 44	28.0	28.4
Flounder, Small-Toothed	*Pseudorhombus jenynsii*	72	65	12	40	12 to 40	26.0	26.1	139	134	10	41	10 to 41	27.0	27.6
Garfish, River	*Hyporhamphus regularis*	72	27	19	29	19 to 29	24.0	23.9	84	46	20	30	20 to 30	25.0	24.7
Garfish, Sea	*Hyporhamphus australis*	25	24	17	29	17 to 29	24.0	23.8	46	35	19	37	19 to 37	28.0	28.8
Goatfish, Blue-Striped	*Upeneichthys lineatus*	1	-	0	0	-	-	-	-	-			-	-	-
Gurnard, Red	*Chelidonichthys kumu*	-	-			-	-	-	3	3	30	35	30 to 35	32.0	32.3
Kingfish	*Seriola lalandi*	2	2	23	55	23 to 55	39.0	39.0	11	10	36	80	36 to 80	56.0	58.3
Leatherjacket, Chinaman	*Nelusetta ayraudi*	-	-			-	-	-	20	20	18	48	18 to 48	24.5	26.6
Leatherjacket, Fan-Bellied	*Monacanthus chinensis*	56	46	10	32	10 to 32	25.0	24.2	32	31	20	45	20 to 45	32.0	31.0
Leatherjacket, Rough	*Scobinichthys granulatus*	6	6	20	32	20 to 32	26.0	25.8	9	9	27	37	27 to 37	35.0	33.1
Leatherjacket, Six-Spined	*Meuschenia freycineti*	45	16	11	33	11 to 33	21.5	20.9	18	17	21	33	21 to 33	29.0	28.5
Leatherjacket, Yellow-Finned	*Meuschenia trachylepis*	179	108	9	32	9 to 32	22.5	22.0	125	93	10	40	10 to 40	18.0	20.8
Longtom, Stout	*Tylosurus gavialoides*	3	2	65	72	65 to 72	68.5	68.5	15	14	40	106	40 to 106	68.5	70.6
Luderick	*Girella tricuspidata*	86	67	24	37	24 to 37	28.0	28.7	371	280	23	40	23 to 40	31.0	30.7
Mackerel, Frigate	*Auxis thazard*	-	-			-	-	-	1	1	36	36	36	36.0	36.0
Mackerel, Slimy	*Scomber australasicus*	-	-			-	-	-	14	14	25	36	25 to 36	27.0	27.6
Mullet, Fan-Tail	*Mugil georgii*	-	-			-	-	-	7	7	23	27	23 to 27	25.0	25.3

Appendix 3, continued.

COMMON NAME	SCIENTIFIC NAME	BOAT-BASED FISHERY									
		SURVEY YEAR 1 (March 1999 to February 2000)					SURVEY YEAR 2 (December 2003 to November 2004)				
		N	n	Range	Median	Mean	N	n	Range	Median	Mean
Mullet, Flat-Tail	*Liza argentea*	71	37	20 to 37	28.0	29.3	189	177	18 to 45	30.0	31.3
Mullet, Sand	*Myxus elongatus*	151	64	18 to 37	26.0	26.3	26	26	27 to 45	37.5	37.1
Mullet, Sea	*Mugil cephalus*	-	-	-	-	-	5	4	36 to 46	43.0	42.0
Mulloway	*Argyrosomus hololepidotus*	5	5	58 to 99	67.0	70.6	7	7	57 to 146	73.0	93.1
Octopus	*Octopus spp.*	1	-	-	-	-	26	-	-	-	-
Perch, Butterfly	*Caesioperca lepidoptera*	-	-	-	-	-	1	1	35	35.0	35.0
Ray, Shovelnose	*Rhinobatidae*	1	1	75	75.0	75.0	2	2	57 to 85	71.0	71.0
Salmon, Australian	*Arripis trutta*	-	-	-	-	-	18	18	42 to 80	55.0	58.2
Scorpioncod, Red	*Scorpaena cardinalis*	-	-	-	-	-	1	1	28	28.0	28.0
Seapike, Long-Finned	*Dinolestes lewini*	-	-	-	-	-	2	2	40 to 44	42.0	42.0
Seapike, Striped	*Sphyraena obtusata*	1	1	30	30.0	30.0	34	34	20 to 50	30.0	33.3
Shark, Wobbegong	*Orectolobus spp.*	-	-	-	-	-	1	1	58	58.0	58.0
Silver biddy	*Gerres subfasciatus*	-	-	-	-	-	3	3	28 to 32	30.0	30.0
Snapper	*Pagrus auratus*	97	91	10 to 54	27.0	26.8	247	244	19 to 45	29.0	28.9
Sole, Black	*Synaptura nigra*	1	-	-	-	-	-	-	-	-	-
Squid, Common	*Photololigo spp.*	1200	833	6 to 33	16.0	16.7	1855	1416	6 to 40	18.0	17.8
Stingarees & Black Stingrays	*Urolophidae & Dasyatididae*	-	-	-	-	-	3	-	-	-	-

Appendix 3, continued.

		BOAT-BASED FISHERY													
COMMON NAME	SCIENTIFIC NAME	SURVEY YEAR 1 (March 1999 to February 2000)							SURVEY YEAR 2 (December 2003 to November 2004)						
		N	n	Min	Max	Range	Median	Mean	N	n	Min	Max	Range	Median	Mean
Surgeon Fish	*Acanthuridae*	1	1	27	27	27	27.0	27.0	-	-			-	-	-
Sweep, Silver	*Scorpis lineolatus*	1	1	15	15	15	15.0	15.0	2	2	26	32	26 to 32	29.0	29.0
Tailor	*Pomatomus saltatrix*	176	135	11	45	11 to 45	32.0	31.3	1428	1279	10	64	10 to 64	34.0	36.4
Tarwhine	*Rhabdosargus sarba*	6	2	22	30	22 to 30	26.0	26.0	84	80	18	46	18 to 46	26.0	25.4
Teraglin	*Atractoscion aequidens*	5	5	40	45	40 to 45	42.0	41.8	-	-			-	-	-
Trevally, Silver	*Pseudocaranx dentex*	-	-			-	-	-	43	43	17	50	17 to 50	28.0	29.7
Trumpeter, Six-Lined	*Pelates quadrilineatus*	2	-	0	0	-	-	-	8	-	0	0	-	-	-
Whiting, Sand	*Sillago ciliata*	96	94	19	38	19 to 38	27.5	27.9	593	481	14	45	14 to 45	28.0	28.6
Whiting, School	*Sillago flindersi*	7	7	21	26	21 to 26	25.0	24.3	9	9	21	26	21 to 26	24.0	23.8
Whiting, Trumpeter	*Sillago maculata*	674	498	7	34	7 to 34	21.0	20.7	4975	3493	9	33	9 to 33	21.0	21.2
Wirrah	*Acanthistius ocellatus*	3	3	28	30	28 to 30	28.0	28.7	-	-			-	-	-
Wrasse, Crimson-Banded	*Notolabrus gymnogenis*	1	1	31	31	31	31.0	31.0	2	2	30	30	30	30.0	30.0
Yellowtail	*Trachurus novaezelandiae*	1	1	27	27	27	27.0	27.0	75	40	19	36	19 to 36	24.0	24.9

- no observations or measurements made

Appendix 4. The number of individuals observed (N), the number of individuals measured (n), size range (cm), median length (cm), and mean lengths (cm) for all taxa recorded with shore-based recreational fishers in the Lake Macquarie recreational fishery during each survey year.

COMMON NAME	SCIENTIFIC NAME	SHORE-BASED FISHERY									
		SURVEY YEAR 1 (March 1999 to February 2000)					SURVEY YEAR 2 (December 2003 to November 2004)				
		N	n	Range	Median	Mean	N	n	Range	Median	Mean
Batfish, Silver	*Monodactylus argenteus*	1	1	14	14.0	14.0	23	14	8 to 14	11.0	11.2
Blackfish, Rock	*Girella elevata*	2	2	25 to 26	25.5	25.5	2	2	24 to 30	27.0	27.0
Bream, Yellowfin	*Acanthopagrus australis*	239	224	9 to 42	27.0	26.6	415	397	13 to 45	29.0	29.0
Butterfish, Striped	*Scatophagus argus*	-	-	-	-	-	6	6	20 to 31	21.5	23.2
Calamari, Southern	*Sepioteuthis australis*	9	5	23 to 36	26.0	27.4	19	14	15 to 35	24.0	24.9
Crab, Blue Swimmer	*Portunus pelagicus*	25	8	7 to 9	8.0	7.8	40	40	6 to 16	9.0	9.6
Crab, Mud	*Scylla serrata*	-	-	-	-	-	3	3	13 to 14	14.0	13.7
Cuttlefish	*Sepia spp.*	-	-	-	-	-	3	3	10 to 15	12.0	12.3
Eel, Long-Finned	*Anguilla reinhardtii*	-	-	-	-	-	1	1	44	44.0	44.0
Eels	*Anguilliformes*	1	1	65	65.0	65.0	-	-	-	-	-
Flathead, Dusky	*Platycephalus fuscus*	33	33	24 to 72	47.0	48.2	189	186	23 to 80	41.0	43.3
Flathead, Marbled	*Platycephalus marmoratus*	1	1	51	51.0	51.0	-	-	-	-	-
Flathead, Tiger	*Neoplatycephalus richardsoni*	1	1	68	68.0	68.0	-	-	-	-	-
Flounder, Large-Toothed	*Pseudorhombus arsius*	1	1	27	27.0	27.0	20	20	20 to 40	28.0	28.6
Flounder, Small-Toothed	*Pseudorhombus jenynsii*	1	1	28	28.0	28.0	5	5	18 to 33	30.0	27.0
Garfish, River	*Hyporhamphus regularis*	-	-	-	-	-	60	42	18 to 34	26.0	25.8
Garfish, Sea	*Hyporhamphus australis*	-	-	-	-	-	10	10	25 to 35	32.5	31.8

Appendix 4, continued.

COMMON NAME	SCIENTIFIC NAME	SHORE-BASED FISHERY									
		SURVEY YEAR 1 (March 1999 to February 2000)					SURVEY YEAR 2 (December 2003 to November 2004)				
		N	n	Range	Median	Mean	N	n	Range	Median	Mean
Herring, Giant	*Elops machnata*	1	1	62	62.0	62.0	-	-	-	-	-
Herring, Southern	*Herklotsichthys castelnaui*	125	125	5 to 20	10.0	10.7	31	28	7 to 13	8.0	8.7
Kingfish	*Seriola lalandi*	1	1	76	76.0	76.0	3	3	63 to 71	63.0	65.7
Leatherjacket, Chinaman	*Nelusetta ayraudi*	5	-	-	-	-	3	3	20 to 24	21.0	21.7
Leatherjacket, Fan-Bellied	*Monacanthus chinensis*	22	17	16 to 31	25.0	24.1	4	4	20 to 25	23.0	22.8
Leatherjacket, Rough	*Scobinichthys granulatus*	1	1	22	22.0	22.0	3	3	12 to 33	30.0	25.0
Leatherjacket, Six-Spined	*Meuschenia freycineti*	109	100	7 to 32	17.0	17.2	39	26	8 to 38	20.0	19.7
Leatherjacket, Yellow-Finned	*Meuschenia trachylepis*	70	65	8 to 30	24.0	23.0	45	45	14 to 36	22.0	23.4
Longtom, Stout	*Tylosurus gavialoides*	6	6	29 to 105	54.0	57.3	5	4	39 to 72	57.5	56.5
Luderick	*Girella tricuspidata*	1207	1159	22 to 44	28.0	28.5	2061	1856	19 to 46	30.0	30.6
Morwong, Red	*Cheilodactylus fuscus*	-	-	-	-	-	1	1	28	28.0	28.0
Mullet, Fan-Tail	*Mugil georgii*	8	3	25 to 28	26.0	26.3	2	2	22 to 23	22.5	22.5
Mullet, Flat-Tail	*Liza argentea*	50	43	17 to 38	27.0	25.5	42	33	27 to 49	31.0	32.8
Mullet, Sand	*Myxus elongatus*	146	54	13 to 36	27.0	25.9	70	36	5 to 39	16.5	20.3
Mullet, Sea	*Mugil cephalus*	2	2	32 to 33	32.5	32.5	27	26	21 to 43	23.0	26.7
Mulloway	*Argyrosomus hololepidotus*	1	1	72	72.0	72.0	-	-	-	-	-
Octopus	*Octopus spp.*	-	-	-	-	-	4	-	-	-	-

Appendix 4, continued.

COMMON NAME	SCIENTIFIC NAME	SHORE-BASED FISHERY									
		SURVEY YEAR 1 (March 1999 to February 2000)					SURVEY YEAR 2 (December 2003 to November 2004)				
		N	n	Range	Median	Mean	N	n	Range	Median	Mean
Salmon, Australian	*Arripis trutta*	1	1	58	58.0	58.0	-	-	-	-	-
Seapike, Long-Finned	*Dinolestes lewini*	-	-	-	-	-	4	4	32 to 34	32.5	32.8
Seapike, Striped	*Sphyraena obtusata*	-	-	-	-	-	1	1	45	45.0	45.0
Snapper	*Pagrus auratus*	4	4	8 to 18	15.0	14.0	6	6	11 to 30	26.0	24.0
Squid, Arrow	*Nototodarus gouldi*	1	1	12	12.0	12.0	-	-	-	-	-
Squid, Common	*Photololigo spp.*	96	86	6 to 50	14.0	15.2	108	86	9 to 33	18.0	18.0
Surgeon Fish	*Acanthuridae*	-	-	-	-	-	1	1	34	34.0	34.0
Sweep, Silver	*Scorpis lineolatus*	-	-	-	-	-	8	8	16 to 18	17.5	17.3
Tailor	*Pomatomus saltatrix*	30	30	18 to 32	23.5	23.9	116	112	10 to 56	32.0	30.4
Tarwhine	*Rhabdosargus sarba*	65	59	18 to 31	24.0	23.8	39	29	17 to 34	27.0	26.3
Trevally, Black (Spinefoot)	*Siganus spp.*	74	33	10 to 19	14.0	14.5	1	1	12	12.0	12.0
Trevally, Silver	*Pseudocaranx dentex*	8	8	23 to 59	25.0	29.1	10	10	28 to 59	40.5	41.9
Trumpeter, Six-Lined	*Pelates quadrilineatus*	12	10	6 to 10	7.5	7.7	4	4	8 to 12	9.5	9.8
Whiting, Sand	*Sillago ciliata*	15	15	15 to 30	25.0	24.1	52	52	15 to 40	27.5	27.8
Whiting, Trumpeter	*Sillago maculata*	22	22	8 to 26	22.0	21.1	566	550	10 to 30	20.0	20.0
Wrasse, Crimson-Banded	*Notolabrus gymnogenis*	1	1	24	24.0	24.0	1	1	22	22.0	22.0
Yellowtail	*Trachurus novaezelandiae*	-	-	-	-	-	3	3	15	15.0	15.0

- no observations or measurements made

10. SURVEY PERSONNEL

The following tables present lists of persons who worked in either the 1999/2000 and/or the 2003/2004 survey as field staff. Persons are listed according to their affiliation with an organised group. We again thank all of the following personnel for their valuable contributions to this project.

Survey personnel from the Lake Macquarie Concerned Anglers Group and NSW DPI Fishcare Volunteer program.

Name	Affiliation	Survey Year 1 1999/2000	Survey Year 2 2003/2004
Steve Anderson	1	*	
Tom Archbold	1	*	
Brian Arnold	2		*
Col Austin	1	*	
Liz Bailey	1	*	
Ian Beresford	1		*
Winstone Buffrey	1	*	
George Burrell	1		*
John Cheyne	2		*
Graham Clark	2		*
Frank Druery	1	*	
Bill Gray	1	*	
Patricia Hall	1	*	
Richard Hall	1	*	
Graham Halley	1	*	
Ron Hemsley	1	*	
Brian Hilton	2		*
Jack Howell	1		*
Angelo Iacono	2		*
Lionel Jones	1	*	*
Craig Jones	1	*	
Lionel Jones	1	*	

Survey personnel from the Lake Macquarie Concerned Anglers Group and NSW DPI Fishcare Volunteer program, continued.

Name	Affiliation	Survey Year 1 1999/2000	Survey Year 2 2003/2004
Alan Keft	1	*	
John Lightfoot	1,2	*	*
Jan McLeod	1,2	*	*
John McLeod	1,2	*	*
Dennis Morgan	1	*	
Col Munro	1	*	*
Gary Pearce	1,2	*	*
Allen Rae	1	*	
Ray Searle	2		*
Noel Stoops	1	*	*
Rosalind Stoops	1		*
Kevin Turner	1	*	
Noel Vidler	1	*	
Ray Ward	1	*	
Sam Wilson	1,2	*	*
Gail Young	1		*

Affiliation Key:

1 - Lake Macquarie Concerned Anglers Group

2- NSW DPI Fishcare Volunteers

* denotes participation in either survey year 1 and/or survey year 2

Survey personnel affiliated with B&L Fishing and Cruises.

Name	Survey Year 1 1999/2000	Survey Year 2 2003/2004
Steve Baggs		*
Jason Bennett	*	
Michael Chipchase		*
Brett Corbett	*	*
Adrian Cornwall		*
Ted Doggett		*
Michael Ede		*
Aaron Edwards		*
Dane Haigh		*
Elise Harris		*
Dave Harris	*	
Chris Hird	*	
Ian Hobden		*
Ian Hobden	*	
Ben Howe		*
Steven Jest		*
Clyde Kelton		*
Aaron Kinghorn	*	
Eric McGilvray		*
Tim McGowan	*	
Brad Minors		*
Steve Minors	*	*
Fiona Minors	*	*
Ben Minors	*	
Linda Minors	*	
Norma Minors	*	
Keith Morgan		*
Micheal Mottley		*
Will Paul		*
Merilee Prangell		*
Garth Quick		*
Sharon Simington		*
Ryan Spong	*	

* denotes participation in either survey year 1 and/or survey year 2

Survey personnel affiliated with the Swansea Australian Volunteer Coast Guard.

Name	Survey Year 1 1999/2000	Survey Year 2 2003/2004
Larry Baker	*	
Nola Ellis	*	
Norm Ellis	*	
Allan Ferrier	*	
John Green	*	
Mike Hawkins	*	
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