

# Mail surveys of Tasmanian inland water recreational fisheries: preliminary results and sources of error

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## **Abstract**

*Results of work in progress on the analysis of nine years of standardised Statewide Tasmanian inland fishery mail surveys are described in the context of sources of error and uncertainty in mail questionnaires. Initial results indicate a consistency in response rate, types of responses and realistic results, which allow some reliance to be placed on trends and relative fishery performance. Limited tests for bias due to non-return and recall suggest that these are relatively small. A relatively high return rate and consistency of response are likely to be at least partially influenced by the institutional setting of inland fishery management in Tasmania.*

## **Introduction**

Mail questionnaire surveys can be a low-cost source of extensive data on recreational fisheries. To what degree such survey techniques provide accurate, precise and repeatable data is strongly dependent on a number of factors, all of which influence the number and sources of error. While multiple sources of error are common to all fishery survey techniques, the mail survey has

been frequently viewed as a tool of limited use and applicability. Under certain circumstances, however, routine mail surveys can be used to obtain reasonably reliable data on fishery trends and relative magnitudes. This paper describes such a situation for Tasmanian recreational trout fisheries, the sources of error and the means by which such errors may be quantified, as well as the institutional setting of fishery management, the survey methods and general results and the methods used to estimate sources of error. As this paper is intended only to present the initial results of work in progress, they are given only in summary form. A full treatment of results, errors and trends is to be published elsewhere.

## **The inland fisheries survey**

### ***Institutional setting***

The Inland Fisheries Commission (IFC) is the sole agency responsible for the management of the recreational and commercial fisheries of Tasmanian inland waters. It is a semi-government agency, comprising: a Commission of three representatives

elected from each of three regional recreational fisheries Associations and one State government employee; a permanent staff of 20 personnel including eight enforcement staff. Commission members have a direct input into the activities of IFC staff and into policy development.

The IFC is responsible for the licensing of all recreational fisheries. Licences for trout fishing are issued by the IFC or by agents acting on its behalf, selling licences on commission. Licences for adults (> 17 years) are issued for a full season and for 1, 3 or 14 days with one licence issued for each individual angler. Licences are issued for juveniles (14–17 years) but not for children of less than 14 years of age. The majority of sales are for full season adult licences, typically numbering some 20–25 thousand per annum. The trout fishing season varies slightly in length depending on the species and water being fished, but for the majority of waters the season is of nine months' duration, from August to May.

Licences are issued with details of the angler's name and address, and carbon copies of all licences are returned to the Commission by agents for accounting purposes. Until the late 1980s, licence copies were not returned by agents until the completion of the fishing season.

The primary role of the IFC is the management of the recreational fisheries for introduced trout. Brown trout have established self-sustaining populations throughout Tasmania, with only a few exceptions (Davies 1989), and the majority of inland water recreational fisheries are brown trout fisheries that do not require maintenance through stocking. A limited number of rainbow trout fisheries exist, with most

requiring maintenance or supplementation from stocking programmes.

Prior to 1985, only limited information was available on the status of the more than 500 lake or riverine fisheries in Tasmania. Nicholls (1957; 1958a; 1958b; 1961) described the characteristics of riverine brown trout fisheries based on a combination of licence form surveys and scale collections, but similar work of his on lake fisheries was never published. In 1985, it was decided to initiate a mail questionnaire survey of the population of adult angling licence holders. Following its initial success, judged by a high return rate, the mail survey was repeated annually. Subsequently, questionnaires were also sent to holders of other licence types (juvenile, 3, 14 day) on at least one occasion.

### **Survey aims**

The aims of the survey were to provide summary data on the effort, visitation and catch rates from all waters in Tasmania, at low cost and with definable errors and biases, with an emphasis on:

- the assessment of trends, especially responses to stocking and environmental impacts;
- the relative ranking of waters in terms of effort and harvest;
- fishing methods and preferences of anglers.

The limitations and biases inherent within mail surveys (Brown 1991; Pollock *et al.* 1994) were implicitly recognised from the outset of the surveys.

## Survey method

The survey method was defined by Brown (1991) as a *licence file survey*, in which addresses from licences are used for sampling. Thus, following the return of all licence copies, typically in May, a random selection of 2000 or 10% of full season adult licences was made (whichever was the greater). A standard questionnaire form on a single page (Appendix 1) was sent to the licence holders within 6 weeks of the end of the fishing season, accompanied by an explanatory covering letter and a reply-paid envelope. For the nine years of the survey conducted to date, the questions asked on the front of the form were the same, while questions on the reverse side varied in order to address specific questions of management interest.

## Standard questions

The standard questions were aimed at providing routine information on angler visitation, effort, catch per unit effort and harvest in a standard repeated manner. The questions were in fact based on those first asked by Nicholls (1958a) in his surveys based on returns of licences with a questionnaire on the reverse side, so that longer-term comparison could be made with data derived by him over the 1945–1958 period.

## Supplementary questions

The supplementary questions were aimed at addressing the following issues:

- Location and relative effort associated with angling 'spots' on rivers;
- The blackfish and lobster fisheries (waters, effort, catch);
- Catch of other species;

- Opinions on fishery management;
- Fisheries in farm dams;
- Other angler details (shack ownership, club membership etc.);
- Other details of fishing activities in specific areas (e.g. 'Western Lakes').

Returns were entered into a database and analysed to derive the following statistics for each of up to 175 lakes and 215 rivers and streams:

- Total number of anglers—derived by multiplying the ratio of the number of questionnaire respondents who fished the water to the number of returned questionnaires by the total number of licenced anglers.
- Total effort in angler days exerted—derived by multiplying the total number of anglers by the mean days per season for respondents who fished the water.
- Total harvest of each species—derived by multiplying the total number of anglers by the mean number of fish caught at that water by respondents.
- Mean catch per angler day—derived by dividing the mean number of fish caught by the mean days per season fished at that water.

## Sources of error

In any mail survey there are several sources of error or variability (Pollock *et al.* 1994).

### i) Questionnaire distribution

Errors associated with questionnaire distribution are primarily related to the random nature of the sample. Care must be taken to ensure that the pool of addresses drawn from the population is indeed random in

relation to factors such as residential region, which influences the choice of waters fished, experience and club affiliation, which may influence catch per day estimates. Similarly, the random nature of the returns must be assessed for these factors. This can be statistically evaluated for those factors whose distribution is already known, for example residential region.

## ii) Questionnaire design

The design of a questionnaire, as with an interview session, is another potential source of error or bias. Consistency, simplicity and clarity are all key essentials in the formulation of survey questions. Maintaining a low number of pages and questions facilitates high response rates.

## iii) Non-return bias

A major area of potential error in mail surveys is non-return bias. Return rates for questionnaires from interest groups are frequently higher (typically ranging from 20–60%) than for non-interest groups (ranging from 0.1–15%), but a large proportion of the population sampled does not respond. In recreational fishery surveys, the respondents may be more motivated, experienced and successful and may come from a more restricted geographic area or socio-economic group than occurs in the larger angling population. This can have serious implications for attempts to estimate population-wide estimates of effort and harvest. Outer bounds on errors due to non-return bias can be estimated, assuming extreme high and low performance for non-respondents (Pollock *et al.* 1994), although these bounds are unrealistically wide. Non-return bias may not, however, have a significant impact on the analysis of trends

provided any such bias is consistent from survey to survey.

## iv) Recall

A second major source of potential error in surveys relying on memory of fishing activities is recall bias. Many studies have shown that details of fishing trips are lost to a significant degree over periods of ensuing weeks. These recall biases may not have a single direction however, as anglers may exaggerate small catches, include party catches with their own, forget individual trips and erroneously reduce the size of large bags.

## v) Data analysis

Questionnaire response data are frequently non-normal and skewed in distribution. The use of statistical tests without appropriate transformations or which are not satisfied by the data distribution can lead to major errors in analysis. Estimation of error bounds in survey data on angler numbers can be performed using the binomial distribution, while Poisson type distributions are typical of the catch and effort data.

Catch per unit effort data collected from recreational fisher surveys are typically recorded in terms of fish per hour. Such data cannot be collected from questionnaires based on several months' recall. The use of catch per day data derived from mail surveys therefore requires an assessment of the length of an 'angler day' which can vary depending primarily on the fishing method used and a range of other factors. As several fishing methods can be used at many waters, care must be taken in the interpretation of catch per 'angler day' data.

## Results

### General results of survey

Response rates for the standard survey were stable over the nine years ranging between 42 and 49%. One exception occurred in 1989, when an anomalously low return rate was experienced (33%) thought to be due to the addition of a complex new survey form, subsequently discarded.

Respondents reported fishing at over 230 rivers and 200 lakes. Typically 6–7 waters (including two rivers) accounted for 50% of the total fishing effort expended in the State (Table 1). The relative order of lakes and rivers in terms of effort and angler numbers was remarkably consistent from year to year, with major changes in relative position found for only a small number of lakes, all of which were subject to significant stocking events (e.g. Lake Crescent, Craighourne Dam) or which suffered significant environmental impacts (e.g. Lagoon of Islands, Brushy Lagoon). Little change was noted in catch rates for most lakes over the nine year period, with some exceptions. In contrast, while the relative ranking of rivers in terms of effort was relatively stable, marked interannual changes in catch per unit effort were observed.

Estimates of total effort expended on trout fishing ranged between 400 000 and 500 000 'angler days' per year. Mean lake catch per 'angler day' ranged between 0.2 and 3.2 for brown trout and 0.05 and 1.1 for rainbow trout (for those waters containing those species).

Analysis of postal code data in returned questionnaires in 1986 indicated that most effort on rivers was expended by local residents or by residents of large towns within

or neighbouring the catchments. Fishing in highland lakes was performed almost exclusively by lowland residents, with a strong regional bias. Of the major lakes, Great Lake and Arthurs Lake were primarily fished by northern residents (> 65%), while lakes of the Bronte system, Lake Pedder and Lake Sorell were primarily fished by southern residents (> 60%).

An examination of trends in effort, visitation and catch has shown results consistent with field staff observations, creel results and with expected responses to stocking. A preliminary examination of interannual fluctuations in survey catch figures for waters with self-sustaining populations shows significant correlations with independently derived indices of recruitment, for example in the St Patricks River (Davies *et al.* 1988; Davies and Diggle in press) and in Lake Sorell (Davies unpub. data).

Long-term trends in fishery performance can also be examined by combining results from the 1986–1994 surveys with those derived by Nicholls (1957; 1958a; 1958b; 1961; unpub. data) for lakes and rivers. While Nicholls' data were collected using voluntary return of licences at the end of the season, and response rates were lower than occurred in the recent surveys, the results are still comparable. A significant increase in anglers fishing for trout has taken place in Tasmania since 1945 (Figure 1). This has been accompanied in many waters by significant increases in angler patronage, harvest and effort (Figure 2A, B). Preliminary examination of plots of total harvest against total effort suggest that the fisheries of many lakes are not limited by fishing pressure (Figure 2C).

## Sources of error

### i) Questionnaire distribution

The randomness of address selection was evaluated in two years by comparing the distribution of postal codes in the 10% sample with that assessed for the whole population of adult licence holders. There was no significant difference between the sample and population distributions (Kolmogorov-Smirnoff test,  $p > 0.5$ ).

The randomness of addresses in the respondent data set was also evaluated and again, no significant differences were found between the frequency distributions of postal codes in the respondent data and that in the original mailed sample.

### ii) Questionnaire design

In the IFC surveys, simple questions were used in a consistent, single-page format for obtaining the standard fishery data in all years. Interviews with angling club members indicated that the questions were generally well understood and accepted. The 1989 survey included an additional five pages appended to the standard sheet. This led to a very low return rate (33%) and a statistically significant bias toward fly-fishers (as compared with data from all previous years,  $p < 0.01$  by  $\chi^2$  test). The simpler one page design was reinstated for all future surveys.

In 1988 a supplementary question was asked about estuarine fishing. While few estuarine waters are included within the legal definition of inland waters under the Tasmanian Fisheries Act (1959), responses strongly indicated that respondents did not understand the meaning of the word estuary and this question was therefore discarded in future surveys. Care is taken instead in the interpretation of responses

for several rivers for which estuarine fishing is known to be significant, but which are reported as rivers in responses.

### iii) Non-return bias

As some 50–60% of questionnaires mailed were not returned, it was decided to evaluate non-return bias by the use of prompting letters (Brown 1991). Thus, prompting letters were sent out following the receipt of the majority of responses in 1987, accompanied by a second copy of the survey form and a reply-paid envelope. This elicited a further 322 responses. Data from these responses were analysed as for the unprompted responses, and ratios of numbers of anglers, catch per angler day and days per angler for the most popular waters did not differ significantly. This suggested that non-return, if present, is likely to be small.

### iv) Recall

Specific tests recommended for recall bias include phone interviews or follow-up face to face interviews combined with the normal mail survey. These have not been conducted to date for the IFC survey, primarily due to cost. However a combined test for recall and non-return bias was conducted over four years using low intensity creel surveys on five occasions during the angling season on six popular waters. Anglers were asked to recall catch and days fished at that water up to the date of interview. No attempt was made to count anglers. Combined creel catch per day data were compared with survey data and showed no significant bias for all four years (regression slopes not significantly different from 1.0, all  $p > 0.2$ ).

Bias was detected, however, when comparisons were made between survey data

for 1989 and the result of an intensive road-side interview programme for the Western Lakes, a predominantly fly-fishing area of small, neighbouring lakes. Catch per day data from questionnaires were, on average, twice as high as those recorded in the interview programme. This was at least partially attributable to the method of calculating mail survey catch per day figures for this region, as many anglers fish more than one lake per day in this region.

#### v) Data analysis

To date, analysis of the data has been focussed on developing the summary statistics illustrated in Table 1. While mean figures derived from respondent data are appropriate for estimating total effort and harvest, they are not appropriate for further statistical analysis, which requires either data transformation or the use of median (or other percentile) values for non-parametric tests. Similarly, for reporting the survey statistics to anglers, the use of means is inappropriate due to the tendency of means to be biased upward by the infrequent high values associated with experienced or dedicated anglers. The experience of the 'average' angler at a water is better represented by reporting median values. The analysis of trends and differences using percentile values is currently being conducted for the IFC survey data set.

### Discussion

In summary, the IFC mail survey produces a relatively high return rate (by comparison with other resource management mail surveys) which is remarkably stable from year to year. Tasmanian inland fishery management is of relatively low intensity. It does not rely on high cost stocking programmes,

there are no highly detailed fishery regulations requiring detailed management information for assessing compliance or success and the main need is for 'broad brush' information on how waters are performing relative to one another and how they change with time. Recall and non-return bias in the mail survey, though not completely assessed, appear sufficiently low to warrant use of the summary statistics in a manner suitable for the current level of management. There is, however, a need to quantify error bounds for the summary statistics for each water as much as practicable.

The size and consistency of the return rate, the consistency of the data from year to year (both between survey years and between survey and creel results) and the general acceptance of the survey in the angling body is in large part a reflection of the institutional setting of Tasmanian inland fishery management. The close association between the IFC and its 'client body' and the fact that a semi-autonomous agency exists dedicated almost exclusively to the management of inland fisheries engenders a generally good working relationship between the bulk of the angling body and the IFC. This, combined with the high level of interest by many trout anglers in their sport, enhances angler participation in providing information relevant to management.

It may still, however, be of value to increase the return rate—although only after validating the need by conducting a detailed assessment of non-return bias through interviews (Pollock *et al.* 1994). Increasing return rates can be achieved through a variety of mechanisms including a reward system.

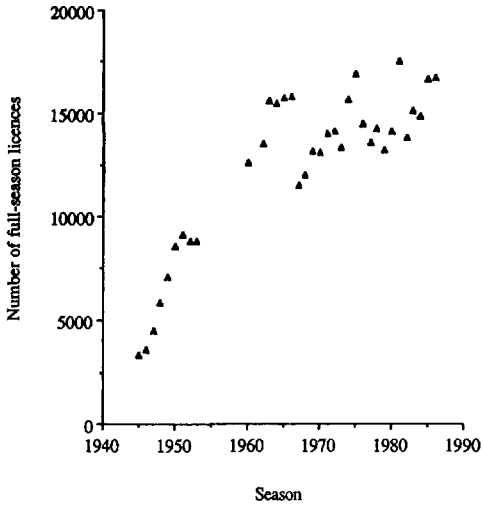
Given the wide coverage of waters achieved from the mail survey, it has proven to be an inexpensive, reasonably representative, consistent way of collecting fishery data as a basis for assessing short and long-term trends and relative fishery performance. Due to the low level of staff resources within the IFC it acts as a valuable alternative to high intensity creel surveys, although it does not replace them for the detailed evaluation of specific fisheries and should not be used beyond its limitations (Brown 1991).

## References

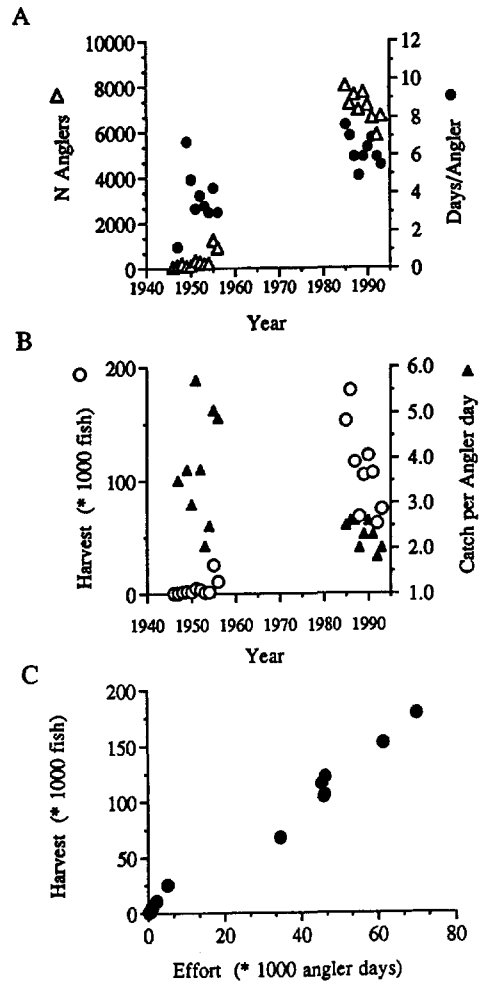
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**Table 1.** Summary results for the IFC mail survey for the 1991/92 season for waters with  $\geq 50$  respondents. Catch/day and days/season/angler values are means.

Water		Effort (Angler days)	N Anglers (Full season)	Days (n/ angler/ season)	Catch/ day	Harvest	Catch/ day	Harvest
Type	Name							
Lake	Sorell	56 700	7 650	7.4	1.6	92 200	0.1	6 850
Lake	Arthurs	46 000	6 650	6.9	2.3	106 450		
Lake	Great	38 750	6 600	5.9	0.8	30 700	0.3	12 500
River	Derwent	21 100	2 950	7.2	0.9	19 150		400
Lake	Brushy	19 650	2 800	7.0	0.3	6 300	0.6	11 900
River	South Esk	18 250	2 600	6.9	1.5	26 800		300
Lake	Pedder	15 200	1 300	11.5	1.6	24 650		150
River	Mersey	13 750	2 100	6.6	0.9	12 650		400
River	Macquarie	11 900	2 050	5.8	1.3	15 750	0.1	1 000
Lake	Crescent	11 650	3 000	3.9	0.6	6 600	0.2	2 700
Lake	Bronte	11 300	2 850	3.9	1.2	13 650	0.1	1 100
River	Meander	11 000	1 650	6.7	1.8	19 550		150
River	Leven	10 500	1 450	7.2	0.9	9 900		
River	Brumbys	10 400	1 850	5.6	0.8	8 100	0.1	1 300
Lake	Crescent	9 129	1 921	4.7	0.4	3 750	0.2	1 693
Lake	Little Pine	8 450	1 750	4.8	1.4	11 500		
Lake	Leake	6 400	1 050	6.0	0.7	4 400	0.1	650
Lake	Echo	6 350	1 650	3.8	1.7	10 800	0.1	700
Lake	Augusta	6 250	1 250	5.0	1.4	8 900	0.4	2 400
Lake	Bradys	6 150	1 900	3.2	0.6	3 700	0.1	550
River	North Esk	6 000	1 150	5.1	1.6	9 450		200
River	Tyenna	5 200	1 150	4.4	1.2	6 400	0.3	1 650
Lake	Penstock	4 950	1 050	4.6	1	5 000	0.2	750
River	St Patricks	4 850	1 400	3.4	2.7	13 000		50
Lake	Rowallan	4 600	1 200	3.8	2.1	9 800	0.2	1 000
Lake	Binney	3 800	1 050	3.6	1	3 950		50
River	Huon	3 750	1 050	3.6	0.6	2 200		100
Lake	Meadowbank	3 250	1 050	3.0	0.7	2 150		50
Lake	Woods	2 950	1 050	2.9	1	3 050		



**Figure 1.** Trend in annual full-season licence sales for Tasmanian inland water trout fisheries.



**Figure 2.** Plots of summary fishery statistics for Arthurs Lake against year (A, B) and of total harvest of brown trout against total effort (C).

## Inland Fisheries Commission 1989/90 Questionnaire

1. What is your postcode? \_\_\_\_\_

2. In the table below we would like you to detail your trout fishing for the 1989/90 season, for STREAMS and RIVERS ONLY - please combine information for freshwater and estuary catches for each stream or river.

(a) In the first column (headed LOCATION), please list all the streams or rivers that you can remember visiting during the 1989/90 season;

(b) In the second column (headed NUMBER OF DAYS FISHED), please indicate the total number of days that you spent fishing at each stream during the season;

(c) In the third column (headed TOTAL NUMBER OF TROUT CAUGHT), please indicate the number of trout that you personally caught at each stream during the season;

LOCATION STREAMS ONLY	TOTAL NUMBER OF DAYS FISHED	TOTAL NUMBER OF TROUT CAUGHT BY ME
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		

3. In the table below we would like you to detail your trout fishing for the 1989/90 season, for LAKES ONLY. Please fill in the table in the same way as for rivers. PLEASE NOTE that a separate sheet is enclosed for WESTERN LAKE waters.

**PLEASE WRITE YOUR TOTAL CATCHES FOR RAINBOW, BROWN AND BROOK TROUT SEPARATELY.**

LOCATION LAKES ONLY	TOTAL NUMBER OF DAYS FISHED	TOTAL NUMBER OF TROUT CAUGHT BY ME		
		BROWN	RAINBOW	BROOK
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				

PLEASE TURN OVER THE PAGE

**Appendix 1.** Standard questions asked in the Tasmanian inland fishery mail survey.