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NEW ZEALAND ANGLING 1947–1968
AN ASSESSMENT OF THE NATIONAL ANGLING DIARY AND POSTAL QUESTIONNAIRE SCHEMES

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FISHERIES TECHNICAL REPORT

New Zealand Angling 1947-1968

An assessment of the national angling diary and postal questionnaire schemes

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SUMMARY

This report analyses the value of statistics collected through the New Zealand national angling diary and postal questionnaire schemes run from 1947 to 1967 and complements the district reports based on these statistics (Graynoth 1973 a-b, 1974 a-d, Graynoth and Skrzynski 1973 a-d, 1974 a-d). A total of 5,500 diaries returned by freshwater anglers contained details of 100,000 days angling and 260,000 fish caught in several hundred waters throughout New Zealand. A summary of the basic angling statistics from 129 major waters is included.

The objective in collecting these data was to monitor the state of the fish stocks, the size and nature of the fishing effort and the size and distribution of the angling catch using angling statistics. This report therefore contains a detailed review of the variables which influence angling statistics and the consequent conclusions which may be made from them.

The variables influencing the catch per unit effort of freshwater sport fishermen were classified into those linked to the definition, measurement and relationship between angling effort and catch and those linked to the characteristics of the anglers, angling regulations, environment and fish populations. The effect of these variables on the catch per day and catch per hour rates of diarists was measured where possible. Field surveys in the Wellington District provided evidence for a positive relationship between the densities of brown trout (Salmo trutta) and anglers' catch rates. The variables influencing the size of fish caught and other angling statistics were also studied. There was no evidence for any national trends in anglers' catch rates during the last 10 years of the scheme (1957-1967) or trends in the size of fish caught in 20 years (1947-67). It was estimated that changes in catch rate had occurred in 25%, and in the size of fish in 21% of the waters covered by the scheme.

A postal questionnaire scheme with personal interviews of the non-respondent licence holders provided strong evidence that the anglers who returned diaries fished more frequently and were more successful than the average licence holder. This report describes the techniques used in correcting this bias and other calculation methods used in the reports on individual acclimatisation districts of New Zealand.

It was concluded that the national angling diary schemes could not be used to accurately monitor the state of the fish stocks because many variables influencing angling statistics had not been measured and because of the lack of direct studies on the relationship between these statistics and the state of the fish stocks. As problems were also encountered in fulfilling the other objectives of the schemes, it was decided to discontinue them in their present form.

I INTRODUCTION

The national angling diary scheme run from 1947 to 1952 was described by Allen and Cunningham (1957). Similar schemes were run at five year intervals in 1957, 1962 and 1967. The objectives of these later schemes were to historically monitor the state of the fish stocks, the size and nature of the fishing effort, and the size and distribution of angling catch. The objective of the 1947-1952 scheme was to describe the state of these characteristics throughout New Zealand. Because most waters in New Zealand are open for angling only from October to April, the data were collected by "season" extending over two calendar years e.g. the first diary scheme covered 5 seasons from 1947-48 to 1951-52. Only the opening year of each season is mentioned subsequently in this text. The 1958 and 1963 postal questionnaire schemes (seeking information on 1957-58 and 1962-63 angling seasons respectively) were to act as a check on the accuracy of angling diary schemes and to provide information on the expenditure and other characteristics of anglers which could not be otherwise collected.

For ease of comparison this report follows the format established by Allen and Cunningham (1957).

II THE BASIC DATA

1. Collection

Similar printed angling diary forms were used throughout all schemes (see Allen and Cunningham 1957, p.18). These post paid diaries and publicity leaflets were distributed locally by the Acclimatisation Societies to the licence sellers. Lecture tours and radio broadcasts were made to stimulate interest in the scheme and to obtain an adequate return of diaries.

Table 1 details the overall results from the various Acclimatisation Districts. The best returns were in 1962, the decrease in 1967 possibly being due to a less intensive publicity effort during that year. The total recorded angling effort and catch from the angling diary schemes are shown in Table 2. In total, nearly 5,500 diaries were received recording 100,000 days fishing to catch 260,000 fish.

TABLE 1

Diaries Returned by District and Season

District	Starting year	No. of Seasons	No. of Diaries Returned until				Total No. of Diaries
			1951-52	1957-58	1962-63	1967-68	
Ashburton	1948	7	29	19	37	13	98
Auckland	1948	7	105	62	194	39	400
Hawera	1948	4	14	18	30	14	76
Hawke's Bay	1947	8	47	44	133	63	287
Marlborough	1949	6	14	22	21	28	85
Nelson	1946	9	262	106	75	91	534
North Canterbury	1947	8	109	75	205	220	609
Otago	1946	9	452	290	344	146	1,232
South Canterbury	1947	8	59	66	99	38	262
Southland	1947	8	144	205	157	102	608
Stratford	1957	3	0	14	12	5	31
Taranaki	1947	8	28	34	30	17	109
Waimarino	1947	8	123	9	27	11	170
Waitaki Valley	1957	3	0	56	105	30	191
Wellington	1948	7	98	115	263	101	577
West Coast	1949	6	32	44	53	2	131
Westland	1950	5	7	8	16	11	42
			1,523	1,187	1,801	931	5,442

Questionnaires were sent to approximately 10% of the licence holders in a selection of Acclimatisation Districts. In 1963 students of the School of Social Science at Victoria University of Wellington conducted personal interviews with the postal questionnaire non-respondents.

TABLE 2

The Total Recorded Angling Effort and Catch During the Whole Period of the General Diary Scheme

District	Days	Hours	Undersized Fish	Takable Fish Returned	Fish Kept
Ashburton	2,248	7,779	996	180	3,507
Auckland	6,334	23,277	6,419	680	10,303
Hawera	1,411	3,625	555	104	1,985
Hawke's Bay	5,637	16,498	2,548	390	5,383
Marlborough	1,547	4,234	155	121	1,369
Nelson	8,852	26,268	3,737	822	14,300
North Canterbury	10,558	36,194	3,111	974	11,244
Otago	23,035	91,760	28,013	1,777	58,833
South Canterbury	6,432	21,934	4,532	799	11,083
Southland	11,802	41,557	11,794	2,525	27,873
Stratford	649	1,573	114	29	698
Taranaki	2,277	6,197	843	85	2,274
Waimarino	3,336	7,956	1,362	376	5,018
Waitaki Valley	4,356	17,982	2,142	664	5,452
Wellington	9,313	26,025	3,156	924	12,069
West Coast	2,455	7,053	906	211	3,508
Westland	618	1,551	65	29	681
Total	100,860	341,463	70,448	10,690	175,580

2. Analysis

The angling diary data were tabulated by Acclimatisation District and then by water. The total angling results for each water and district were then sorted in a variety of ways such as by indvidual angler, licence category, month or locality of the water fished.

Historical comparisons of angling statistics were made more complex by the changes in analytical techniques. The diaries from 1947 to 1949 had been tabulated by hand. The information from 1950, 1951 and 1957 was punched on Power Samas cards and from 1962 and 1967 on I.B.M. cards. To assess historical trends manual extraction of some data was required from the basic machine or computer tabulation. The appropriate statistical tests were applied using a programable calculator. The 1962 and 1967 data have been stored on magnetic tape for future computer analysis.

The analysis of the angling diary data was time consuming despite the low returns of diaries. For example, in 1962 some 50,000 computer cards had to be coded, punched and checked. The basic tabulations of the 1962 and 1967 angling diary schemes were not completed until December 1970. For the angling diary scheme to act as an efficient monitoring scheme, determining trends as they occurred, this was a serious delay.

III THE STATE OF FISH STOCKS

1. Rate of Catch

Anglers' catch rates were measured in order to assess historical trends in the quality of the fishing and the density of the fish stocks. Catch rates are however very variable and can be influenced by many factors. It was therefore necessary to carry out detailed studies to determine which factors actually caused the changes found in diarists' catch rates through the years.

(a) Classification of Variables

No comprehensive reviews have been published on the factors which influence anglers' catch rates. In recent years many detailed studies of the factors which influence marine commercial catch per unit effort statistics were published e.g. Gulland (1964b). Some of these factors are fairly similar to those influencing anglers' catch rates but in general the classification systems and mathematical models cannot be directly applied.

Also, the results of the extensive studies of the relationship between catch rates per unit effort and important fisheries parameters such as density, mortality and exploitation rates (e.g. Ricker 1940 and 1958) cannot be directly applied to catch rates derived from the angling diary schemes. The preliminary assumptions in these studies are rarely met by the angling diary data. In particular, the effectiveness of the unit of effort is not stable, being influenced by a large number of variables.

The variables have been divided into specific ones and those which are derived from an accumulation, or combination, of specific variables. Classes of specific variables are those due to the definition, measurement and relationships between angling effort and catch and those due to the specific characteristics of the anglers, angling regulations, environment and the fish populations. Combination variables occur when anglers' catch rates are subdivided in a general way such as by individual water, locality, year, season, individual angler's results or angling method.

It is hoped that the majority of variables influencing trout fishermen's catch rates have been listed but no doubt some remain to be identified. Some variables such as individual angler's skill are difficult to quantify and it is only possible to use some other quantity as their measure. Anglers' experience in years, angling effort per season or licence category can act as useful measures of skill. Other variables can only be measured in qualitative terms such as angling methods.

(b) Measurement of Angling Effort

In any catch per unit effort study it is essential to measure the unit of effort as accurately as possible. The unit of effort used in the angling diary scheme was time. As a general rule the difficulty of accurately measuring it decreases as the time unit increases in length. However, it is desirable to have the smallest practicable unit of time to obtain the best relationship between effort and catch.

Occasionally, angling effort has been recorded as a unit of six months or a season. This unit is an inexact measurement of effort, and catch per season rates are only of limited value. Many angling studies have used the angling day as a unit of effort. However, angling days are of different lengths and often greater precision is required such as the hour. The following variables influence the accuracy of the number of days recorded in voluntary angling diary and postal questionnaire schemes.

Diarists tended not to record the days when they were unsuccessful at catching fish (Allen and Cunningham 1957, p. 32). Some anglers noted that their diaries were incomplete records. The importance of this variable can be measured by comparing the daily catch frequency distribution with that produced by a log (n+2) distribution (Allen 1955). A lower than expected number of nil bags would indicate that anglers had not recorded their unsuccessful fishing days. Where evidence existed that a diary contained inaccurate records of angling effort, these results were coded as incomplete and analysed separately.

These results can still be used for historical and other comparisons by excluding all the unsuccessful days fishing and only comparing catch rates on days when anglers caught fish. This procedure was used in a Tasmanian angling diary scheme (Nicholls 1957).

The number of days fishing per annum recorded in postal questionnaire schemes showed a selection of even numbers and of the numbers 5, 10, 20, 30 etc. If sufficient results are available this bias should have no influence on the mean effort.

The unit of effort was also recorded as the hours spent angling per day. Variables influencing this statistic are those due to the definition of angling time during the day and those due to the inaccurate recording of this unit of effort by the diarists. In the scheme, angling time was defined as the difference between the commencement and completion of angling, except when anglers specifically excluded some of this. Anglers will however differ in their intensity of angling (in the sense of their rate of casting and time taken to play and land a fish) and in their length of rest periods (e.g. Grosslein 1961, Di Costanzo 1956). Variations will occur depending upon what angling methods are used (Allen and Cunningham 1957, p. 90).

It was noticed that diarists recorded their effort to the nearest half hour. The actual accuracy of diarists' estimates of time spent fishing has not been checked in New Zealand, but Johnson (1956) found that in 1,700 days angling the anglers' records of the mean length of angling day were only 0.007 of an hour in error from the actual time recorded by rangers. In another study 44 anglers overestimated their daily fishing effort by 11% (Edwards 1971). Individual diarists may have significant systematic errors in their estimates.

Therefore, catch per hour rates should only be compared between records derived from either one or a good selection of anglers.

(c) <u>Length of Angling Day</u>

This variable can have a very important influence on catch per day and catch per hour rates. When comparisons are made between catch per unit effort ratios collected from creel census or angling diary schemes, the effect of this variable should always be assessed.

In the angling diary scheme, as only the total hours and total catch per day were recorded, no information was available on the rates at which fish were caught during each day's fishing. Allen and Cunningham (1957, p. 23) sorted angling results by the length of angling day. As would be expected, they found an increase in the daily catch as days of greater length were considered. However, catch per hour rates decreased for days of greater length i.e. the catch was not directly proportional to the time spent fishing per day. For example in the Mataura River anglers who fished two hours per day caught on average 2.6 fish (1.3 fish per hour), anglers who fished eight hours caught 5.1 fish (0.85 fish per hour), a decrease of 0.45 fish per hour. This decrease in catch per hour rate was unaffected by differences between individual anglers, methods, waters or time of the day fished. Similar decreases were found in angling competition results.

It was suggested by Allen and Cunningham (1957, p. 27) that this decrease in catch per hour rate was caused by several factors, such as a decrease in the anglers' concentration and energy and an increase in rest periods during longer fishing days.

In three creel census schemes examined, no uniform relationship was found between anglers' catch rates and length of fishing day. Results from a Tongariro River creel census in 1954 showed little change in catch per hour rates with longer fishing days (Fig. 1(b)). In a Lake Hawea creel census anglers who fished for two hours per day had exceptionally high catch rates (Fig. 1(c)). Creel census records of the Waitaki River salmon fishery showed that anglers who fished for over six hours per day had very high catch rates (Fig. 1(c)).

The influence of the length of fishing day on catch rates has also been investigated overseas. For example, catch per hour rates decreased as longer days were fished in Spirit Lake and in West Okoboji Lake (Rose 1956). Di Costanzo (1956) also found marked differences in catch per hour rates between incomplete (short) days and complete (long) angling days. These differences were affected by the season, angling methods and species of fish caught.

The effect of the length of angling day can be removed by two analysis techniques. Catch rate ratios can be compared between samples of equal day length, but this will reduce the data available and consequent statistical significance of any differences measured. Alternatively, catch per unit effort ratios can be rejected and comparisons made of the relationship between the length of angling day and catch.

In the angling diary scheme there was a linear increase in catch with increasing day length. With sufficient information, angling days of equal length can be grouped and the mean catch plotted against day length (e.g. Allen and Cunningham 1957, p. 24 and 26). Where there is less information or where greater accuracy is required, the individual day results can be plotted as in Fig. 1(a) (for this it is generally necessary to normalise the anglers' daily catch distribution by log (n + 2)). Regression lines can then be calculated and the significance of differences in catch rates at different day lengths assessed.

In the angling diary scheme, the influence of this factor varies between waters. For example in the Taieri River (Allen and Cunningham 1957, p. 24) accurate catch rate comparisons can be made between catch per day rates, but not catch per hour rates. Most commonly changes in the length of angling day have the greatest effect on catch per day rates.

An increase in the accuracy of catch per day and catch per hour results would be expected when the length of angling day is taken into account. This increase was measured for the Mataura River results shown in Fig. 1(a). After transformation of the catch by log (n + 2) and calculation of the linear regression line, 95% confidence limits of the mean catch per day rate were reduced from + 16.2% to + 14.5% and from - 14.5% to - 13.1% i.e. a small increase in accuracy when the length of angling day was taken into account. In other samples where the regression line had a steeper slope, a larger increase in accuracy would be expected.

In the analysis of the results of the angling diary scheme, it was not practicable to historically compare the relationship between length of angling day and catch instead of the catch per unit effort ratios. In the technical reports describing district trends usually only the catch per unit effort rates from samples with similar average day lengths were historically compared.

(d) Measurement of Catch

In the calculation of catch rates in the angling diary scheme, the catch was defined as the total number of fish over the size limit which were caught. In a few waters the catch contained an appreciable number of fish which were rejected by the anglers and returned to the water.

Small random errors may occur due to anglers incorrectly measuring and recording whether fish were over the size limit or not.

In some areas catch rates are subject to errors due to the catches of two or more species of fish. Anglers did not state in the angling diary scheme which species of fish they were fishing for and the total catch of all species was used to calculate catch rates. Where there are large differences between the catch rates for individual species, catch rates will vary erratically due to the proportion of angling effort devoted to each species. This is a serious error which cannot be easily compensated for in angling diary results. Because of this factor, the catch rate records from the sea run quinnat salmon and brown trout river fisheries of the Canterbury Plains are of little value.

In some creel census schemes, such as those run at Lake Coleridge, it is possible to distinguish which fish anglers are seeking and hence categorise angling effort by species (M. Flain pers. comm.).

Annual catches were recorded by anglers in the postal questionnaire schemes. Even number selection and selection of 10's, 20's etc. is apparent in these results. If sufficient results were collected, catch rates should be subject to little error due to this factor.

(e) Anglers' Annual Effort

It would be expected that anglers who fished often during a season would have higher catch rates than those anglers who fished infrequently. Keen anglers would have a greater experience of a water, be in practice and generally be more skillful. Also anglers will tend to continue fishing only if they are successful.

This hypothesis was first examined for the Pomahaka River in 1962 and it was found that anglers who fished over 14 hours per season had very much higher catch per hour rates (Table 3). A detailed study was therefore made of data collected from the Mataura River by Otago and Southland diarists in 1948, 1949, 1962 and 1967 in order to accurately measure the importance of this variable and the influence of different years and diarists' origins upon it.

Individual diarists' annual catches were plotted (Y axis) against their annual effort in days or hours. It was necessary to transform the anglers' effort and catch by Log (n + 2) to obtain normally distributed annual effort and catch frequency distributions. Linear regression equations were then calculated to obtain estimates of the average angler's catch and hence catch rate at different annual effort values. Fig. 2(a) demonstrates the adequacy of the transformation and the linearity of the relationship for some typical results.

FIG. 1

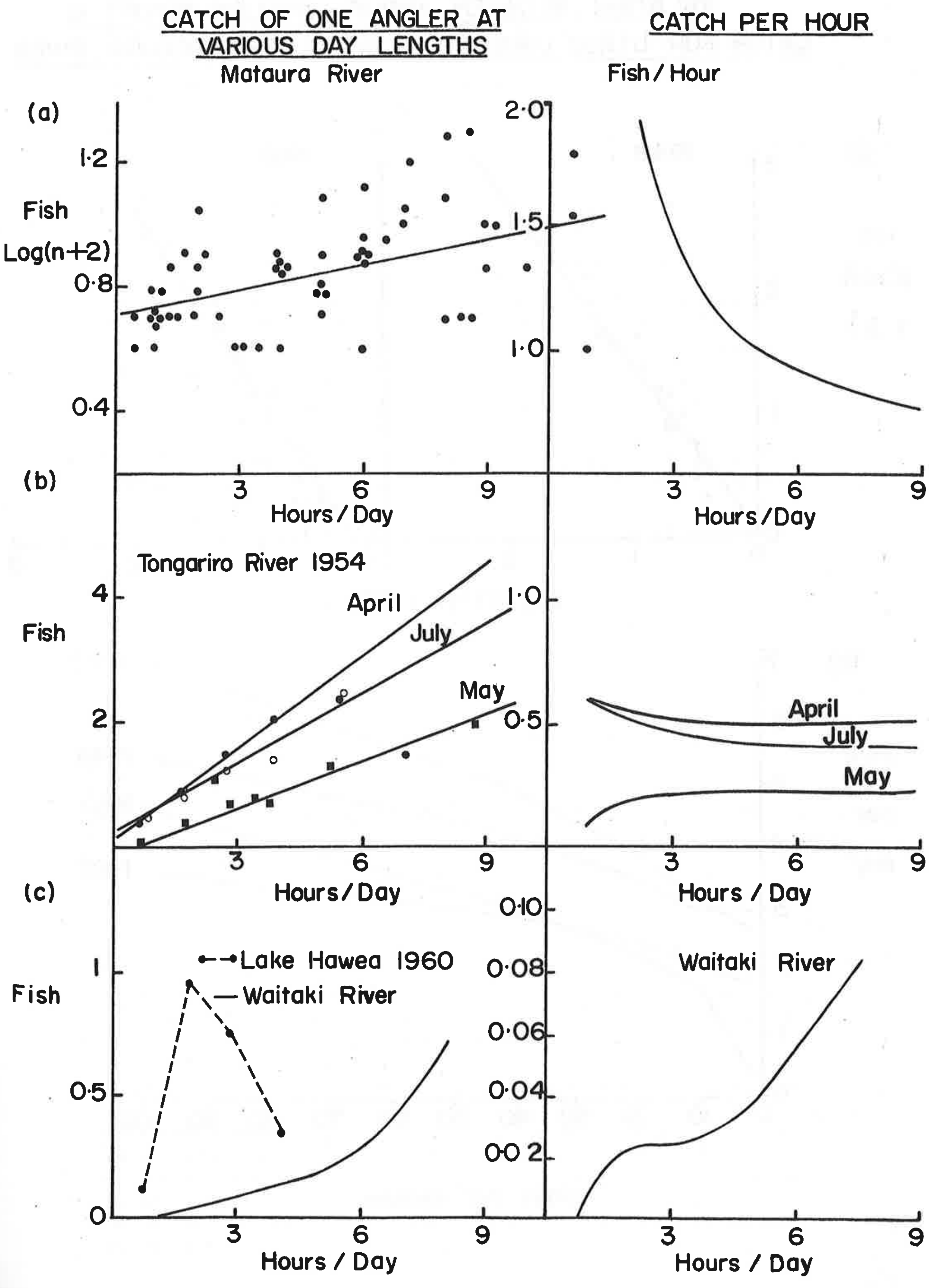

CATCH OF ONE ANGLER AT VARIOUS DAY LENGTHS
CATCH PER HOUR
Mataura River
Fish / Hour
(a)
Fish
Log(n+2)
1·2
0·8
0·4
2·0
1·5
1·0
3
6
9
Hours / Day
(b)
Tongariro River 1954
April
July
May
Fish
4
2
1·0
0·5
(c)
Lake Hawea 1960
Waitaki River
1
0·5
0
0·10
0·08
0·06
0·04
0·02

FIG. 2

RELATION BETWEEN ANNUAL ANGLING EFFORT & CATCH FOR OTAGO DIARISTS FISHING THE MATAURA RIVER

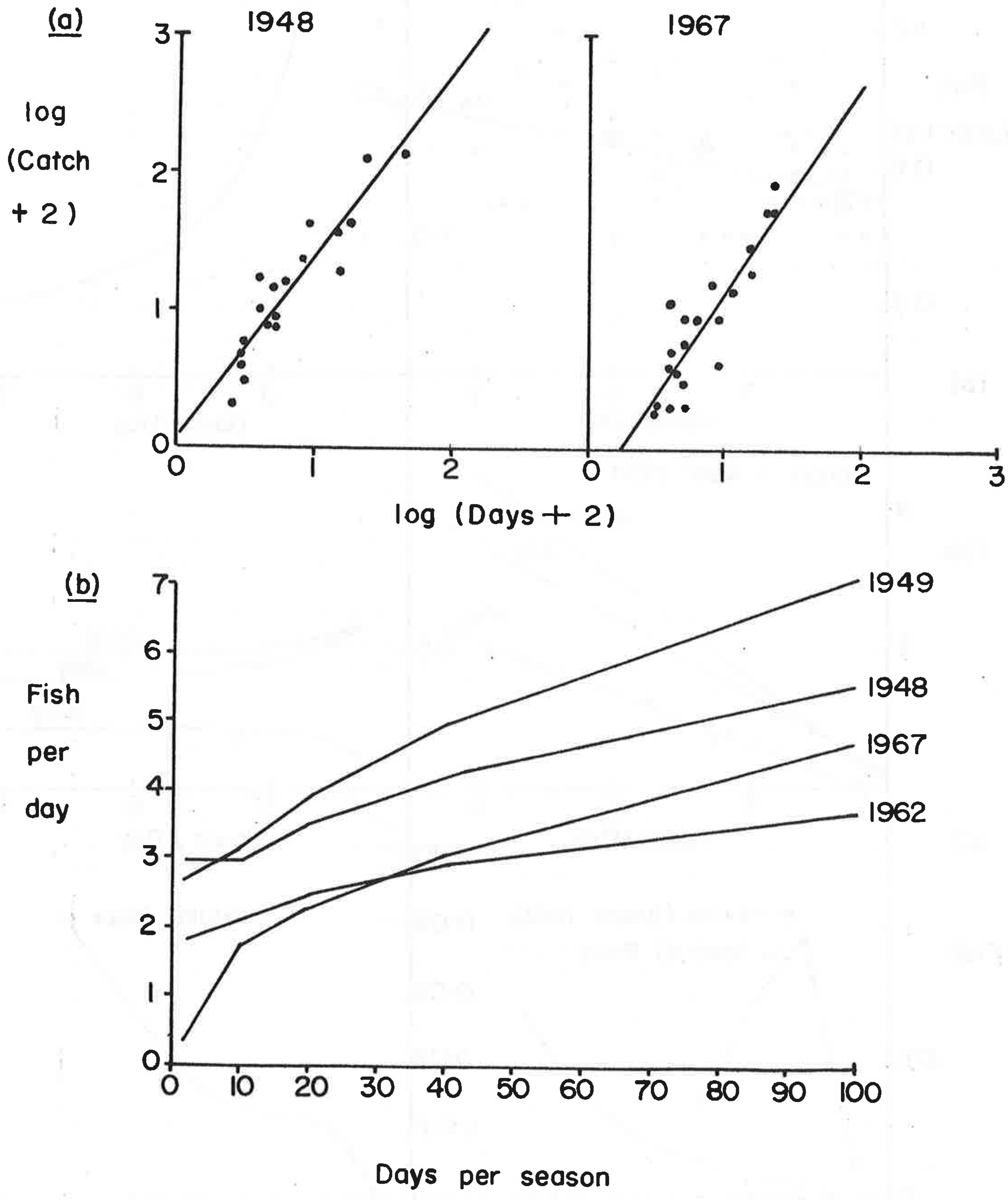


TABLE 3

Relationship between Annual Angling Effort and Catch per Hour Rates for the Pomahaka River in 1962-63

Hours per Annum	Number of Anglers	Mean Hours	Catch per Hour
1 - 6	16	4.41	0.47
7 - 11	21	8.79	0.48
14 - 22.5	16	18.47	0.72
32 - 105.5	17	52.68	0.77

In 15 out of the 16 regression lines, the intercept on the Y axis was negative (Table 4). In four, this difference from 0 was significant at the 95% level. This is clear evidence that diarists who often fish the Mataura River record higher catch rates than those anglers who fish infrequently e.g. Fig. 2(b).

TABLE 4

Value of Intercept on Catch Axis of the Linear Relationship between Log (catch + 2) of Annual Catch and Log (effort + 2) of Annual Effort in Hours and Days for Otago and Southland Diarists Fishing the Mataura River

Year	Days		Hours	
	Otago	Southland	Otago	Southland
1948	+ 0.06	- 0.07	- 0.02	- 0.72*
1949	- 0.01	- 0.12	- 0.26	- 0.20
1962	- 0.04	- 0.16*	- 0.16	- 0.16
1967	- 0.36*	- 0.27	- 0.27	- 0.41*

* Significantly different from 0 at the 95% level

Typical linear regression statistics - Otago diarists' annual effort in days

Year							Mean Square
1948	Log (Catch + 2)	=	0.06	+	1.34 Log	(Days + 2)	0.039
1949	"	=	- 0.01	+	1.43	"	0.072
1962	"	=	- 0.04	+	1.30	"	0.068
1967	"	=	- 0.36	+	1.52	"	0.055

The value of the intercept was not significantly influenced by different years or the origins of the diarists. It is, therefore, strongly suspected that this variable will influence diarists' catch rates from all waters and in all years.

Historical or other comparisons of diarists' catch rates should allow for this variable if the influence of other variables is to be accurately measured. Historical comparisons can be made by assessing the differences between samples by covariance analysis. This technique however is useful only if there is no historical bias in the spatial distribution of angling effort and other variables. It should not be assumed that no bias occurs just because a large sample of diarists' results was collected. Where bias exists, comparison of samples using transformations and multiple covariance analysis becomes very unwieldy.

Historical differences in the values of the intercept and slope of this relationship can also lead to the complex situation shown in Fig. 2(b) where catch rates of infrequent anglers were lower in 1967 than in 1962 but catch rates of keen anglers were higher in 1967 than in 1962.

An important result of this linear regression analysis technique is that diarists' results can be used to predict the catch rate of the average licence holder who generally fishes less frequently. The average licence holder's catch rate is a valuable statistic used in calculating the annual crop from a given water. However, accurate estimates of the annual effort of the "average" licence holder on specific waters are not available at present, records only being available for individual acclimatisation districts.

Creel census results and angling diary catch rate results could be combined if the creel census ranger recorded or calculated the number of days per season the average licence holder spends fishing each water. This could be a valuable technique in situations where it is relatively expensive to collect creel census records compared to angling diaries.

(f) Anglers' Skill

In these analyses an individual's angling skill is regarded as the sum of four components. Firstly, his angling experience and knowledge of waters he fishes. Secondly, his physical attributes which affect his angling ability and catch. Thirdly, his intensity of angling effort such as the number of casts per hour and finally his wish and desire to catch fish.

That anglers differ in skill is a well known fact. But in previous studies the influence of skill on catch rates has been rarely separated, or measured, from that of other factors such as angling methods or angling localities. The studies of Shetter and Alexander (1965) were the exception and showed significant differences between anglers in their ability to catch trout. Probably the best evidence, that skill is an important variable influencing anglers' catch rates, comes from the results of European Coarse Fishing Competitions such as those detailed in the weekly paper the "Angling Times". In many of these competitions anglers fish equidistantly along a uniform stretch of water for set periods of time using similar methods. Differences in anglers' catches are mainly caused by differences in angling skill, and differences in the fish population and local environment. As some anglers consistently record better catch rates than others, one can safely conclude that this is due to a difference in angling skill.

In New Zealand again the best available evidence of the influence of angling skil came from the results of angling competitions. Detailed results were available for competitions held in 1948-50 on the Mataura River in Otago District. In twelve hours anglers, using a specified method, attempted to catch the highest weight of brown trout. Differences between anglers in the total weight of fish caught were therefore caused by differences in anglers' skill or by the characteristics of the locality fished. Consistent differences between anglers in individual competitions will only be caused by differences in their skill which include the ability of individual anglers to select the best localities.

The results of five anglers who fished in five competitions were selected for study (Table 5). A two way analysis of variance showed that the anglers did differ in their skill and that this was highly significant. Additional evidence that angling skill has an influence on catch rates was also obtained from a detailed study of two anglers' records from the Mataura River in the 1948-1950 seasons.

TABLE 5

Square Roots of Total Weight of Brown Trout Caught by Anglers in Mataura River Competitions 1948-50

Angler Number	Competition Number (8 am to 8 pm) 1	2	3	4	5	$\bar{x}$
1	3	2.63	4.58	4.69	4.24	3.83
2	4.53	2.97	5.55	6.51	4.36	4.78
3	4.37	2.66	3.21	2.74	2.55	3.11
4	3.24	2.97	3.10	4.16	3.28*	3.35
5	3.35	2.66	4.67	6.05	4.56	4.26
$\bar{x}$	3.70	2.78	4.22	4.83	3.80	3.87

Source of Variation	Degrees of Freedom	Mean Square	F	Significance
Competitions	4	2.84	4.41	98.5%
Anglers	4	2.22	3.45	96.5%
Error	15	0.64		

* Missing data estimated by method of Snedecor 1956, p. 310.

Angler A fished for 48 days at an average catch rate of 0.65 fish per hour, 4.1 fish per day. Angler B was more successful and fished for 41 days at an average rate of 1.48 fish per hour, 4.3 fish per day. The significance of angler's B higher average annual catch was assessed by covariance analysis so as to exclude the effect of the factor of length of angling day on catch rates. Each angler's daily catch (n) was directly related to the hours he spent fishing per day (H) (Figure 3). The regression lines were similar in slope, identical in variance but significantly different at the 99.5% level in elevation. Therefore the higher catch rates of angler B are independent of the length of angling day.

The higher catch rate of angler B can still be caused by a variety of variables. Both anglers had a similar distribution of angling effort throughout the season, angler B having higher catch rates, using minnow techniques in October, November and February, and also having a higher catch rate using artificial fly techniques from December to April. It is therefore concluded that the differences in catch rates shown are very probably due to differences in anglers' skill, which include selection of the best days and localities to fish. However, the possibility that differences are caused by inaccurate effort and catch records cannot be completely excluded.

Other evidence which indicates that catch rates are affected by differences in anglers' skill comes from various sources.

Anglers recorded a highly significant increase in annual catch rates with increasing angling experience in a 1962 postal questionnaire scheme run in Wellington Acclimatisation District (Table 6). This increase is probably due in part to an increase in angling skill although the influence of other factors such as selection of the best waters cannot be excluded. The anglers' age or occupation did not appear to have such an important influence on catch rates in this scheme (Table 6).

TABLE 6

Certain Anglers' Characteristics and Catch Rates in Wellington Acclimatisation District 1962-63

Occupation	Fish per Day	Age	Fish per Day	Years Angling	Fish per Day
Professional	0.50	Under 20	0.62	1	0.22
Minor Business	0.55	20s	0.39	2	0.30
Clerical	0.38	30s	0.84	3 - 4	0.41
Farmers	0.87	40s	0.75	5 - 7	0.75
Skilled	0.74	50s	0.45	8 - 10	0.59
Semi-skilled	1.01	60s	0.99	11 - 19	0.38
		70+	0.78	20 - 29	0.60
				30 - 39	1.39
Sample size	248			40+	1.78

Men who bought whole season angling licences consistently recorded higher catch rates than women, children, or short term licence holders (Table 7). These higher catch rates again are probably due in part to these anglers having higher angling skill than other licence holders.

TABLE 7

Average Catch (fish per day) of Wellington Acclimatisation District Licence Holders 1962-63

Angling Region	Licence Type Whole Season Men	Women	Children	Half Season	Weekly
Wellington District	0.67	0.42	0.19	0.28	0.18
Other Areas	1.22	0.08	0.11		
Sample Size	259				

It was also calculated that anglers who returned angling diaries or postal questionnaires in Wellington District in 1962-63 were on average significantly more successful than those anglers who did not reply (Table 8). Anglers who returned these diaries may well have recorded higher catch rates because they were more interested in the sport, more skillful and had greater angling experience (Table 8).

This would indicate that Allen and Cunningham's (1957, p. 117) suggestion that diarist's catch rates are typical of the average licence holder is incorrect. If this is so the total crop estimates for 1951-52 (p. 153) will be overestimates.

As anglers differ in their skill, anglers' catch rates can be affected by seasonal, geographical or historical changes in skill.

FIG. 3

RELATION BETWEEN DAILY EFFORT & CATCH OF 2 ANGLERS

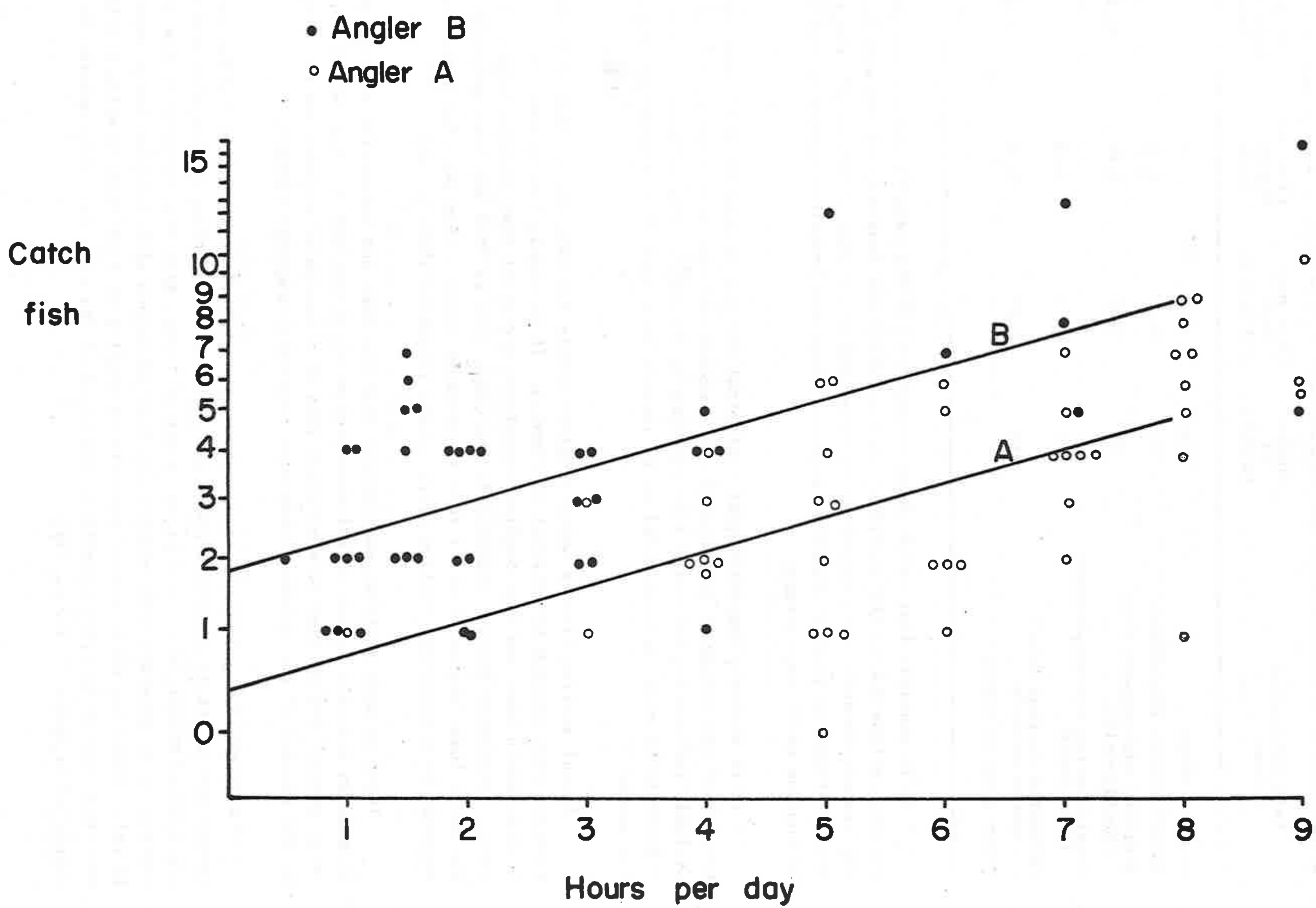


TABLE 8

Catch Rates Recorded by Wellington Acclimatisation District Anglers in 1962

Data Collection Scheme	Number of Anglers	Fish per Day Wellington	Fish per Day Other Areas	Angling Experience Years	Age Years
Angling diary	148	1.10	1.52		
Questionnaire respondents	86	0.77	0.92		
Diarists who responded to questionnaire	32	0.95	1.07	21.6	47
Questionnaire non-respondents interviewed	173	0.61	1.43		
Estimated Average M.W.S. Licence Holders (from questionnaire)	259	0.67	1.22	13.6	41.4

It is possible that catch rates at popular holiday resorts may decline during the holiday periods due to the visitors' lack of skill and knowledge of the waters. Geographical differences in skill were suspected by Allen and Cunningham (1957, p. 29) who considered that anglers from the South Canterbury, Waitaki, Otago and Southland districts had a higher level of angling skill than others.

It is strongly suspected that historical changes in angling skill have occurred throughout the period of the angling diary scheme and that this has been a significant variable influencing the catch rate recorded by diarists. The evidence, however, for this hypothesis is only circumstantial as no records were kept of the diarists' skill through the years.

Annual angling licence sales remained stable for many years until 1957 when there was a nation wide upsurge of interest in fishing. It is highly likely that these new licence holders would have had less angling experience and skill than licence holders in previous years. Therefore diaries returned in the years 1957 to 1967 may have come from anglers who had a lower degree of skill than in previous years. This was also suspected to have occurred in a Tasmanian angling diary scheme (Nicholls 1958, p. 40).

There is also a strong possibility that the keen and successful anglers who returned diaries in the past became disillusioned with the scheme and did not return diaries in later years. The arithmetic mean catch rate of a sample of anglers can be severely reduced by the removal of one or two of the most successful anglers' results.

Also there may have been a change in the anglers' attitudes to fishing over the past twenty years. It is suspected that there has been a reduction in the wish and desire of the average angler to catch a large number of fish. With the increase in the standard of living, it is possible that anglers are less concerned with catching large numbers of fish to eat. There may be increased emphasis on angling as a recreation using sporting methods and light tackle to catch relatively few trout of larger size. This opinion is also supported by Hobbs (1948, p. 110).

(g) Angling Legislation

Legal restrictions on angling methods, size and number of fish which can be taken can also influence anglers' catch rates. Allen and Cunningham (1957, p. 133) reviewed the effectiveness of various angling methods and showed that no methods were consistently or markedly more successful than others in all waters. However, some methods are consistently better in specific waters and historical and other comparisons should ideally be made only between similar angling methods. Difficulties, however, can arise through historical trends in the quality and effectiveness of the angling equipment available. Light and strong fibre glass rods together with plastic fly lines and nylon casts have replaced split cane rods, silk lines and gut casts used twenty years ago. It would be expected that these trends should increase catch rates nowadays.

The influence of size limits was assessed by Allen (1954). The effects on anglers' catch rates can be assessed by a study of the length frequency distributions of the trout caught. The influence of daily bag limits on anglers' catch rates can be assessed from Allen (1955). It was shown that in most districts the bag limits had little effect on anglers' catch rates (Allen and Cunningham 1957, p. 127).

(h) Environmental Variables

Over 1,100 waters, ranging in size from tiny brooks to Lake Taupo, were recorded as being fished by anglers in the national angling diary scheme. There is a great deal of variability between these waters in their basic physical, chemical and biological characteristics and this must affect the rate at which anglers catch fish. Superimposed upon these basic characteristics are those environmental variables which fluctuate with time such as light, temperature, eutrophication etc. A short list of these environmental variables which may influence anglers' catch rates is given in Table 9.

TABLE 9

Some Environmental Characteristics of Trout Waters which may Influence Anglers' Catch Rates

Geographical:	Temperature, wind, rainfall, light, barometric pressure.
Physical:	Accessibility to anglers and amount of angling obstructions and snags. Water depth, width, slope, flow, substrate composition and size. Temperature, thermocline and turbidity.
Chemical:	Oxygen concentration and degree of pollution and eutrophication.
Biological:	Riparian vegetation, aquatic macrophytes, algal blooms, invertebrate and fish population characteristics.

Due to the number and complexity of the environmental variables there have been no catch rate studies which have defined the relative importance of all these variables on catch rates. However, some studies have attempted to define the effect of specific environmental variables such as temperature.

Catch rates recorded in the angling diary scheme were positively correlated with the logarithm of the daily mean temperature during the fishing season in consecutive years (Allen and Cunningham 1957, p. 74). It was suggested that the relationship found was more likely to arise from the influence of the weather conditions during that season or the suitability of conditions for angling than from temperature effects on the size of the fish population. Overseas studies of the importance of temperature have shown conflicting results depending upon the species of fish. For example, catch rates for brook, rainbow and brown trout fisheries in Sagehen Creek in California increased during the season as the stream temperatures rose (Gard and Seegrist 1972). In another study catch rates for coarse fish decreased as the temperature increased (Lux and Smith 1960).

In the analysis of historical trends in catch rates recorded by the angling diary scheme, the influence of historical changes in environmental variables could not be assessed as the environmental variables had, in general, not been measured. These environmental variables must also contribute significantly to the differences in catch rates recorded between different waters.

(i) Fish Population Characteristics

Behaviour

The behaviour of the prey has a marked effect on anglers' catch rates. Salmonid behaviour is influenced by many factors such as the size of fish, densities and seasonal effects. In many cases there are great behavioural differences between species or strains of salmonids which affect anglers' catch rates (e.g. Alexander and Shetter 1969, Calhoun 1966, Flick and Webster 1962, Hunt and Jones 1972).

In New Zealand the situation is fairly simple because only a few species of salmonids are present. The low volume of hatchery liberations also reduces the variety of strains which may be present in individual waters.

Scientific observations on the behaviour of salmonids in New Zealand waters are very limited. In the summers of 1971, 1972 and 1973 skindiving observations were carried out on the brown trout stocks of the Hutt and Otaki rivers in Wellington Acclimatisation District. In general, during the day, brown trout of all sizes remained close to the substrate or cover. In pools fish of similar size formed slow moving shoals whilst in rapid water fish remained as stationary individuals. In February 1971 similar observations of the rainbow trout stocks of Hawke's Bay rivers showed that rainbow trout of all sizes formed free swimming, actively moving shoals in the mid water. Small rainbow trout of less than 20 cm in length shoaled in pools in side channels of the braided rivers, whilst larger trout shoaled in rapids and pools in the main channel.

Observations have not been made on New Zealand river dwelling brown and rainbow trout under other environmental conditions or where mixed stocks occur. The observations above indicate that in a river, where equal densities of both species were present, anglers using spinning or wet fly methods would generally cast their bait closer to a rainbow than a brown trout. As it is also thought that rainbow trout are more "aggressive" feeders than brown trout it is quite possible that up to 10 rainbow trout could be hooked for every brown trout under these circumstances. Under other environmental conditions and using other methods, such as dry fly, this proportion could be reduced and even possibly reversed. In general, however, it is probable that rainbow trout are easier to catch than brown trout in rivers (Needham 1938, Schuck 1942). There is no information on sea run quinnat salmon.

Observations have been made on the behaviour of brown and rainbow trout and land locked quinnat salmon in Lake Coleridge (M. Flain pers. comm.). There, quinnat salmon are more active than rainbow trout which in turn are more active than brown trout. A description of the relation between behavioural effects and other factors affecting anglers' catch rates in New Zealand lakes has yet to be published. It is suspected that rainbow trout are easier to catch than brown trout in lakes. For example in Lake Rotorua in the early 1960's far more rainbow trout were caught than brown trout, even though both species were present in approximately equal numbers in the major spawning run (unpublished Internal Affairs reports). Because of this low utilisation of brown trout, their numbers were systematically reduced by removing adults from spawning runs.

A similar situation also exists in Lake Taupo, where the percentage of brown trout present in the spawning runs is significantly higher than the percentage taken by anglers (Cunningham 1960).

In the angling diary scheme the influence of fish behaviour was reduced by comparing where possible catch rates of one species of salmonid. Historical changes in strains could have occurred and it is feasible, due to heavy angling mortality in some waters, that new strains have evolved which are less catchable than original strains.

Size

The influence of trout size on anglers' catch rates is surprisingly complex and due to a lack of direct experimental records no comprehensive statement can be made.

In any trout fishery anglers' catch rates of larger trout will be increased firstly by the aggressiveness and greater food intake of the larger trout, secondly by the larger trout selecting the best position in the water and thirdly and most importantly by anglers selecting the methods and techniques which will catch the largest trout.

Catch rates, however, will be decreased firstly by the larger trouts' caution (i.e. their knowledge of the natural food and memory of previous angling experiences), secondly by regulations prohibiting live-bait and spinning methods which are effective against large piscivorous trout, thirdly by the greater ability of large trout to escape after hooking, and finally by the lower abundance of large trout.

Allen (1963) found that in the Horokiwi Stream the length frequency distribution of anglers' catches fairly closely resembled that of the actual population when fry were excluded i.e. trout size had no overall effect on anglers' catch rates. In the Motueka River he found the anglers' catches to be deficient in small brown trout which indicated that a selection of larger fish was taking place there. The actual population was assumed to contain fish of small size. Recent electric fishing surveys revealed large numbers of small fish in the upper spawning tributaries of the Motueka River and suggest the possibility that the lower waters fished by anglers contain few fish of this size. It has also been shown that, in some South Canterbury rivers, as in the Horokiwi Stream, the size distribution of fish caught by anglers was very similar to the size distribution of trout present in the population when fry were excluded (Graynoth and Skrzynski 1973c).

An exact assessment of the relationships between the size of trout present and that of trout caught by anglers in different water types could be of great value, as it is considerably easier and cheaper to collect length frequency information from angling diaries than by more direct means. Alternatively, if it can be shown that larger trout are easier to catch than small trout at similar densities, there may be merit in reducing trout densities where trout are small and abundant. This should increase the average size of trout present. The increased catchability of these larger trout should then compensate for the lower densities and catch rates may remain stable, while the size of trout and the weight of the anglers' daily bags would be increased.

In lakes, where the whole population is subject to fishing pressure, there seems to be little doubt that anglers catch the larger fish from the population. In New Zealand this appears to be so in Lake Alexandrina (Graynoth and Skrzynski 1973c) and in Lake Marymere (Hobbs 1948, p. 38). In California's Convict Lake, anglers caught more rapidly 8-8.9 inch hatchery reared rainbow trout than 7-7.9 inch trout (Butler and Borgeson 1965), liberated in equal numbers so that differential natural mortality effects were negligible. In the angling diary scheme, as it seems likely that differences in the size of trout caught will have little overall effect on anglers' catch rates, this factor was not considered to be very important in historical comparisons.

Sex

No detailed studies have been made on the influence of behavioural differences due to sex of the fish on anglers' catch rates. In Lake Alexandrina it was found that male rainbow trout were more freely caught by anglers at the beginning of the season in the ratio of 2.5 males to one female (Moore et al. 1962). The low absolute number of males in this lake may have been caused in part by this difference in catchability.

Food Supply

Trout appear to be more catchable when they are feeding heavily and are in good condition but conflicting results have been reported and it probably depends on the ability of the anglers to accurately immitate the natural food. Quinnat salmon do not feed during their spawning runs but still take anglers' bait.

Spatial Distribution

Fish populations are generally aggregated into shoals and their distribution in space can be described by a negative binomial distribution (Lambou 1963). It is probable that anglers do not cast in a random fashion throughout a water but give high coverage of localities where fish are expected and low coverage elsewhere. The basic interaction of these two aggregated distributions appears to result in the fish not being caught at equal time intervals (Allen 1955).

Where the spatial distribution of the fish becomes more random it could be expected that this variable would be of lesser importance. Catch rates would then show less variation. For further details of this effect in marine fisheries see Andersen (1964).

Shoaling may have a direct influence on catch rates obtained by different angling techniques. Higher catch rates using dry fly techniques would be expected where the fish were uniformly spaced and where the hooking and landing of individual fish would not disturb others. However, shoaling may increase catch rates where the fish are invisible and the anglers' searching time is reduced by past knowledge of the fish behaviour in a particular environment. For details of the inter-relationship between searching time, fish shoaling and catch rates see Paloheimo and Dickie (1964).

Density

Studies of the relationship between catch rates and trout density have important implications in the calculation of the optimum yield which can be taken from a trout fishery. Most studies have assumed that the catch per unit effort is directly proportional to the population size. However, optimum yields or "satisfactory angling success" for anglers may only be obtained at population levels substantially above those necessary to yield a "maximum sustained yield" (Radovich 1973). Also if catch rates remain stable while the trout population density declines it may be possible to severely overfish the stock.

This relationship is also important because the majority of trout management practices are aimed at maintaining or increasing the trout stocks. If it was shown that large changes in stock densities have little effect on anglers' catch rates, the value of many fisheries management practices would be open to serious question.

Anglers' catch rates have been accurately related to trout densities in only a few studies. This is generally because of the difficulty in removing or counteracting other variables which affect anglers' catch rates and the problems involved in accurately measuring trout population densities.

One of the first direct studies of this important relationship in rivers was carried out by Schuck (1942). An excellent positive relationship was found between anglers' catch rates and the population density of small brook trout liberated in Crystal Creek, New York State (Figure 4). No relationship was found between anglers catch rates and the densities of small brown trout liberated there.

In Lawrence Creek, Wisconsin it was found that inexperienced anglers' catch rates were more dependent upon trout density than those of experienced anglers (McFadden 1961). The annual crop was significantly related to the initial stock density at the beginning of the season and the annual angling effort. When the anglers' annual catch rate was plotted against the initial stock density, a significant increase in catch rate occurred with increasing stock density (Figure 5). Lawrence Creek fishery was, by New Zealand standards, very heavily fished and contained very high populations of small brook trout. The relationship found may not apply to New Zealand rivers.

A positive and possibly linear relationship between anglers' annual catch per hour rates and the standing crop of trout in Sagehen Creek, California was derived from data published by Gard and Seegrist (1972)(Fig. 6). The low 1953 catch rate was excluded from the regression and may have been caused by the presence of unskilled anglers who contributed to the exceptionally high fishing pressure in that year.

In the Horokiwi Stream in New Zealand, it was shown that catch rates of anglers dropped markedly for several years after the floods of 1941. This drop may have, in part, been caused by the large reduction in the density of the trout populations (Allen 1951). In the upper waters the rate of catch of takable fish was correlated with the rate of catch of undersized fish in the previous season. It was suggested that this was evidence that the abundance of the stock played an important part in determining the rate of catch.

Trout densities in Wellington and Hawke's Bay streams and rivers were assessed in January and February 1971 by electric fishing and diving counts (Table 10). These densities were compared to catch rates recorded by anglers in 1967-68 (Fig. 7). Due to the sampling errors in estimating the trout densities and changes in these densities with location, season and time, 95% confidence limits of trout densities are at best around $\pm$ 80%. Catch rates are subject to similar errors due to the variation in catch rates between anglers and influences of other variables such as the environmental characteristics of each water and fish population characteristics other than density. The larger points in Fig. 7 are relatively more accurate and there is a positive, and possibly causative relationship between trout numbers per kilometre and anglers' catch rates in this comparison.

TABLE 10

Comparison of Brown Trout Densities and Anglers' Catch Rates in some Wellington and Hawke's Bay Rivers

Code	Water	Estimated stock takables 1971 Per Mile	Per Acre	Anglers' catch per hour 1967-68	Average weight of angler caught trout (kg)
1	South Karori Stream	130	89	0.49	0.26
2	Makara Stream	151	86	0.26	0.34
3	Wainuiomata River	221	44	0.86	0.66
4	Hutt River	177	15	0.40	0.60
5	Waikanae River	107	25	0.24	0.93
6	Otaki River	25	2.7	0.09	1.27
7	Ruamahanga River	56	3.3	0.37	0.73
8	Waipoua River	50	9.9	0.17	0.60
9	Kopuaranga River	84	28	0.47	1.15
10	Tauherenikau River	31	2.5	0.00	1.46
11	Waingawa River	34	2.5	0.10	1.33
12	Maraetotara River	37	12.7	0.33	1.36
	Tukituki River*	19	1.4	0.32	0.77
	Waipawa River*	30	2.27	0.35	0.73
	Ngaruroro River*	34	3.5	0.46	0.73
	Tutaekuri River*	19	1.3	0.25	0.68

* Rainbow trout waters not included in Fig. 7.

Note: No. per mile x 0.62 = No. per kilometre, No. per acre x 2.47 = No. per hectare

There have been fewer studies of this relationship in lakes.

In Lake Opeonger (Fry 1949), there was a close linear relation between the catch per boat hour and the size of the "virtual population" of lake trout of seven years of age plus. Fry found extensive seasonal changes in catch rate related to the migratory and feeding behaviour of the lake trout in response to the summer cycle of thermal stratification.

Anglers' catch per hour rates of hatchery reared brook trout in Crecy Lake, New Brunswick increased from an average of 0.5 (range 0.2-1.0) in the years 1943 to 1949 to 2.1 (range 1.4-3.2) in 1951 to 1955 (Smith 1956). This was almost certainly caused by an increase in the density of the takable stocks produced by increased stocking rates, predator control and lake fertilisation.

In California, after the liberation of small "catchable" rainbow trout, anglers' catch per hour rates dropped as the catch of these fish increased (Butler and Borgeson 1965). The anglers' catch rates were directly dependent on trout density in many lakes where a high proportion of liberated trout were caught and unaccounted mortality was low. The probability of capture of individual fish per unit effort was the same at all densities and angling efficiency did not increase at low densities. If this situation occurred with a natural stock of trout, its density could be estimated from catch rates using the method of diminishing returns. It was also found that annual catch rates were not dependent upon stocking rates, as angling effort adjusted in proportion to the stock and presumably always reduced the stock to low levels. In

FIG. 4 FISH PER HOUR & FISH PER ACRE RELATIONSHIP FROM SCHUCK 1942

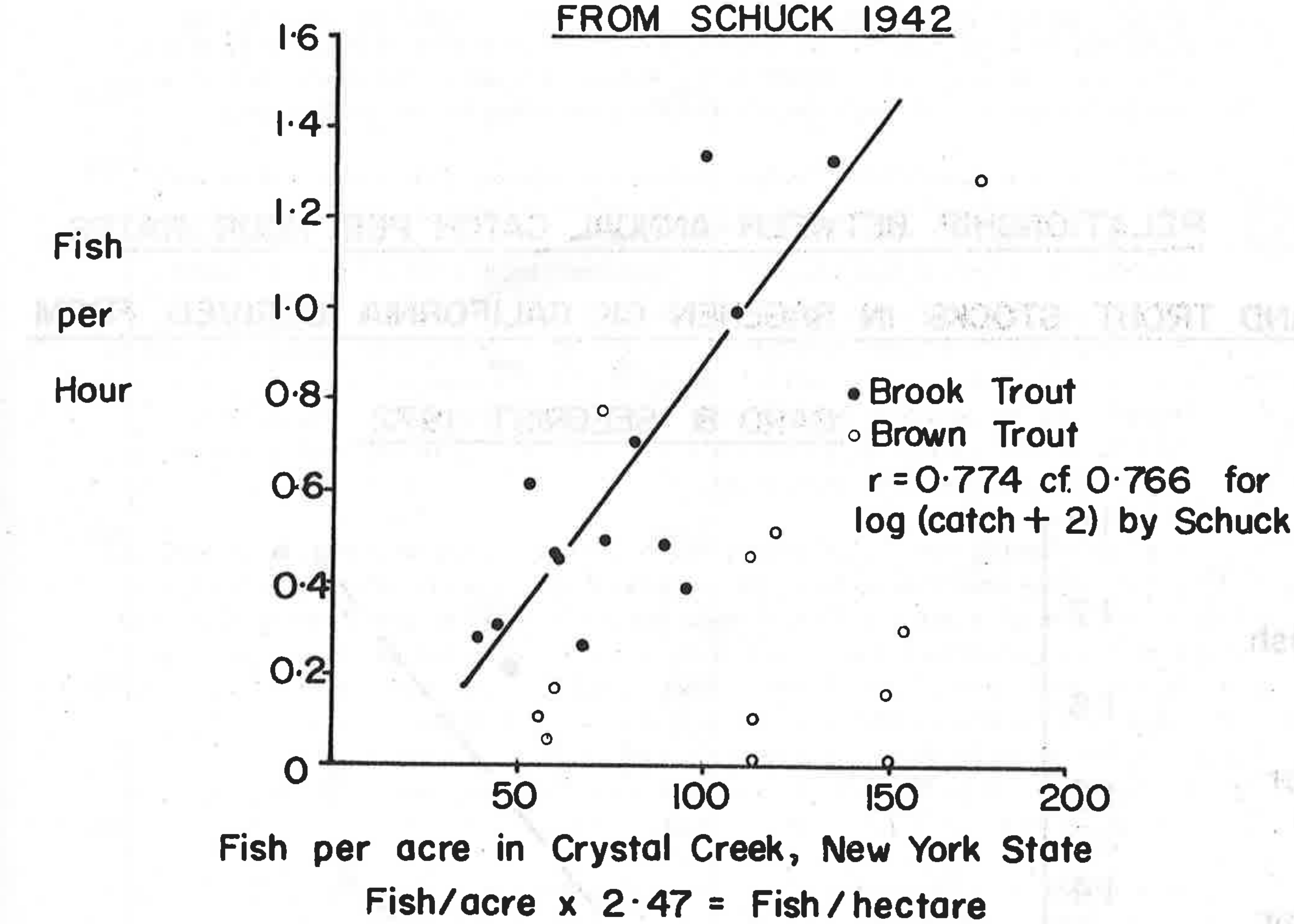


FIG. 5 ANNUAL CATCH RATE / BROOK TROUT DENSITY LAWRENCE CK. - DERIVED FROM McFADDEN 1961

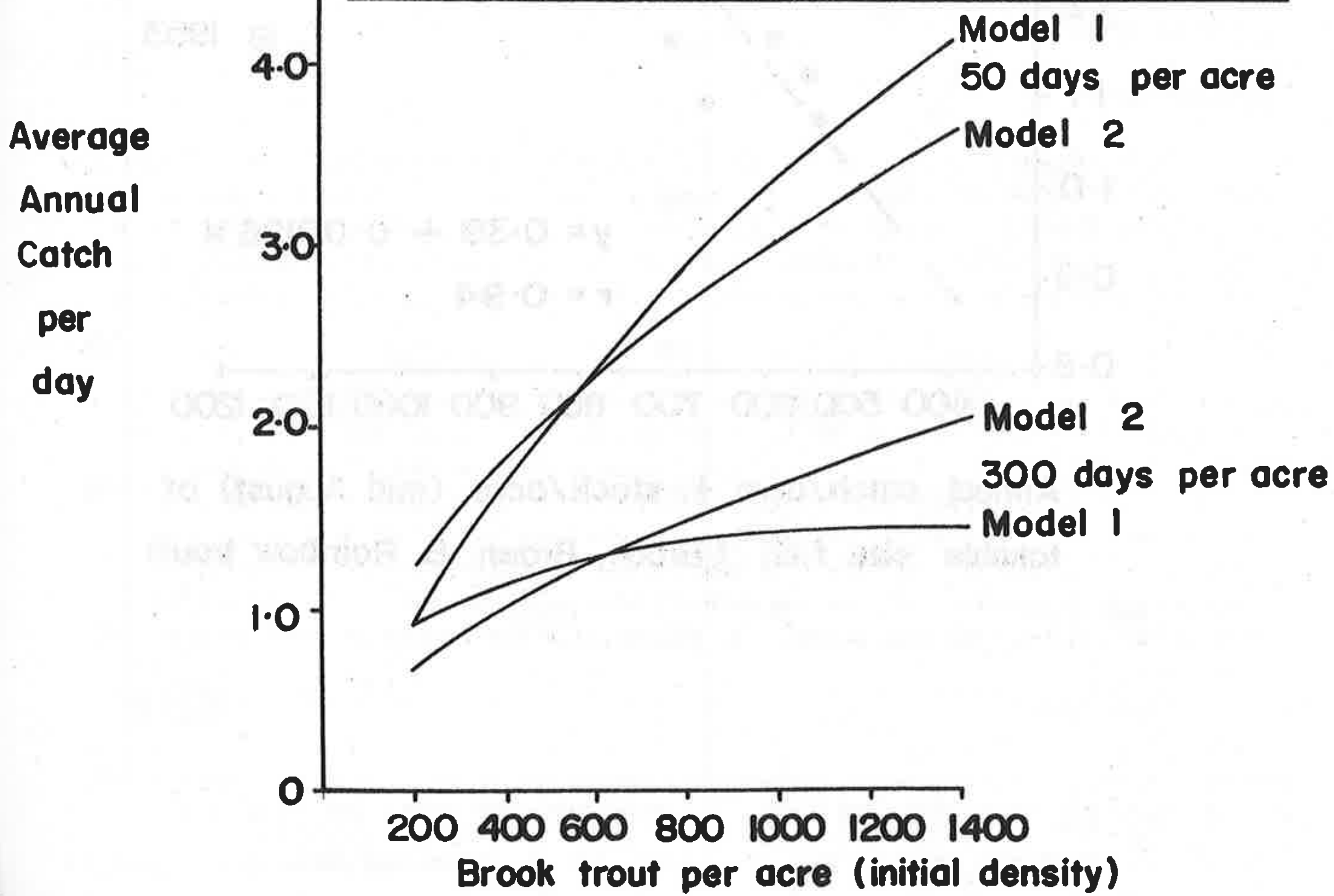


FIG. 6

RELATIONSHIP BETWEEN ANNUAL CATCH PER HOUR RATES AND TROUT STOCKS IN SAGEHEN CK. CALIFORNIA DERIVED FROM GARD & SEEGRIST 1972

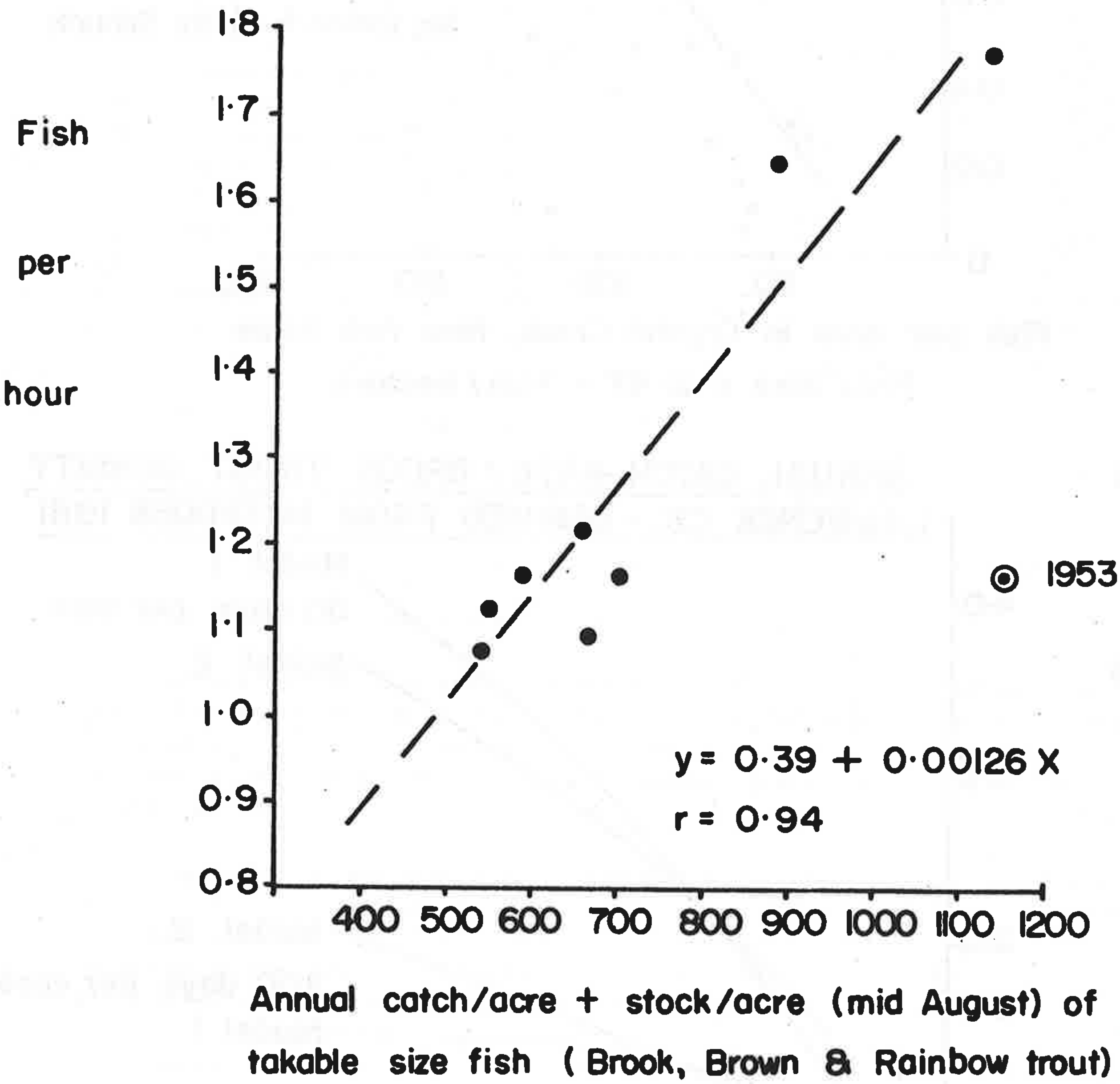
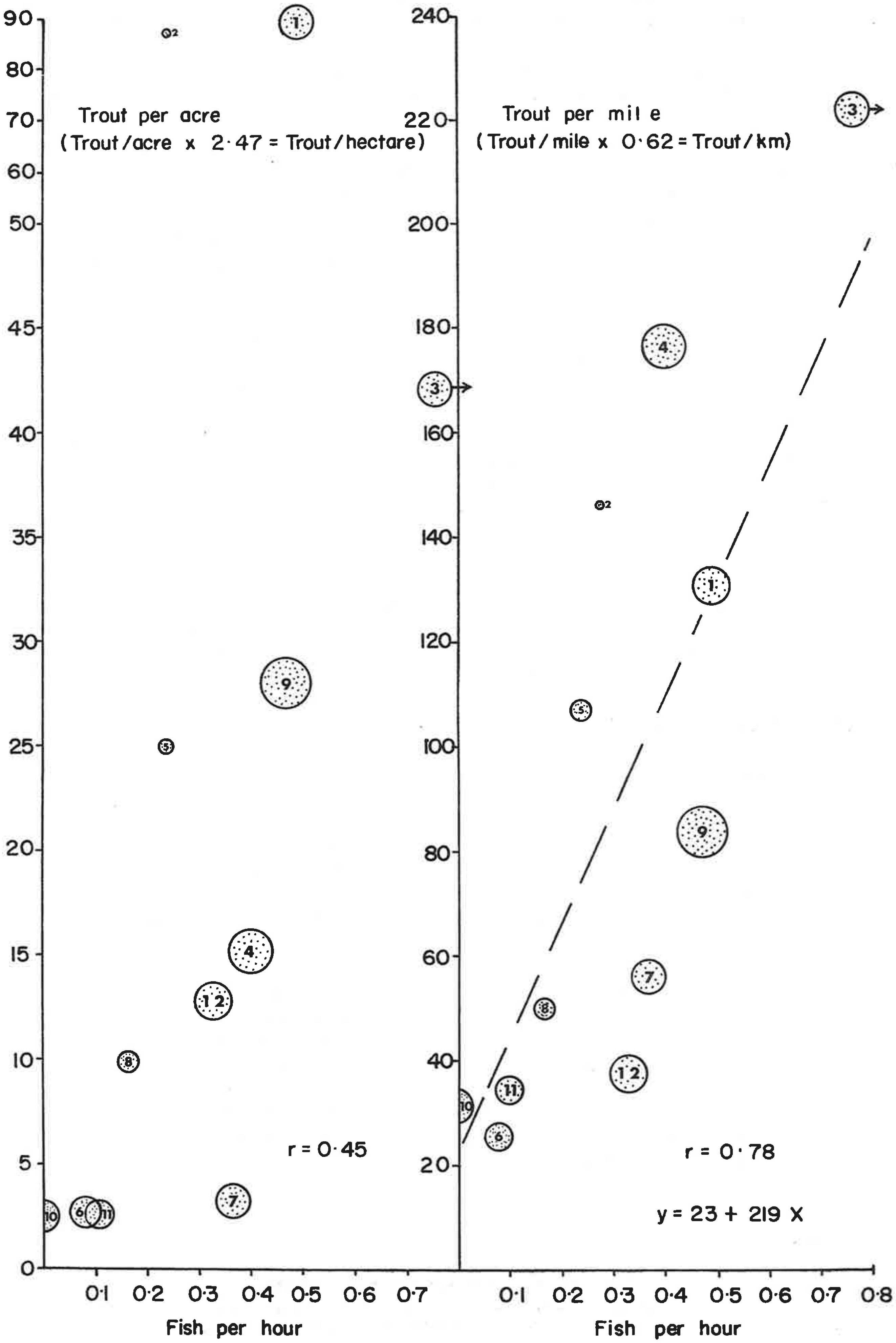


FIG. 7

RELATION BETWEEN TROUT DENSITY AND ANGLERS' CATCH RATES



general in New Zealand, takable trout densities probably remain fairly stable throughout each season but can change significantly between seasons. Therefore, annual catch rates should be better related to trout density than those in the above study.

Studies by Shetter (1950), Thorpe, Rayner and Webster (1947) and Shetter and Alexander (1962) (Fig. 8) found poor or no relationship between trout densities and anglers' catch rates.

In general, there appears to be a positive linear relationship between anglers' catch per hour rates and trout densities. The aim of scientists and trout managers to increase trout densities and so improve catch rates would seem to be valid. In many situations in New Zealand however the exact benefit to anglers of an increase in trout density is not clear. It is possible that any benefit can be easily destroyed due to other factors lowering catch rates.

The relationship may be influenced by, or interact with, anglers', environmental or fish population characteristics. For example anglers' skill, fishing methods and rates of coverage of a water may counteract low densities. McFadden (1961) described how one skilled angler continued to catch about ten brook trout per day whilst the stock density fell from 354 to 75 brook trout per acre. In clear streams anglers can search and find the trout and direct their bait towards the fish. In turbid lakes anglers' baits would be distributed more randomly and catch rates would be more dependent upon fish density. For these reasons further experimental studies of this relationship would be of great value.

In the angling diary scheme one of the major reasons for collecting catch rate statistics was to monitor trout densities in individual waters. As will be shown later, the effect of the many variables influencing these catch rate statistics could not be removed and therefore changes in catch rates could not be ascribed to any single factor such as fish density with any degree of certainty.

(j) Compound Variables

Introduction

Compound variables are those which accumulate the effects of more than one factor. For example, the annual catch rate of one angler from a water is dependent upon many subsidiary variables, such as the angler's skill, angling methods, the locality and the days on which he fished. The compound variable in this case is defined as that due to the individual angler and it incorporates the effects of variables listed above and others.

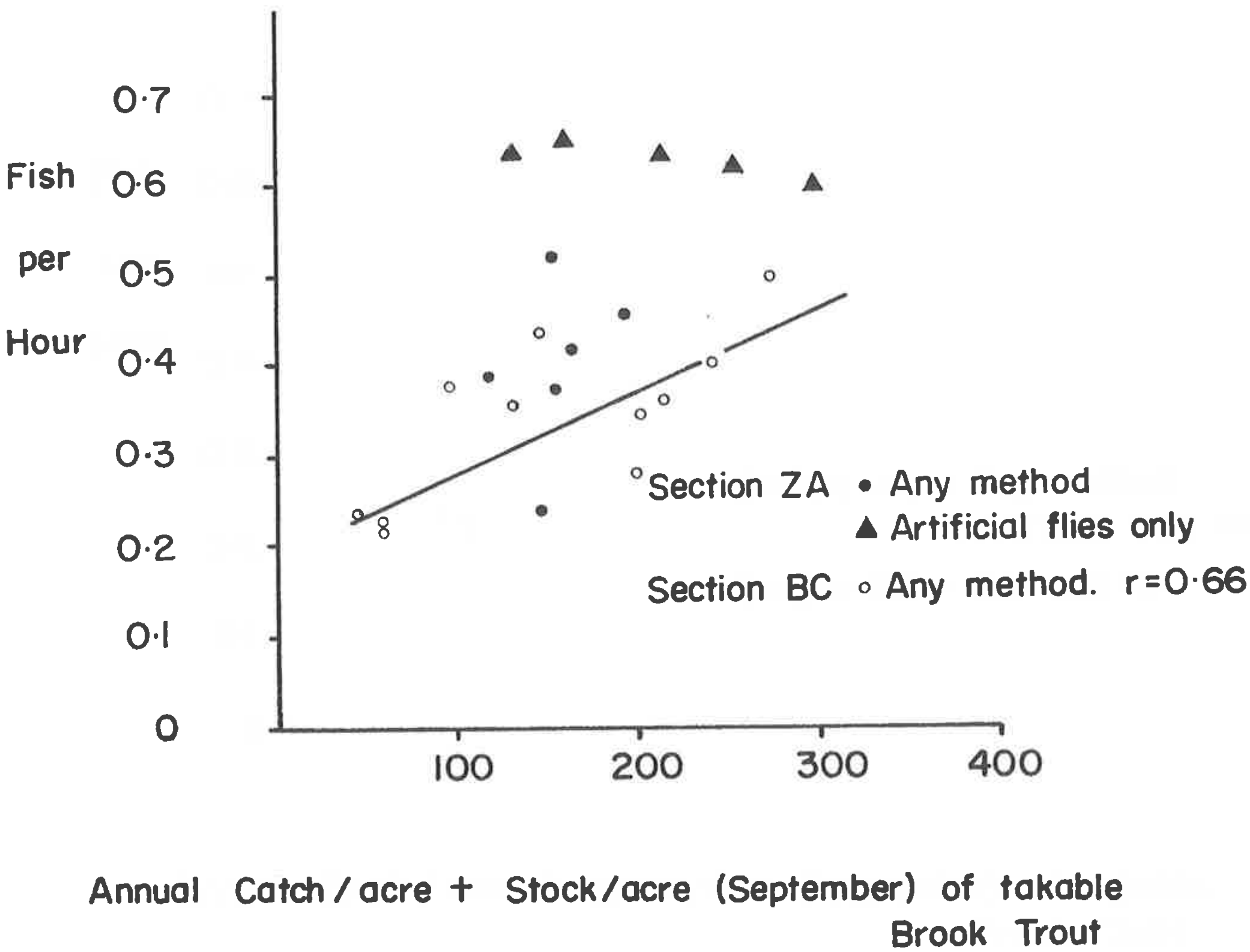
In any given situation the effects of a compound variable tend to be difficult to predict because of the complexity of the interactions between the specific variables which it incorporates. Usually only poor generalisations of the effect of each compound variable can be made. Previous studies of data collected by angling diary schemes have been made on the following compound variables: length of angling day, season fished, size of fish, mean air temperature, individual angler's results, Acclimatisation District and angling method (Allen and Cunningham 1957, Allen 1955). Additional studies were made possible by the computer tabulations of the 1962 and 1967 data.

Analysis

Anglers' daily catch frequency distributions are asymetrical with a high proportion of low catches. These distributions can be transformed to a normal distribution by log (Catch + 2) (Allen 1955). The standard deviation of this transformed

FIG. 8

RELATIONSHIP BETWEEN ANNUAL CATCH PER HOUR RATES AND BROOK TROUT STOCKS FROM 1949 TO 1959 IN HUNT CK. MICHIGAN DERIVED FROM SHETTER & ALEXANDER 1962



distribution can be taken as 0.28 in the majority of cases (Q is equal to 1.9) (Allen 1954). It is possible to directly estimate the value of the transformed mean catch per day from the arithmetic catch per day value using the following equation:

Transformed mean = log (0.887 arithmetic catch per day + 1.211).

The 1962 and 1967 tabulations contain only the number of days and average catch per day rates. Therefore the transformed catch per day rates had to be derived using the above equation. A programmable calculator was used to measure the variation introduced by each compound variable. This was then tested by an 'f' test.

Results and Discussion

The influences of the compound variables: years, individual anglers' annual results, angling methods, month and locality on catch per day rates recorded from the Mataura River are listed in Tables 11 and 12. The variation between diary years from 1947 to 1967 was the greatest source of variation. It is, however, interesting to note that when the diary years were divided into categories such as 1957 to 1967 and 1947 to 1951, the variation dropped considerably. This could indicate that the data collection techniques have caused the low catch rates recorded from 1957 onwards (see page 33).

TABLE 11

The Influence of the Compound Variable: Year and Origin of Diarists on Catch per Day Rates Recorded from the Mataura River

Year	Otago		Southland	
	Days	Catch/day	Days	Catch/day
1947	239	3.30	325	3.89
1948	137	3.53	281	3.12
1949	251	4.61	185	3.51
1950	357	4.75	146	3.70
1951	290	4.70	183	3.90
1957	198	2.00	847	2.22
1962	230	2.77	842	1.79
1967	144	2.06	173	1.97

Years Mean Square

Data	1947-1967	1947-1951	1957-1967
Otago	2.54*	0.76*	0.52*
Southland	3.18*	0.22*	0.64*

Origin of Diarists mean square = 0.64*

Catch per day = Kept Fish Only

Log (n + 2) distribution Mean Square = 0.077

The origin of diarists contributed a significant variation to the catch per day rates. Southland and Otago diarists showed significant differences in their choice of angling methods, angling location and distribution of angling effort throughout the year. The Southland anglers also were keener and fished more often during the season.

TABLE 12

The Influence of Certain Compound Variables on Catch per Day Rates Recorded by Otago and Southland Diarists During 1962 and 1967 from the Mataura River

District	Year	Compound Variables - Mean Square				
		Location	Month	Licence Cat.	Method	Angler
Otago	1962	0.07	0.06	0.14	0.20*	0.17*
Southland	1962	0.12	0.11	0.17*	0.62*	0.21*
Otago	1967	0.56*	0.33*	0.22*	0.18*	0.22*
Southland	1967	0.01	0.22*	0.19*	0.35*	0.21*

Log (n + 2) distribution   Mean Square = 0.077

Source of Variation	Degrees of Freedom	Mean Square
Compound Variables	4	0.018
Districts + years	3	0.027
Error	12	0.023

Notes:

(1) Location, Month and Licence category catch/day of dry fly angling method only.

(2) Location and Month values were derived from all licence categories including incomplete diary records.

(3) Method and Angler values were for men whole season licence holders who returned a complete diary.

* Significantly higher than 0.077 at 95% level.

The mean squares of the remaining compound variables: location, month, licence category, method and angler, ahd varying degrees of importance in the results from different years and different districts. The exact influence of each compound variable was not predictable. In general, angling methods and the influence of individual anglers had highly significant effects on catch rates. Licence categories in three out of the four years had significant effects. Both the variations due to months and due to locations in the river were highly variable.

The reason for the high mean square for Otago diarists in 1967 by location was investigated. It was found that the majority of angling effort was in the lower reaches of the Mataura River where a very high catch rate was recorded. Only a few results with low catch rates from the upper reaches were recorded. The low catch per day rates there may have been caused by a combination of variables such as a low fish population, or unskilled anglers, or fishing for short days or in the wrong season.

A component analysis of the variation due to individual anglers showed that the standard deviation ranged from 0.105 to 0.177 for the examples studied. A standard deviation for other situations could be taken as 0.2 which then could be used to estimate confidence limits of the catch per day results when a differing number of diarists' records are available. As an example it was calculated that when one, five, ten or fifty anglers' results were available, the 95% confidence limits of a catch rate of two fish per day would be plus or minus 65, 29, 21, or 9% respectively. Lower catch per day rates would have higher 95% confidence limits. This sytem can be used as an estimate of the accuracy of catch per day rates when no form of bias is present.

(k) Historical Changes in Diarists' Catch Rates

Local

Previous studies of historical changes in diarists' catch rates were undertaken by Allen and Cunningham (1957). They stated (p. 32) "it appears likely that variations of up to about one-third may occur in the hourly rate of catch from season to season without it being necessary to ascribe them to fluctuations in the state of the fish population".

It should be noted that this statement strictly applies only to catch per hour rates of this magnitude collected in consecutive years. Also it is not, of course, always true that variations over one-third are caused by fluctuations in the state of the fish population as many other variables can cause this.

An analysis was made of the possible causes for the drop in diarists' catch rate recorded from the Mangatainoka River in Wellington Acclimatisation District. This is a popular brown trout fishery and the diarists' results are very typical of many other waters (Table 13).

TABLE 13

A Historical Decrease in Catch Rates from the Mangatainoka River Recorded in the National Angling Diary Scheme by Wellington Men's Whole Season Licence Holders

Year	Anglers	Days	Days Per Angler	Hours Per Day	Fish Per Day	Fish Per Day*	Fish Per Hour	Fish Per Hour*	Fish Average Length
1962	42	340	8.1	2.9	1.03	0.33	0.35	0.18	42 cm
1967	9	43	4.8	3.0	0.4**	0.19**	0.13**	0.12**	48 cm

* Mean of bag distribution transformed by log (n + 2) (Allen 1955) Standard deviation = 0.28 (q = 1.90)

** Significantly different at the 99% level. 'F' test for transformed data and x^2 test on actual data.

Analysis by Method

Method	Fish per day 1962	Fish per day 1967	Fish per hour 1962	Fish per hour 1967
Dry Fly	1.11	0.63	0.40	0.12
Wet Fly	0.94	0.15	0.32	0.07
Minnow	0.83	0.47	0.24	0.19

The drop in annual mean catch rate was highly significant statistically when tested by both parametric and non parametric methods.

Table 14 lists 13 variables which could have caused this decrease in catch rate. A careful analysis of the data available showed that it was unlikely that four variables (3, 6, 8, 10) caused this decrease in catch rate. Further, more complex studies could show that this was also true of variables 1 and 4. The individual influence of the remaining variables cannot be completely assessed, generally because of the absence of historical data and the lack of knowledge of the relationship between these data and catch rates. The only possible conclusion which can be derived therefore, is that the difference in catch rates could have been caused by any of the individual variables No. 2, 5, 7, 9, 11, 12 and 13 or by a combination of the above variables or by other unknown variables. This conclusion is of very little value as it does not specify which variable caused the decrease in catch rates.

TABLE 14

List of possible Variables Causing the Low 1967 Catch Rate Recorded by Diarists from the Mangatainoka River

No.	Variable Description	Hypothesis	Data or Evidence Available for Examination of Hypothesis	Tests	Conclusion or Opinion of Effect
1	Error in diary record of effort in days (Allen and Cunningham 1957, p. 32).	Unsuccessful days not recorded in 1962.	Only bag frequency distribution in 1962.	Prove nil bags significantly lower than expected from Log (n+2) distribution.	Improbable, unlikely to be significant.
2	Error in diary record of effort in hours.	Overestimate of hours fished in 1967.	None.	None.	Possible effect on catch/hour.
3	Length of angling day (Allen and Cunningham 1957, p.23).	Catch/day drop due to shorter days in 1967. Catch/hour drop due to longer days in 1967.	Table 1.	Both rates have decreased.	Unlikely to be significant.
4	Distribution of effort.	Poor localities and seasons fished in 1967.	Catch rates can be tabulated by 10 mile locations and days.	x2 tests on effort distribution.	Possible.
5	Skill - Anglers' experience.	Anglers had less years or days per season experience in 1967.	Table 1 shows 1967 anglers fished on fewer days per season. No data on years experienced.	Covariance analysis of relation between annual effort and catch.	Probable.
6	Skill - Licence type.	Inconsistant licence types compared or classification errors.	Results sorted by licence category.	None required.	Not important.
7	Skill - Occupation and age.	Changes between 1962 and 1967.	Nil.	Nil.	Possible.
8	Angling methods.	Only poor methods used in 1967.	Table 1.	All methods especially fly, worse in 1967.	Not important.

TABLE 14 CONTINUED

No.	Variable Description	Hypothesis	Data or Evidence Available for Examination of Hypothesis	Tests	Conclusion or Opinion of Effect
9	Environmental features.	An increase in weed growth. A decrease in deep pools. A deterioration in weather conditions etc.	Angler observations of increase in bed load. Weather data records. No other measurements.	Only of weather conditions.	Very probable.
10	Trout population - Species.	Changes in species composition.	Species caught recorded.	Only brown trout caught.	Not significant.
11	Trout population - Size.	The larger 1967 trout caught were less catchable.	Size recorded (Table 1) but no good evidence of effect of size on catch rates available.	Nil.	Possible.
12	Trout population - Food.	Change in feeding habits made fish less catchable.	Angler observations of present day poor fly hatch and greater effectiveness of nymph methods.	Nil.	Possible.
13	Trout population - Density.	Lower densities in 1967.	Angler observations agree. Larger fish caught in 1967.	Nil.	Very probable.

The data are very typical of those collected by angling diary schemes and the majority of these variables will affect catch rates collected by these schemes. For some waters a greater quantity of data have been collected. This will not remove the effects of the seven variables listed above and no more definite or valuable conclusions can be reached.

In summary, this means that historical differences in catch rates can be caused by differences in anglers' skill, environmental conditions and fish population characteristics. If the diary scheme was to be used to measure specific fish population characteristics, such as fish density, through the years, records should have been kept of the anglers' skill, environmental conditions and other characteristics of the fish population other than density. This was not done and it would be a complex and difficult task.

In retrospect, the diary scheme should not have been designed to monitor the abundance of fish stocks in individual waters without undertaking a detailed study of the relationship between catch rates and fish density and the many factors which affect catch rates collected in an angling diary scheme.

National

The angling diary scheme was also intended to monitor national trends in the catch rates of anglers. Seventy-six waters containing adequate records from 1947 to 1967 were selected for study from the 129 listed in Appendix 1. These waters can be regarded as a good sample of the most important brown trout fisheries in New Zealand. The sample excludes the majority of the major lake fisheries.

The records from each water were examined for historical trends in both catch per hour and catch per day rates. In only three rivers, the Mangatainoka, Waipoua and Otaki in Wellington District, was there a continuous decrease in diarists' catch rate from 1947 to 1967. In no water was there an increase in catch rate. In 46% of the sample the 1947-1952 catch rates were noticably higher than all later ones. These catch per hour rates were then compared with later results for specific years and it was found that the number of waters where the 1947-1952 results exceeded later ones was significantly higher than the 50% expected. The 1957-1967 results were not significantly different from this value (Table 15).

TABLE 15

(a) Percentage of catch per hour rates which were higher than those in later years

	1947-52	1957-58	1962-63
1957-58	74**		
1962-63	80**	53	
1967-68	81**	50	46

* < 0.05

** < 0.005 n = 76

(b) Percentage mean trout lengths which were higher than those in later years

	1947-52	1957-58	1962-63
1957-58	54		
1962-63	49	49	
1967-68	45	54	51

(c) Percentage of proportions of undersized fish caught which were higher than those in later years

	1947-52	1957-58	1962-63
1957-58	56		
1962-63	66*	61	
1967-68	73**	65*	54

Therefore, there was a definite national change in the rate of catch recorded by diarists between 1952 and 1957. It was unlikely that this was caused by changes in the environmental conditions or fish population characteristics of all these waters distributed throughout the country. It was probably caused by a decrease in the average diarist's skill due to various changes in the angling diary scheme and the increase in licence sales.

If this hypothesis is accepted, then only the 1957-1967 records can be used to accurately monitor the catch rates of anglers. These records indicate a decrease in catch rate for 9 rivers, an increase for 10 rivers and stable or fluctuating rates for the remaining 57 waters. The variables which have caused, or concealed, trends in the 76 waters were not examined and the results taken at their face value with the following conclusions:

(1) There is no evidence for a national change in anglers' catch rates from the major brown trout fisheries in New Zealand during the period 1957-1967.

(2) There has been a continuous decline in catch rate for 4% of these waters for the period 1947-1967 and for 12% of these waters for the period 1957-1967.

(3) This decline has been compensated by an increase in catch rate in 13% of these waters for the period 1957-1967.

(4) Despite fluctuations, the large majority (75%) of waters have remained stable in catch rates over the period 1957-1967.

2. Size of Fish

(a) Local Trends

One of the objectives of the five year angling diary schemes was to monitor changes in the size of fish recorded by diarists from particular waters. It was hoped that by careful analyses of changes in the size of fish caught, changes in the size of trout present in the waters in New Zealand could be monitored.

Allen and Cunningham (1957, p. 33) stated "variations in mean length from year to year are probably not due to variations in the population if less than about 1 inch"(2.5 cm). As in the analysis of catch rates, this statement is true only for consecutive annual schemes with fish averaging about 40 cm in length. In five year schemes, historical trends in certain variables can result in far greater changes in fish length occuring without having to ascribe them to variations in the population.

A careful examination was made of the variables influencing the length of brown trout recorded by diarists from the Mangatainoka River in Wellington District in 1962 and 1967 (Table 16). In 1967 the brown trout were considerably larger averaging 50.3 cm compared to 43.9 cm in 1962. Table 16(c) shows that the hypothesis that both samples of fish caught by dry fly techniques in 1962 and 1967 could have come from the same population of diaries is rejected at the 99.9% level by a chi-square test.

TABLE 16

Influence of Some Compound Variables on the Length of Brown Trout Recorded by Diarists in 1962 and 1967 from the Mangatainoka River in Wellington District

Length class	(a) Angling Method 1962 Number of Fish Recorded by			(b) Locality, Distance Upstream from Manawatu River	
	Dry Fly	Wet Fly	Minnow	0-16 km	16-32 km
1	63	24	22	110	11
2	209	36	9	229	32
3	25	10	1	28	8
	x^2 = 39.3 > 99.9%			x^2 = 4.5 < 90%	

Length class	(c) Years		(d) Month 1962-63						
	Dry Fly 1962	Dry Fly 1967	Oct	Nov	Dec	Jan	Feb	March	Apr
1	63	8	27	35	29	13	4	5	10
2	209	45	45	47	60	54	15	17	26
3	25	65	2	6	5	11	4	1	8
	x^2 = 109.4 > 99.9%		x^2 = 28.1 > 97.5%						

Length class

1	=	25.4 - 38.1 cm	(10-15 inches)
2	=	40.6 - 48.3 cm	(16-19 inches)
3	=	50.8+ cm	(20+ inches)

Table 17 lists the variables which could have caused this difference in the size of fish caught. Allen and Cunningham (1957, pp. 34-39) comprehensively covered some of these variables such as the measurement bias, influence of angling locality, rate of catch and the influence of size limits. The influence of some other compound variables is shown in Table 16 and it appears that angling method (16(a)) is of greater importance than the season (16(d)) or locality of the river fished (16(b)). In other cases this may not apply.

TABLE 17

List of possible Variables causing the Increase in Length of Brown Trout Recorded by Diarists from the Mangatainoka River in 1967

No.	Variable Description	Hypothesis	Data or Evidence Available for Examination of Hypothesis	Tests	Conclusion or Opinion of Effect
1	Incorrect measurement by diarists including even number bias.	Over-estimate of length in 1967 and under-estimate of length in 1962.	1967 length records from 20 anglers, 1962 length records from 51 anglers.	None.	Unlikely to be very important.
2	Tabulation and calculation.	Clerical and calculation errors caused increase.	Frequency distributions, computer tabulation.	A few clerical errors would have little effect.	Unlikely to be very important.
3	Angler skill.	Anglers more skillful at catching large fish in 1967.	Only relation between size and number of fish caught per annum.	No complete tests possible.	Possible.
4	Anglers' desire to catch large fish.	Anglers more selective and determined to catch large fish in 1967.	Nil.	None possible.	Possible.
5	Takable fish returned.	Anglers returned more small fish in 1967.	Fish returned in 1962, fish returned in 1967.	Insignificant numbers.	Unlikely.
6	Angling method.	Better methods for catching larger fish used in 1967.	Tabulation by method (Table 16).	x^2 for one variable and non-parametric multiple analysis of variance for more than one.	Unlikely.
7	Angling locality.	Only large fish localities fished in 1967.	Tabulation by locality (Table 16(b)).	"	Possible.
8	Season fished.	Only the best seasons fished in 1967.	Tabulation by month (Table 16(d)).	"	Possible.
9	Size limits.	Increase in minimum size limit in 1967.	No change in size limit.	-	No effect.
10	Environmental features.	Changes increased catchability of large trout.	Nil.	Not possible.	Possible.
11	Trout population - migrations.	Small fish migrate to unfished areas.	None.	Not possible.	Unlikely.

12	Trout population - food.	Decrease in natural food availability for large trout and diet changed to items used as bait by anglers.	None.	Not possible.	Possible
13	Trout population - species.	More large sea run browns caught in 1967.	None.	Not possible.	Possible.
14	Trout population - density.	Increase in numbers and more large fish available in 1967.	Catch rates similar, otherwise none.	Not possible.	Possible.
15	Trout population - size of takable fish.	Average size of takable fish higher in 1967.	None.	Not possible.	Very likely.

Of the fifteen variables which could have caused this difference, the effect of three variables 2, 5 and 9 can be fairly easily removed. A more complex analysis, using non-parametric multiple analyses of variance techniques, could remove the influence of variables 6, 7 and 8. The total influence of the remaining nine variables cannot be completely removed. It is considered that two are fairly unimportant, No. 1 and 11. Six variables could have caused the difference observed. No. 3, 4, 10, 12, 13 and 14. However, the most likely cause for the increase in size is the No. 15, (i.e. an increase in the average size of takable fish present in this water in 1967).

In conclusion, historical changes in the size of fish caught by diarists from particular waters could have been due to the anglers, the environment and the fish population characteristics. The size of fish caught is probably a better guide to the size of fish present in the population than the anglers' catch rate is to the density of fish stocks present.

There is a need for more detailed studies of the practicability of predicting the size of fish in fish stocks from the size of fish caught by anglers. When such studies have been carried out these angling diary data may become valuable for monitoring trends.

Details of the size of fish caught in the various years of the angling diary scheme are included in Appendix 1 and detailed descriptions of the historical changes by water are published in the district reports.

(b) National Trends

There is no evidence of any national trends in the size of fish caught by anglers over the period 1947-1967. Of the 76 waters examined for changes in catch rate (page 32) there was an equal number of waters (8 each) which showed an increase or decrease in the size of fish caught. In the remaining 60 waters, the size of fish generally fluctuated less than a few centimetres between years. There was no correlation between changes in size and the changes in catch rate noted earlier. The Kauaeranga River was the only water which showed a decrease in both the fish size and anglers' catch rates (1957-1967) and the upper Manawatu River the only water with an increase in both the fish size and catch rates (1957-1967). Also in no year was there a significantly higher number of waters which had larger fish than in other years (Table 15(b)).

3. Proportion of Undersized Fish

Some of the factors influencing the proportion of undersized fish caught by diarists were described by Allen and Cunningham (1957, p. 51). The reason why this statistic was collected through the five yearly angling diary scheme was not stated. It was assumed that it was intended to monitor the percentage of the actual trout population which was under the size limit. The number of fish which would be available for anglers to catch in proceeding years could then be predicted. This could not be achieved because of the number of variables influencing this statistic. Many of these variables are similar to those influencing the actual size of fish recorded by diarists.

Amongst these variables are those due to angler measurement errors and historical angler selection errors. It is possible for example that more takable fish are returned as undersized nowadays. The percentage of undersized fish varies between waters and between angling methods and it was shown that size limits had a direct positive correlation with the percentage of undersized fish recorded (Allen and Cunningham 1957, p. 144). Environmental variables could influence the percentage of undersized fish caught but no examples are known. It is strongly suspected that rainbow trout fingerlings are more catchable than brown trout fingerlings and that there would be differences in the proportion of undersized fish caught depending upon changes in species composition. Another fish population characteristic which could affect the proportion of undersized fish caught could be the density of the stocks. There may be a drop in the proportion of undersized fish caught as the density of takables increases. Also there is probably a direct negative relationship between the size of the takable trout in the actual population and the numbers of undersized fish caught (Allen and Cunningham 1957, p. 144). Finally, probably the most significant variable is the proportion of trout population which is under the size limit. This proportion will vary between rivers and between localities and seasons in any water.

Therefore, historical monitoring of the statistic is fairly complex and a number of variables have to be taken into account.

(a) National Trends

There are some indications of a small decrease in the percentage of undersized fish caught. Of the 76 waters examined for trends, 10 showed a decrease in the percentage of undersized fish caught, and only 1 an increase, over the period 1947-1967. This trend was confirmed by a count of the number of waters which had a higher percentage of undersized fish in 1947-1952 than in later years (Table 15(c)). It was found that the incidence of decrease in the percentage of undersized fish was significantly higher in the North Island of New Zealand at 28% (7 waters) compared to 5% (3 waters) in the South Island. The factors causing this trend were not examined.

4. Distribution of Species

A clear account of the distribution of various species of salmonids in New Zealand was given by Allen and Cunningham (1957). Detailed accounts of the distribution patterns of trout in various Acclimatisation Districts are given in the district reports. It was shown that the distribution of rainbow and brown trout (Salmo gairdneri and S. trutta) was fairly stable and a minor objective of the five yearly angling diary scheme was to confirm this. There are relatively few variables which could affect the proportions of species in different waters. These include historical changes in angling techniques, localities and seasons and historical changes in the anglers' preferences for particular species. However, in general as is shown in Appendix 1 there have been no significant changes in the distribution of the various species throughout the country. Some of the local changes mentioned in the district reports include probable river dwelling rainbow trout stocks in some South Island rivers, a decrease in the number of Atlantic salmon (Salmo salar) caught in the Waiau system and a decrease in the percentage of brown trout caught from the Tukituki River.

IV THE ANGLING EFFORT

One objective of the five yearly national angling diary scheme was to monitor historical trends in the angling effort of average anglers and in annual totals in Acclimatisation Districts. With information on the average licence holder's catch rate, trends in the total crop of fish could be determined. In general, the scheme succeeded in this objective and historical trends have been detailed in the district reports.

1. The Individual Angler

(a) Annual Fishing Effort

The features of individual diarist's annual fishing effort records were adequately described by Allen and Cunningham (1957, p. 76). Data from the 1958 and 1963 postal questionnaire schemes were available for further studies on the degree to which diary records overestimated the mean annual effort of the average licence holder (see Allen and Cunningham 1957, p. 77).

Table 18 shows that the diarists recorded a more limited range of mean effort values from 13.25 to 21.7 days per season than postal questionnaire respondents who recorded from 9.70 to 28.5 days per season. These results indicate that the questionnaire respondents recorded lower effort levels when the diarists' effort was low but considerably higher effort levels when the diarists' effort was high (Fig. 9).

TABLE 18

Comparison of Annual Angling Effort in Days in own Acclimatisation District of Men's Whole Season Licence Holders, collected by Voluntary Postal Questionnaire and Angling Diary Schemes

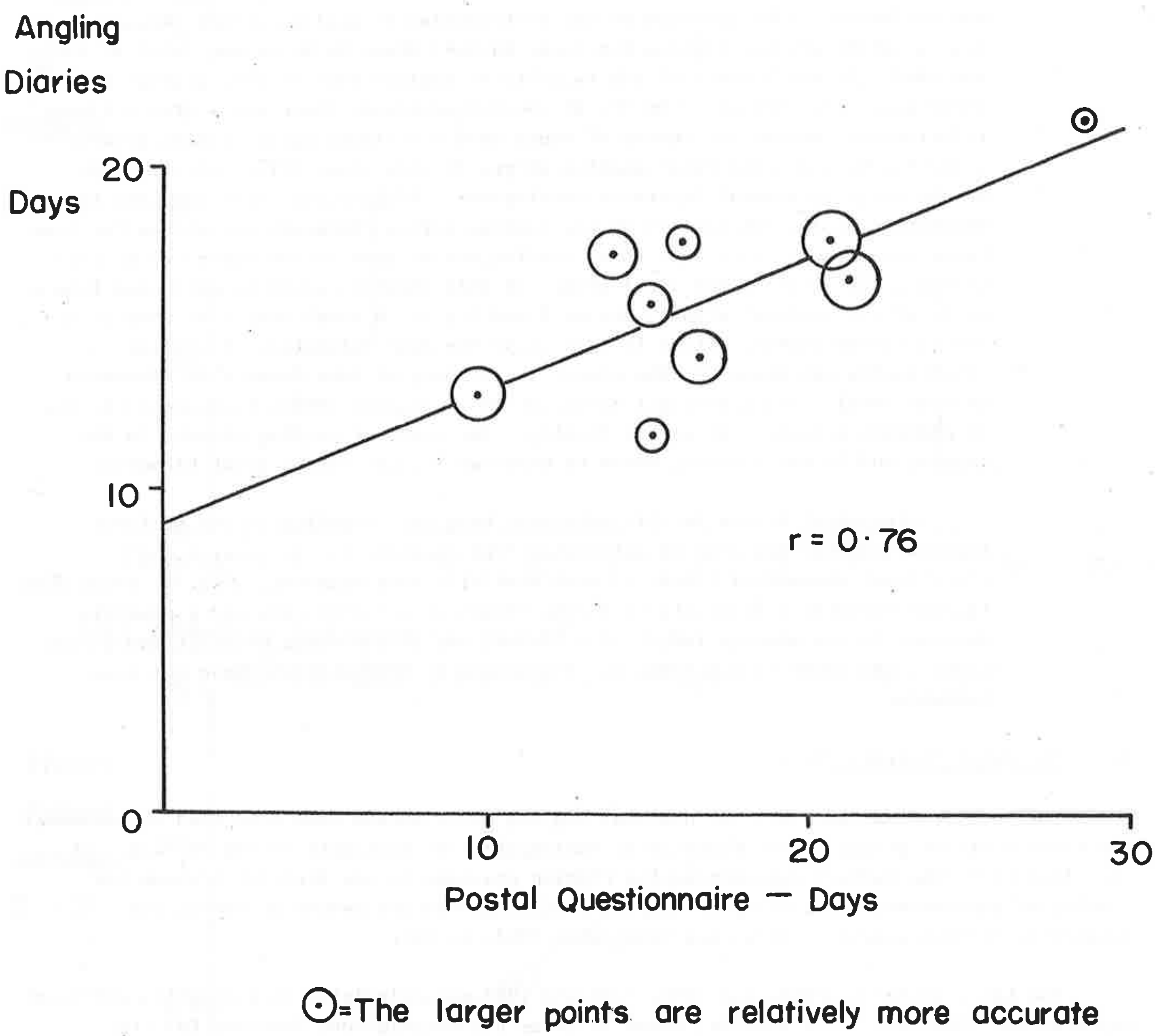
Acclimatisation District	Year	Angling Diaries			Postal Questionnaire		
		% Return	No.	Mean Days	% Return	No.	Mean Days
Auckland	1957	3	44	17.86	55	79	16.20
	1962	8	115	14.39	58	203	16.60
Waimarino	1962	5	16	21.70	26	52	28.50
Wellington	1962	8	148	15.81	33	86	15.07
					100*	259	12.43
Nelson	1957	18	77	13.25	69	198	9.70
	1962	10	43	11.91	48	107	15.28
North Canterbury	1962	2	112	17.80	44	266	20.63
Otago	1957	4	158	17.44	33	139	13.90
	1962	4	177	16.66	46	143	21.32

* Includes interviewed postal questionnaire non-respondents

The best evidence that diary records overestimate the mean annual effort of the average licence holder was supplied by the 1963 Wellington postal questionnaire scheme. Anglers who did not reply were interviewed. These anglers fished rarely, averaging 11.12 days per season (see Abramson 1963 and Carline 1972). The diarists' angling effort (15.8) and the questionnaire respondents' effort (15.1) significantly overestimated the average licence holder's effort of 12.4 days per season. In the district reports the mean angler's effort was usually calculated from the results of the postal questionnaire schemes. The non-respondents' effort was calculated as 0.74 of the respondents' effort.

FIG. 9

RELATION BETWEEN MEAN ANNUAL ANGLING EFFORT RECORDED BY POSTAL QUESTIONNAIRE & ANGLING DIARY SCHEMES



(b) Hours per Day

The variables influencing this statistic were examined by Allen and Cunningham (1957, p. 81). These variables included the local customs of anglers in certain Acclimatisation Districts and those due to the characteristics of individual diarists, waters, angling methods and the environmental features of the day fished. In one district the length of the fishing day increased with the distance travelled to the water. In other instances the average length of fishing day increased with the number of days fished by individual anglers.

Additional studies on the 1957-1967 information confirmed these findings. One additional study was made of the distribution of angling effort throughout the day by salmon anglers fishing the lower Waitaki River in March and April of 1963 and 1968. It was found that the majority of anglers were fishing between two and three p.m. (Fig. 10(a)). For the 35 anglers examined, there was a direct linear relationship between the number of hours each individual spent fishing between 2 and 3 p.m. and their total angling effort on this river (Fig. 10(b)). This result leads to several important conclusions. Firstly, it indicates that the diarists' results are typical of the average salmon fisherman who fishes for less hours per season. Secondly, these results can be used in the design of a creel census scheme whereby the total effort at this locality could be estimated from a study of the anglers' effort between 2 and 3 p.m. A creel census to monitor the annual salmon fishing effort in this river has been initiated. A similar relationship was found for the winter ice fishery at Lake Mendota in Wisconsin (Parker 1956). The symetrical distribution of angling effort throughout the day is probably a feature of winter fishing. Two peaks of angling effort, in the morning and in the evening, would be expected in most summer trout fisheries.

Historical trends in this statistic have been detailed in the district reports and they may also be calculated from Appendix 1. In general, no significant historical trends in this statistic were apparent. Fig. 11 shows some typical historical fluctuations in the length of a fishing day and a possible decrease in the average length of a fishing day in the Otago District and in two rivers, the Pomahaka and Mataura. The causes of this decrease have not been isolated.

2. The Total District Effort

The results from the 1947-1952 national angling diary scheme have been used to estimate the total district effort in the majority of Acclimatisation Districts in New Zealand. It was found that "the factors determining the fishing pressure in any district include the density of population, the quality of fishing available, and the amount of useful and accessible fishing water." (Allen and Cunningham 1957, p. 99).

The total district effort for 1957, 1962 and 1967 was calculated in a slightly different way than for 1947-1952. For example, Table 19 shows the calculations involved for the Wellington Acclimatisation District in 1962-63. To the total of 55,000 days angling recorded can be added an approximate 6,000 days for visiting anglers from other Acclimatisation Districts. The 95% confidence limits cannot be accurately estimated but it is hoped that the result is accurate to within ± 20% i.e. between 49 and 73 thousand days in that season.

FIG. 10

ANGLING EFFORT OF 35 DIARISTS ON LOWER WAITAKI RIVER, MARCH & APRIL 1963 & 1968

(a) Distribution of angling effort through day

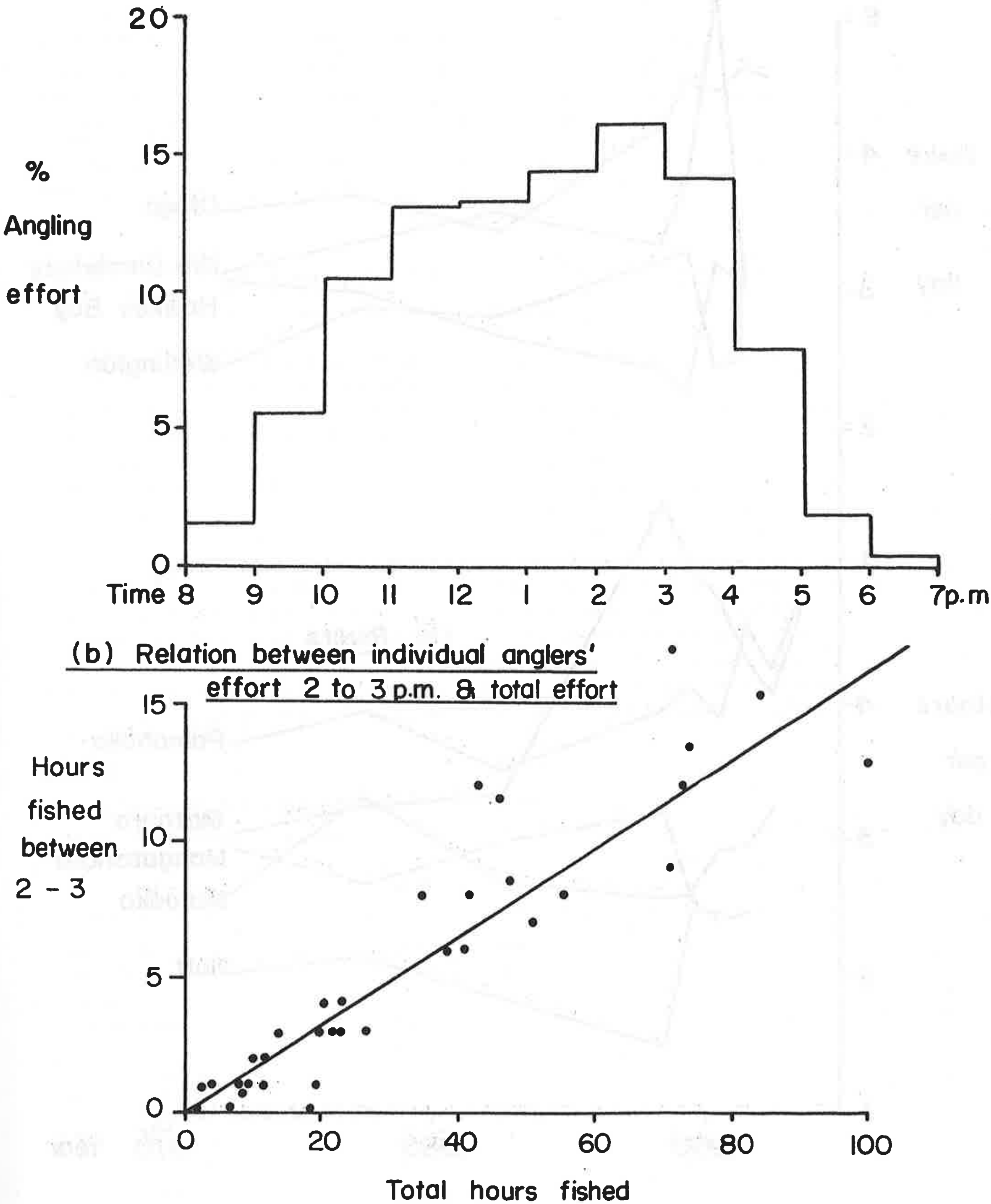


FIG. 11

HISTORICAL CHANGES IN LENGTH OF FISHING DAY

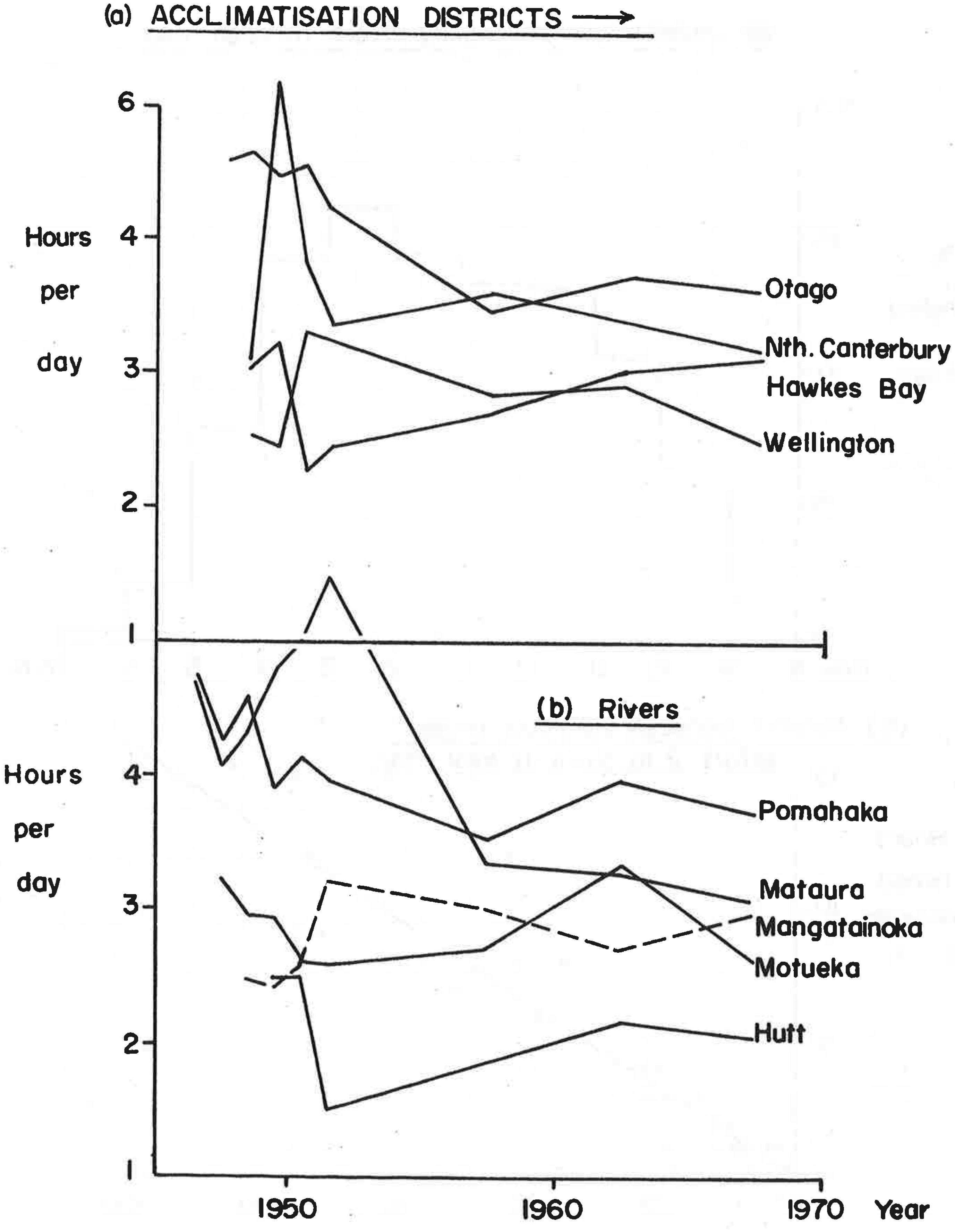


TABLE 19

Calculation of the Total Days Angling per Season in Wellington Acclimatisation District by Wellington Acclimatisation Society Licence Holders in 1962-63

Licence Type	Total No. Licences	Angling Diaries		Postal Questionnaire and Interviews		Total Days Angling* in District
		No.	Mean Days	No.	Mean Days	
Men's Whole Season	1,861	148	15.81	259	12.43	23,132
Women's Whole Season	197	7	7.86	18	10.90	2,147
Children's Whole Season	1,711	55	12.64	113	16.20	27,718
Half Season	191	1	3.00	37	8.90	1,700
Weekly	150	0		28	2.90	435
	4,110					55,132

* Postal Questionnaire mean effort used as 100% return of sample was obtained.

One of the main objectives of the angling diary scheme was to monitor changes in the district angling effort and hence catch. Table 20 shows the angling diary results from Wellington District from 1948 to 1967 with the estimates of the average licence holder's annual fishing effort. Twelve variables which could have influenced these historical estimates of the average licence holder's fishing effort and the calculations from this of the total district effort are shown in Table 21. It is considered that six variables are not important (No. 3, 4, 5, 8, 9 and 10) and of the remaining six, three can be measured (No. 2, 6 and 7) which leaves variables No. 1, 11 and 12 as important sources of variation which cannot be easily assessed. A large number of variables makes difficult the determination of what caused these historical trends. However, in the district reports estimates have been given of the total district effort between diary years and opinions on the factors which have caused the historical changes. In general, it is apparent that although licence sales in some districts have increased, there has been a slow decrease in the average licence holder's annual effort so that often the total district effort has remained very similar for many years. If this trend continues, then an increase in licence sales will not necessarily result in an increase in angling effort.

TABLE 20

Angling Effort of Men's Whole Season Diarists 1948 to 1967

	YEAR						
	1948	1949	1950	1951	1957	1962	1967
Licence Sales	1,245	1,509	1,750	1,467	1,412	1,861	1,792
Diaries Returned	6	26	23	21	84	148	41
% Return	0.5	1.7	1.3	1.4	5.9	7.9	2.3
Mean Days Fishing	42.67	18.8	23.9	21.18	17.57	15.81	16.56
Est. Days Fishing by Average Licence Holder			10.2*		13.8**	12.43***	13.0**

* Derived from regression analysis (Allen and Cunningham 1957)

** Approximate reduction of 21.4% as 1962-63

*** 1963 postal questionnaire result

TABLE 21

Some Variables Influencing the Historical Estimates of Wellington Licence Holders' Average Days Fishing and Total District Effort in Wellington District using the Angling Diary Records from 1948 to 1967

Variables	Hypothesis	Tests	Conclusions on Importance of Hypothesis
1 Changes in diary format	Decrease from 300 day record spaces in 1948-1952 to 22 spaces in 1967	Exceptional peak of returns in 1962 and 1967 around 20-22 days	Probable
2 Inclusion of incomplete diary records	Subjective estimates on diary completeness varied	None possible except fit of catch per day rates to log (n + 2) distribution	Possible
3 Geographical distribution	Some licence sellers did not receive diaries	Nil	Unlikely in Wellington District
4 Voluntary return from different angler types	Change in character of respondent, e.g. (1) Occupation (2) Age (3) Experience	Table 22 shows little variation in effort between these features	Unlikely here
5 Geographical changes in diary return	In some years diaries only from districts where anglers fished little	Table 23 shows increased returns from Wellington and Hutt cities but little difference in mean effort	Unlikely here
6 Individual diarist variability	Low returns and random variations caused changes	Coefficient variation range from 0.7 to 1.0	Probable cause for variation in average licence holder's effort estimate
7 Analysis technique	Errors in regression system for 1948-51 or reduction factor 1957-67	Statistical confidence limits fairly large	Probable
8 Licence sales	Errors in records	Nil	Very unlikely
9 Visiting anglers	Estimates incorrect	Nil	Possible but not very significant in total
10 Unlicenced angling	Historical changes	Few prosecutions	" "
11 Environmental	Poor weather conditions in some years	No detailed studies made	Probable
12 Fish population	Low catchability in some years reduced effort	Nil	Probable

TABLE 22

Angling Effort of various Types of Anglers in Wellington Acclimatisation District 1962-63

Occupation	Angling Diaries	Postal Questionnaire and Interview Scheme					
	% Return	% Return	Days	Age	Days	Years Angling	Days
Professional	22	18	13.3	Under 20	21.9	1-10	13.7
Minor Business	16	12	12.2	20s	10.7	11-19	14.7
Clerical	19	15	13.0	30s	10.9	20-29	11.3
Farmers	13	16	11.8	40s	15.9	30-39	14.5
Skilled	22	22	14.5	50s	13.2	40+	7.8
Semi-skilled	9	17	14.2	60s	12.4		
Sample size	35	248		70+	5.7		

TABLE 23

Geographical Distribution of Wellington Acclimatisation Society Diarists 1948-67

Region	% Diaries Returned				Mean Days Angling*
	1948-52	1957-58	1962-63	1967-68	1962-63
Wellington and Hutt	26	38	35	56	17.4
Wairarapa	30	29	22	17	16.9
Manawatu	34	23	21	14	14.9
Taihape	10	4	5	3	16.4
Unspecified	0	7	17	10	
Number Diaries (all licence types)	80	114	167	90	

* Men's whole season licence holders only

3. Distribution Within Districts

A map of angling effort throughout New Zealand for 1951-52 was constructed, using the proportion of diarists' angling effort on individual waters and the estimated total district angling effort (Allen and Cunningham 1957, pp. 102-3).

Monitoring of historical trends in angling effort on individual waters was not possible and maps were not constructed, as a consistently high return of diaries, well distributed through an Acclimatisation District, was rarely achieved. Also as diarists are skilled anglers with greater angling experience, it is likely that they employ more skilful angling methods such as artificial fly (Hobbs 1948). This difference is clearly shown in Table 24 with children rarely fishing by artificial fly techniques and prefering to use worm and spinning methods. Diarists will therefore tend to select waters where only artificial fly fishing is legal and hence there will be a disproportionate geographical distribution of angling effort, varying between Acclimatisation Districts in relation to the severity of angling method restrictions.

Some tabulations of estimated historical angling effort patterns on the individual waters have been included in the local reports as an aid to Acclimatisation Society management.

TABLE 24

Angling Method Preference by Different Licence Categories

River	Year	% Angling Days by Angling Method					
		Artificial Fly		Minnow		Worm	
		MWS	CWS	MWS	CWS	MWS	CWS
Ruamahanga	1962	21	9	26	27	50	56
Hutt	1962	72	50	8	43	2	0
Motueka	1967	44	0	41	92	0	0
Clutha	1962	18	3	38	40	17	12
Mataura	1962	60	6	23	50	11	36

MWS Men's whole season licence holder

CWS Children's whole season licence holder

The major value of the results of the detailed distribution of diarists' effort is in planning stratified creel censuses on individual waters. From a study of diarists' effort by location, season, time of day etc. it is possible to obtain accurate creel census results with little field effort.

Recent techniques for conducting these creel censuses are described in Johnson and Wroblewski (1962), Lambou (1961), Pfeiffer (1967), Regier (1971), Robson (1960 and 1961) and von Geldern (1961 and 1972). A bibliography of previous creel census studies was published by Schultz (1959).

4. Distribution Through the Season

Although additional information on anglers' fishing effort through the season was derived from computer tabulations of the 1962 and 1967 diary schemes, no significantly different conclusions to those from the 1947-52 study were derived.

The variability in angling effort between days and the increase in angling effort on holidays and at the close of the season were also found in the 1947-52 scheme. The number of anglers on holidays is less variable than on week days, coefficients of variation of the mean number of anglers averaging about 0.6 and 0.8 respectively.

V THE CATCH

The distribution and the range of diarists' catches were described by Allen and Cunningham (1957, p. 115). Similar features were found in later years axcept that there was a tendency for a greater proportion of diarists to have very low angling catches.

In 1957-67 the total district crop (Table 25) was obtained by multiplying the catch of the average diarist by a correction factor (such as 0.48 for men's whole season licence holders) to get an estimate of the average licence holder's catch. This catch was then multiplied by the licence sales in that year. Neither this system or the 1947-52 method is particularly accurate, the majority of variables listed in Table 21 being able to affect it.

TABLE 25

Estimates of Catch and Effort for 1967-68 Angling Season

District	Total No. Days Angling in 1967-68	Total No. Fish Kept by Anglers 1967-68
Auckland	55,000	37,000
Waimarino	20,000	16,000
Taranaki, Stratford, Hawera	15,000	10,000
Rotorua*	150,000	120,000
Taupo**	93,000	140,000
Hawke's Bay	34,000	13,000
Wellington	49,000	22,000
Others N.I.	10,000	5,000
Total North Island	426,000	363,000
Westland	5,500	3,500
West Coast	18,500	15,000
Nelson	21,000	13,000
Marlborough	9,000	4,500
North Canterbury	210,000	90,000
Ashburton	47,000	18,000
South Canterbury	100,000	58,000
Waitaki Valley	75,000	45,000
Otago	135,000	110,000
Southland	125,000	110,000
Southern Lakes	75,000	50,000
Total South Island	821,000	517,000
Total New Zealand	1,247,000	880,000

* Estimates by Mr B.T. Cunningham for 1958-59 season.

** Estimates by Mr D.F. Hobbs for 1957-58 season but reduced for average licence holder's lower angling effort and catch.

The correction factor was derived from the best available data, a comparison of the diarists' and questionnaire results in Wellington District in 1963. The far lower catch rate and catch of the average licence holder directly conflicts with Allen and Cunningham's study in Nelson in 1950 when diarists averaged annual catches similar to the average angler. Further studies are required to determine how suitable is this correction factor.

In the district reports, estimates have been given of the crop in each year of the angling diary scheme as a guide to the local fisheries managers. The accuracy of the historical trends shown in these reports varies with the quantity of data collected and the effect of those factors affecting anglers' effort and catch rate listed in Tables 21 and 14. In general terms, because of the errors introduced by these variables, it would seem to be easier and more accurate to use postal questionnaires and non-respondent interview schemes for a more accurate assessment of district trends in annual effort and catch.

In the district reports historical estimates of the catch from individual waters are given. These are only very general estimates as all the previously listed errors occur. These crop estimates from individual waters will be of some value where surveys show the stocks to be comparatively high. For example, it was shown that the brown trout population of the Wainuiomata River, when estimated by electric fishing surveys, was about 3 800 takables in October. The annual crop by anglers in 1967-68 was estimated at 600 trout which is only 15% of the takables population (Graynoth 1974c). Similar low crop rates were also found in other Wellington waters and it is suspected that this could be general throughout New Zealand. If direct surveys of individual waters did show that this was the case, many of the stringent angling regulations in New Zealand could be relaxed and an increased crop of fish taken by anglers.

VI THE EFFECT OF REGULATIONS

No new studies were made on the effect of angling regulations as this subject was basically well covered by Allen and Cunningham (1957).

There was no intention to monitor the effects of the angling regulations using the angling diary scheme, although this is possible. The effect of various angling regulations has been recently extensively studied overseas (e.g. Babcock 1971, Hunsaker et al. 1970, Hunt 1970, Shetter 1969).

In New Zealand, problems which arise about the effectiveness of various angling regulations are normally solved by local surveys and by reference to literature. The Ministry has generally recommended to the Acclimatisation Societies that restrictive regulations should be made more lenient except where there is clear evidence of overfishing.

One problem in the assessment of the value of angling regulations is caused by the annual fluctuations in the density of trout stocks. Regulations remain fairly stable through the years whilst in some years there may be an excess of fish and in other years a shortage of fish. The regulations are probably determined in the years of the low stocks when the angling is poor. If it was practical, regulations could be changed each year in line with changes in stock density. This would require rapid stock survey techniques. Alternatively, where stocks are proven to be low, or the species difficult to catch, the liberation of large catchable hatchery fish would be of value. A third alternative would be to publicise which waters contain high stocks of fish and so redirect anglers' effort. The reports on each Acclimatisation District should go some way towards this redistribution of anglers' effort.

VII THE ANGLING DIARY SCHEME AND FUTURE STUDIES

The national angling diary scheme has been discontinued as the result of these studies. The scheme served a useful purpose in the past as ample information was collected to map and describe the national and local patterns in angling effort, catch, catch rates, species, size of fish caught and the effect of angling regulations. However, due to errors inherent in these voluntary angling diary schemes it was not possible to accurately monitor these statistics and the state of the fish populations. It was decided that with the present staff and financial limitations of the Ministry it would be inefficient to devote further effort to similar national angling diary schemes.

Future studies which could be undertaken are as follows:

1. Responsibility for monitoring the state of the fish stocks and the quality of the angling should be accepted by the local fisheries management organisations. It is suggested that regular surveys be made of anglers' opinions on the state of each fishery in the present and in the past. Field Officers should record anglers' opinions and details of the fish they have caught whilst carrying out licence checks. Alternatively, questionnaires could be distributed to a selection of licence holders.

   This concept is suggested because many experienced anglers have clear and accurate memories of the density and other characteristics of the fish stocks in the past. They have also observed the historical changes in the environment and often have excellent practical suggestions on how the fishery can be improved. In particular, anglers should be asked whether fish are scarce or just difficult to catch. I suspect that if several experienced anglers agreed that there has been a decrease in the numbers of fish, then this would be a more accurate measure of density changes than a statistically significant decrease in catch rates.

   Where resources permit, direct studies on the state of the fish stocks can be undertaken with the modern techniques now available.

2. National trends in freshwater angling effort and catch can be assessed by a stratified postal questionnaire scheme involving 500 to 1 000 licence holders. The Department of Statistics or public opinion survey firms could conduct these surveys. Similar surveys have been undertaken in the U.S A. and Great Britain (U.S. Bureau of Sport Fisheries and Wildlife 1972, N.O.P. Market Research Ltd. 1971).

3. Details of the trends in angling effort and catch for individual waters are generally required for "political" and scientific reasons. General trends are satisfactory for "political" reasons and can be estimated from the technical reports and licence sales or from small creel census and postal questionnaire schemes. Very accurate scientific estimates require extensive combined long term studies similar to those being carried out on the Rakaia River, where angling diary, creel census and aerial census studies are being run (R. Goode, pers. comm.).

4. The relationship between trout density and anglers' catch rates and the relationship between the size of trout in the population and in the anglers' catch should be clarified by direct experiments. These should be along the lines of the studies on carp by Beukema (1969). This information will make angling statistics far more valuable.

5. Basic biological information on the density, size, growth rates, behaviour and other features of the brown trout stocks in the larger rivers of New Zealand is sadly lacking. Angling statistics alone are not sufficient to manage these very important fisheries. It is therefore suggested that further research is needed in this field. The development of rapid and efficient survey techniques, such as drift diving, would be of great value in such studies.

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APPENDIX 1

(see note at end)

Water (1)	Number of Days (2)	Number of Hours (3)	Number of Fish: Under-sized (4)	Number of Fish: Takable returned (5)	Number of Fish: Kept (6)	Number of Fish: Mea-sured (7)	Mean Length (cm) (8)	Fish per Hour (9)	Fish per Day (10)	Per cent Under-sized (11)	Species (12) B	Species (12) R
					ASHBURTON							
Ashburton*	169	529	67	0	248	227	40.5B	0.47	1.47	21.3	100[1]	0
							75.2Q					
	64	249	18	4	32	24	34.3B	0.14	0.56	33.3	80[1]	20
						4	67.3Q					
	166	666	59	3	129	90	43.2B	0.20	0.80	30.9	97[1]	3
						79	72.9Q					
	50	221.5	15	7	57	56	33.5B	0.29	1.28	19.0	98[1]	2
						61	83.3Q					
Rangitata*	145	521	98	0	441	393	42.5B	0.85	3.04	18.2	100[1]	0
						1	66.0Q					
	29	144	5	1	22	9	47.0B	0.16	0.79	17.9	86[1]	14
						5	59.9Q					
	186	698.8	5	12	225	179	42.2B	0.34	1.27	2.1	93[1]	7
						162	73.8Q					
	117	389.5	9	9	181	101	40.2B	0.49	1.62	4.5	99[1]	1
						83	77.4Q					
Lake Heron*	100	275	0	0	173	9	58.1B	0.63	1.73	0	5	2
						124	40.9Q				93Q	
							43.2R					
	31	102.5	5	0	21	21	53.6B	0.20	0.68	19.2	89[1]	11
						3	38.1Q					
						3	38.1R					
	83	344.7	5	14	156	137	53.3B	0.49	2.05	2.9	96[1]	4
						18	36.1Q					
						7	46.0R					
	29	122.4	3	2	34	72	51.8B	0.29	1.24	7.7	98[1]	2
						2	38.1Q					
						4	35.8R					
					AUCKLAND							
Arapuni Lake	107	396	51	0	294	215	44.7	0.74	2.75	14.8	2	98
	79	421	15	1	111	111	46.7	0.27	1.42	11.8	3	97
	265	1269.8	65	87	645	1292	47.7	0.58	2.76	8.2	2	98
	7	45	0	0	0	4	32.8	0	0	0	0	100
Awakino	183	910	805	0	599	467	46.0	0.66	3.27	57.3	4	96
	16	99.5	7	1	7	7	37.4	0.08	0.50	46.7	0	100
	-	-	-	-	-	11	40.6	-	-	-	15	85
	-	-	-	-	-	5	36.3	-	-	-	40	60

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	
Karapiro Lake	150	641	25	5	229	182	51.3	0.37	1.56	9.7	2	98
	27	154	1	2	29	27	50.8	0.20	1.15	3.1	14	86
	77	217	2	5	43	47	46.7	0.22	0.62	4.0	2	98
	4	12	0	0	0	0	-	0	0	-	-	-
Kauaeranga*	40	236	63	3	89	89	40.1	0.39	2.30	40.7	0	100
	4	12.5	1	6	4	4	40.0	0.80	2.50	9.1	0	100
	52	168	38	7	72	75	36.3	0.47	1.52	32.5	0	100
	45	125.5	25	9	38	34	34.8	0.37	1.04	34.7	0	100
Mangahoe	27	140	22	0	77	80	50.5	0.55	2.85	22.2	0	100
	2	7.5	0	0	3	3	46.6	0.40	1.50	0	0	100
	-	-	-	-	-	-	-	-	-	-	0	100
			no information									
Mangaotaki	72	364	66	0	232	201	45.7	0.64	3.22	22.2	3	97
	15	65	16	2	27	28	42.3	0.45	1.93	35.6	0	100
	1	6	0	0	2	2	48.3	0.33	2.00	0	0	100
			no information									
Mangatutu	49	241	79	0	82	82	42.3	0.34	1.67	49.1	27	73
	19	83.5	10	5	23	23	40.5	0.33	1.47	26.3	35	65
	17	78.5	3	3	14	14	39.6	0.22	1.00	15.0	7	93
	-	-	-	-	-	4	30.5	-	-	-	80	20
Maratoto	24	129	101	3	50	49	37.8	0.41	2.21	65.6	0	100
	6	23	16	0	7	7	37.0	0.60	1.17	69.6	0	100
	7	29	10	0	5	16	40.6	0.17	0.71	66.7	0	100
	30	89.3	34	17	28	8	22.6	0.50	1.50	43.0	0	100
Waihou*	231	892	377	7	512	454	44.3	0.58	2.25	42.1	0	100
	91	375.5	354	2	164	163	36.0	0.44	1.82	68.1	0	100
	161	596.5	241	9	195	281	40.4	0.34	1.27	54.2	0	100
	64	164.9	42	39	90	77	37.1	0.78	2.02	24.6	0	100
Waiomou*	74	309	266	0	288	287	44.3	0.93	3.89	48.0	0	100
	95	241	21	1	56	56	44.3	0.24	0.60	26.9	0	100
	48	144.5	0	1	26	44	46.5	0.19	0.56	0	0	100
	33	110.2	44	46	45	55	36.1	0.83	2.76	32.6	10	90
Waipa*	153	609	219	1	374	334	41.0	0.62	2.45	36.9	45	55
	32	109.5	18	2	34	36	43.8	0.33	1.13	33.3	47	53
	76	399.8	26	17	83	83	37.6	0.25	1.32	20.6	59	41
	14	35	7	0	17	16	37.9	0.49	1.21	29.2	67	33
Waitekauri*	63	380	124	0	212	173	38.9	0.56	3.37	36.9	5	95
	9	60.5	18	1	28	28	36.2	0.48	3.22	38.3	0	100
	34	128	10	0	34	44	43.2	0.27	1.00	22.7	0	100
	22	48.6	7	3	20	22	34.5	0.47	1.05	23.3	0	100

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	
Waitawheta*	99	465	56	1	158	150	40.9	0.34	1.61	26.1	0	100
	33	183	7	3	68	67	41.1	0.39	2.15	9.0	10	90
	56	224.5	6	1	53	84	39.6	0.24	0.96	10.0	3	97
	17	60.8	8	4	19	10	32.3	0.38	1.35	25.8	0	100
HAWKE'S BAY												
Black Creek	94	192	11	3	60	59	42.4	0.33	0.67	14.9	-	-
	2	1	-	-	-	-	-	-	-	-	-	-
	6	7.5	0	0	2	2	39.4	0.27	0.33	0	50	50
	2	10.5	0	0	0	0	-	0	0	-	-	-
Manawatu*	102	430	20	4	122	120	37.8	0.29	1.24	13.7	100	0
	335	777.5	48	3	316	315	46.0	0.41	0.95	13.1	100	0
	510	1157.9	22	8	490	576	44.2	0.43	0.98	4.2	100	0
	30	82	7	0	44	103	48.4	0.54	1.47	13.7	99	1
Marakeke	121	233	17	9	74	75	42.4	0.36	0.69	17.0	-	-
	4	5	-	-	-	-	-	-	-	-	-	-
	no information											
	4	4.5	5	0	0	-	-	0	0	100	-	-
Tukipo	129	263	21	3	122	122	45.8	0.48	0.97	14.4	-	-
	5	14	0	0	2	-	36.6	0.14	0.40	0	0	100
	38	66.8	0	0	13	12	40.9	0.19	0.34	0	0	100
	9	18.5	1	0	3	3	49.0	0.16	0.33	25	0	100
Tukituki*	1060	3277	909	140	1317	1052	40.4	0.44	1.37	38.4	9	91
	186	516.5	84	1	128	128	40.5	0.25	0.69	39.4	7	93
	464	1557	128	30	448	530	39.6	0.31	1.03	21.1	2	98
	267	819	96	8	256	310	40.7	0.32	0.99	26.7	2	98
Waipawa*	108	294	72	12	89	80	40.9	0.34	0.94	41.6	-	-
	42	104	13	0	34	31	41.5	0.33	0.81	27.7	6	94
	119	353.5	67	12	107	191	37.5	0.34	1.00	36.0	5	95
	30	91	47	11	21	64	41.5	0.35	1.07	59.5	7	93
MARLBOROUGH												
Wairau*	178	571	15	39	249	250	48.6	0.50	1.62	5.0	100	0
	97	307	14	3	103	119	48.6	0.35	1.09	11.7	95	5
	81	220.5	5	4	82	156	53.3	0.39	1.06	5.49	100	0
	134	386.5	5	2	117	157	49.8	0.31	0.89	4.0	100	0
NELSON												
Baton	38	112	62	2	59	60	38.7	0.54	1.61	50.4	100	0
	1	4	-	-	-	-	-	-	-	-	-	-
	no information											
	13	42	9	0	29	31	42.2	0.69	2.23	23.7	94	6

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	
Buller*	707	2275	172	47	1214	1189	49.3	0.55	1.78	12.0	100	0
	170	456	64	18	176	177	47.2	0.43	1.14	24.8	100	0
	108	365.5	23	20	121	154	51.1	0.39	1.31	14.0	99	1
	194	507.6	19	11	192	257	50.3	0.40	1.05	8.6	99	1
Gowan*	62	207	13	0	122	97	50.7	0.59	1.97	9.6	100	0
	51	190.5	5	1	87	87	50.8	0.46	1.73	5.4	99	1
	39	181	2	15	93	110	56.4	0.60	2.77	1.8	100	0
	45	181	2	11	83	38	52.1	0.52	2.09	2.1	100	0
Maitai	398	916	831	28	728	723	34.2	0.83	1.90	52.4	100	0
	57	122	42	18	55	55	32.5	0.60	1.28	36.5	100	0
	18	42.5	0	6	8	10	35.8	0.33	0.78	0	100	0
	6	19	4	4	7	4	18.0	0.58	1.83	26.7	100	0
Mangles	49	161	2	1	89	81	54.6	0.56	1.84	2.2	100	0
	5	13.5	0	0	3	3	55.9	0.22	0.60	0	100	0
	15	63	0	0	19	32	52.6	0.30	1.27	0	100	0
	34	106.7	8	25	80	80	48.5	0.98	3.09	7.1	100	0
Motueka*	1907	5571	946	140	4229	4195	43.5	0.78	2.29	17.8	100	0
	367	1001.5	179	27	423	438	45.1	0.45	1.23	28.5	99	1
	148	526.6	30	18	131	215	43.2	0.28	1.01	16.8	99	1
	422	1175	127	95	823	744	42.7	0.78	2.18	12.2	99	1
Owen	55	213	16	7	86	94	54.7	0.44	1.69	14.7	100	0
	8	31	1	0	9	9	55.0	0.29	1.13	10.0	100	0
	3	10.5	0	0	0	1	58.4	0	0	0	100	0
	9	28	0	5	10	10	56.4	0.54	1.67	0	100	0
Riwaka*	329	1043	266	53	691	697	40.3	0.71	2.26	26.3	100	0
	42	82.5	0	0	19	20	46.0	0.23	0.45	0	100	0
	16	80.5	0	1	15	22	51.8	0.20	1.00	0	100	0
	42	121	7	10	75	77	41.1	0.70	2.02	7.6	100	0
Lake Rotoiti	136	284	60	9	263	279	46.1	0.96	2.00	18.1	100	0
	47	121	12	6	44	44	45.4	0.41	1.06	19.4	98	2
	9	27.5	0	0	15	34	51.6	0.55	1.67	0	100	0
	7	30	0	0	8	27	41.7	0.27	1.14	0	100	0
Takaka	173	313	8	4	87	69	54.0	0.29	0.53	8.1	100	0
	31	60	2	6	25	25	53.1	0.52	1.00	6.1	100	0
	5	14.5	0	0	3	3	38.1	0.21	0.60	0	100	0
	27	88.5	1	2	45	39	41.1	0.53	1.74	2.1	100	0
Travers*	105	401	4	5	231	225	53.3	0.59	2.25	1.7	100	0
	31	140	0	5	50	50	62.0	0.39	1.77	0	100	0
	22	117.3	0	0	44	52	56.1	0.38	2.00	0	100	0
	17	74.5	1	7	42	58	52.8	0.66	2.88	2.0	100	0

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	
Waimea	127	266	35	1	92	88	44.4	0.35	0.73	27.3	100	0
	1	1	-	-	-	-	-	-	-	-	-	-
	1	1.5	0	0	0	-	-	0	0	0	-	-
	1	-	0	0	1	1	58.4	-	1.00	0	100	0
Wairoa	186	466	63	6	239	191	42.4	0.53	1.32	20.5	100	0
	32	78	6	0	20	20	54.6	0.26	0.63	23.1	100	0
	1	1	0	0	0	-	-	0	0	0	-	-
	7	9	1	0	3	4	33.0	0.33	0.43	25.0	100	0
Wakapuaka	74	180	85	4	111	105	34.7	0.64	1.55	42.5	100	0
	6	31	3	0	7	7	56.9	0.23	1.17	30.0	100	0
					no information							
	-	-	-	-	-	4	60.5	-	-	-	100	0
Wangapeka*	252	940	79	16	467	460	49.7	0.51	1.92	14.1	100	0
	67	311.5	2	0	28	28	53.3	0.09	0.42	6.7	100	0
	9	44	1	0	7	9	54.1	0.16	0.78	12.5	100	0
	67	198.5	4	6	73	68	47.5	0.40	1.18	4.8	99	1
Whangamoa	48	131	64	3	76	76	36.9	0.60	1.65	44.8	100	0
	4	13	4	0	4	4	44.5	0.31	1.00	50.0	100	0
	1	1	0	0	0	1	40.6	0	0	0	100	0
	1	2	0	0	0	0	-	0	0	0	-	-
					NORTH CANTERBURY							
Ashley*	103	329	59	2	153	120	39.9	0.47	1.50	27.6	99[1]	1
	36	102	4	0	21	20	43.2B	0.21	0.58	16.0	100[1]	0
						1	63.5Q					
	187	493.4	43	17	134	190	44.7	0.31	0.81	22.2	100	0
	323	855.6	86	29	304	297	38.9B	0.39	1.03	20.5	99[1]	1
						16	84.6Q					
Avon	140	543	55	19	283	140	35.1	0.56	2.16	15.4	99	1
	34	84	4	3	74	74	35.9	0.92	2.26	4.9	100	0
	20	42	21	14	7	72	30.0	0.50	1.05	50.0	92	8
	5	9.5	3	0	0	0	-	0	0	100.0	100	0
Cam	71	177	28	2	82	65	41.5	0.47	1.18	25.0	100	0
	10	18	1	0	6	6	35.1	0.33	0.60	14.3	100	0
	33	81	30	18	51	69	37.8	0.85	2.09	30.3	99	1
	33	79.5	13	6	56	58	37.3	0.78	1.88	17.3	100	0
Lake Coleridge*	131	701	48	7	285	221	54.0	0.42	2.23	14.1	66Q	34
	42	227	30	0	70	2	58.4B	0.31	1.67	30.0	3B	84
						56	55.4R				13Q	
						9	51.7Q					
	79	401.9	83	8	101	25	49.0B	0.27	1.38	43.2	13B	36
						64	56.1R				51Q	
						89	47.2Q					

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	
Lake Coleridge* (cont'd)	231	960.4	51	19	285	42	50.3B	0.32	1.32	14.4	8B	49
						142	50.5R				43Q	
						161	47.8Q					
Lake Ellesmere*	292	1130	13	9	560	469	46.2	0.50	1.95	2.2	100	0
	30	101.5	2	0	24	24	51.2	0.24	0.80	7.7	100	0
	94	280	1	2	91	112	44.7	0.33	0.99	1.1	100	0
	126	348	0	1	90	120	47.8	0.26	0.72	0	100	0
Hororata	79	193	96	17	113	76	36.4	0.67	1.65	42.5	100	0
	15	68.5	18	5	14	14	43.4	0.28	1.27	48.7	100	0
	3	9	2	0	1	6	35.6	0.11	0.33	66.7	100	0
	45	241.4	59	9	183	200	31.5	0.80	4.27	23.5	100	0
Lake Lyndon*	91	262	90	0	116	91	38.4	0.44	1.27	43.7	0	100
	52	241	72	2	166	164	36.7	0.70	3.23	30.0	0	100
	13	72	5	8	65	83	28.4	1.01	5.62	6.4	9	91
	75	278.5	72	47	167	174	32.2	0.77	2.85	25.2	8	92
Lake Shepherd*	53	264	1	20	68	58	50.7	0.33	1.66	1.1	100	0
	11	50	1	4	25	27	57.3	0.58	2.64	3.3	100	0
	17	90.1	0	1	15	19	48.0	0.18	0.94	0	100	0
	24	101	2	1	17	30	53.3	0.18	0.75	10.0	100	0
Selwyn*	392	1387	89	11	667	235	46.5	0.49	1.73	11.6	100	0
	352	1343.5	70	6	282	277	46.2	0.21	0.82	19.6	100	0
	406	1284.4	139	63	456	686	42.9	0.40	1.28	21.1	100	0
	542	1546.3	125	56	471	504	43.2	0.34	0.97	19.2	100	0
Styx*	37	120	66	0	51	51	33.2	0.43	1.38	56.4	100	0
	17	44.5	1	0	7	7	32.6	0.16	0.41	12.5	100	0
	35	101.9	26	12	23	29	38.6	0.34	1.00	42.6	100	0
	115	257.4	3	0	48	60	39.4	0.19	0.42	5.9	100	0
Waimakariri*	347	1292	276	35	445	341	74.1Q	0.37	1.38	36.5	87[1]	13
							40.7B					
							38.8R					
	149	446.5	23	8	88	82	41.3B	0.22	0.64	19.3	99[1]	1
						3	77.7Q					
						1	48.3R					
	155	501.2	21	11	86	144	38.1B	0.19	0.63	17.8	90[1]	10
						12	67.3Q					
	409	1229.5	93	56	202	148	33.5B	0.21	0.63	26.5	96[1]	4
						9	26.9R					
						124	78.2Q					

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	
						OTAGO						
Butchers Dam	54	199	57	0	153	68	32.8	0.77	2.83	27.1	100	0
	13	44.5	21	3	48	22	28.7	1.15	3.92	29.2	86[2]	14
	3	5	0	0	2	3	33.0	0.40	0.67	0	100	0
	13	49.5	10	0	15	12	37.8	0.30	1.15	40.0	100[2]	0
Catlins*	238	790	199	0	643	512	45.7	0.81	2.70	23.6	100	0
	77	264	53	15	141	141	39.7	0.59	2.03	25.4	100	0
	48	168	35	9	104	165	39.6	0.67	2.35	23.7	100	0
	14	70	6	4	36	28	42.2	0.57	2.86	13.0	100	0
Clutha*	1260	5892	929	9	3760	3241	40.5	0.64	2.99	19.8	100[5]	0
	642	2010	421	39	1267	1374	36.9	0.65	2.03	24.4	96[2,5]	4
	566	2219	355	136	1245	1639	36.8	0.62	2.44	20.5	99[2,5]	1
	193	914.2	99	80	489	474	42.4	0.62	2.95	14.8	97[2]	3
Fraser's Dam	23	100	50	0	92	56	38.7	0.92	4.00	35.2	100	0
	26	119.5	14	2	83	79	36.8	0.71	3.27	14.1	100	0
	23	100.9	2	4	28	28	42.4	0.32	1.39	5.9	100	0
	1	3	0	0	0	3	38.1	0	0	-	75	25
Kaihiku	57	124	186	0	234	242	29.8	1.89	4.11	44.3	100	0
	17	33	6	1	35	35	36.1	1.09	2.12	14.3	100	0
	3	7.5	1	0	1	2	30.0	0.13	0.33	50.0	100	0
	-	-	-	-	-	1	55.9	-	-	-	100	0
Leith	383	1031	1170	0	1080	1020	25.7	1.05	2.82	52.0	100	0
	78	190.5	160	15	116	116	26.8	0.69	1.68	55.0	100	0
	-	-	-	-	-	59	25.7	-	-	-	100	0
	2	6	0	0	0	43	26.7	0	0	-	100	0
Mahinerangi-Waipori*	465	3106	145	3	1056	1052	40.8	0.34	2.28	12.0	100	0
	124	597	76	10	220	154	40.3	0.39	1.85	24.8	99[2]	1
	118	528.5	17	26	264	175	42.6	0.55	2.46	5.5	98[2]	2
	39	155	3	3	79	49	40.6	0.53	2.10	3.5	98[2]	2
Manorburn Dam*	45	236	114	0	337	240	34.8	1.43	7.49	25.3	100[2]	0
	34	199.5	6	2	82	81	40.9	0.42	2.47	6.7	43	57
	37	188.5	18	12	122	304	33.6	0.71	3.62	11.8	8	92
	10	47.8	26	0	18	62	40.3	0.38	1.80	59.1	19[2]	81
Manuherikia Dam	138	658	40	0	642	642	36.6	0.98	4.65	5.9	100	0
	3	7	2	0	14	14	41.0	2.00	4.67	12.5	100	0
	5	21.5	1	0	12	13	45.0	0.56	2.40	7.7	100[2]	0
						no information						
Manuherikia River*	37	135	3	0	134	134	43.0	0.99	3.62	2.2	100	0
	96	205.5	51	12	189	188	38.9	0.98	2.09	20.2	100	0
	40	124.5	11	1	38	47	37.6	0.31	0.98	22.0	98[2]	2
	124	325	88	0	161	174	32.8	0.50	1.30	35.3	100[2]	0

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	
Mimihau*	311	1377	947	60	1665	1678	34.6	1.25	5.55	35.4	100	0
	92	307	104	0	138	168	27.8	0.45	1.50	43.0	100	0
	27	79.5	40	17	71	316	35.1	1.11	3.26	31.3	97	3
	3	11.5	7	3	5	7	38.4	0.70	2.67	46.7	100	0
Owaka	74	207	141	0	225	216	37.2	1.09	3.04	38.5	100	0
	28	57	25	0	55	56	33.6	0.96	1.96	31.3	100	0
	11	29	12	8	38	63	34.0	1.59	4.18	20.7	100	0
	-	-	-	-	-	-	-	-	-	-	100	0
Pomahaka*	2383	10116	5863	53	9477	8379	35.0	0.94	4.00	38.1	100	0
	631	2227.5	708	87	1439	1511	33.7	0.69	2.42	31.7	100[2]	0
	345	1494.3	380	108	920	1043	36.1	0.69	2.98	27.0	100[2]	0
	74	267.5	108	47	102	137	39.4	0.56	2.01	42.0	97[2]	3
Poolburn Dam	25	159	15	0	73	70	47.0	0.46	2.92	17.1	100	0
	42	199.5	2	21	55	65	42.0	0.38	1.81	2.6	75	25
	33	160	29	6	60	76	40.4	0.41	2.00	30.5	94	6
	1	4.5	0	0	6	7	37.8	1.33	6.00	0	100	0
Puerua	57	189	43	0	101	101	39.2	0.53	1.77	30.0	100	0
	51	115	34	2	106	106	35.6	0.94	2.12	23.9	100	0
	4	7	0	0	2	23	34.5	0.29	0.50	0	100[2]	0
	7	20.5	8	4	26	19	39.9	1.46	4.29	21.1	100[2]	0
Shag*	353	1589.5	180	0	695	690	35.1	0.44	1.97	20.6	100	0
	104	380	132	19	161	184	34.8	0.47	1.73	42.3	100	0
	221	592.7	51	38	310	464	39.4	0.59	1.57	12.8	100	0
	11	20	0	0	9	36	46.2	0.45	0.82	0	100	0
Taieri*	916	5280	1488	1	2099	1678	35.2	0.40	2.29	41.5	100[2]	0
	434	1393	371	19	508	374	37.8	0.38	1.21	41.3	100[2]	0
	530	1947.8	468	67	807	1051	33.0	0.45	1.65	34.9	100[2]	0
	161	519.2	200	12	183	231	34.0	0.38	1.21	50.6	98[2]	2
Taylor's Creek	89	246	25	0	437	436	32.2	1.78	4.91	5.4	100	0
	7	17	3	0	8	7	34.5	0.47	1.14	27.3	100[2]	0
	no information											
	no information											
Tokomairiro*	101	565	33	0	302	277	38.1	0.53	2.99	9.9	100	0
	170	569	96	8	297	296	36.6	0.54	1.79	23.9	100[2]	0
	115	318	35	10	117	160	38.4	0.40	1.10	21.6	100[2]	0
	6	34	3	0	14	7	43.2	0.41	2.33	17.7	100[2]	0
Tomahawk Lagoon	135	608	18	0	141	125	37.7	0.23	1.04	11.3	100	0
	38	97.5	19	0	44	51	35.7	0.45	1.16	30.2	98	2
	no information											
	no information											

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	
Waikaia*	261	902	388	0	770	759	35.2	0.85	2.95	33.5	100	0
	150	523	196	0	401	406	35.4	0.77	2.67	32.8	100	0
	112	353.5	75	29	252	364	38.9	0.79	2.51	21.1	100[2]	0
	26	93	17	7	28	14	41.4	0.38	1.35	32.7	100	0
Waikouaiti*	117	397	43	0	163	161	40.0	0.41	1.39	20.9	100	0
	87	294	58	4	93	88	41.8	0.33	1.11	37.4	100	0
	66	168.5	19	12	99	126	42.4	0.66	1.68	14.6	100	0
	74	142.4	22	10	74	66	41.7	0.59	1.14	20.8	100	0
Waipahi*	898	4245	2013	4	3563	3455	34.6	0.84	3.97	36.1	100[2]	0
	145	594.5	148	25	357	366	36.5	0.64	2.63	27.9	100[2]	0
	27	145.5	50	11	82	261	35.3	0.64	3.44	35.0	100	0
	57	226	57	30	121	55	42.4	0.67	2.65	27.4	100	0
Waipori River*	334	1886	514	0	815	756	32.7	0.43	2.44	38.7	100	0
	62	228.5	60	8	113	60	36.4	0.53	1.95	33.2	100[2]	0
	62	245.5	33	17	92	99	40.4	0.44	1.76	23.2	98[2]	2
	4	9	2	0	4	11	38.9	0.44	1.00	33.3	100[2]	0
Waiwera	273	859	696	0	769	742	33.6	0.90	2.82	47.5	100	0
	49	137	42	1	83	81	34.1	0.61	1.71	33.3	100[2]	0
	19	50	25	2	29	76	31.5	0.62	1.63	44.6	100	0
	5	9	1	1	1	6	50.3	0.22	0.40	33.3	100	0
Wyndham*	236	1303	468	14	1141	1122	38.4	0.89	4.89	28.8	100	0
	73	288	468	10	126	130	37.4	0.47	1.86	77.5	100	0
	14	39	11	3	39	63	35.8	1.08	3.00	20.8	100	0
	16	49	22	1	34	35	38.9	0.71	2.19	38.6	100	0
					SOUTH CANTERBURY							
Lake Alexandrina*	238	1112	7	12	387	384	53.9	0.36	1.68	1.7	8	92
	476	2192.5	44	25	470	472	53.4	0.23	1.04	8.2	3[1]	97
	230	1099.6	19	10	235	398	50.8	0.22	1.07	7.2	9[1]	91
	29	90.6	2	0	21	88	56.7	0.23	0.72	8.7	16	84
Opawa	29	80	77	10	139	139	31.2	1.86	5.14	34.1	100	0
					no information							
	-	-	-	-	-	9	45.7	-	-	-	100	0
					no information							
Opihi*	498	1604	396	100	1144	985	37.0	0.78	2.50	24.2	100[1]	0
	347	1065.5	281	19	317	269	37.4	0.32	0.97	45.5	100[1]	0
	317	921.4	63	17	427	608	39.4	0.48	1.40	12.4	99[1]	1
	185	425.2	67	16	360	396	34.0	0.88	2.03	15.1	99[1]	1

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	
Pareora*	154	521	117	67	484	444	36.5	1.06	3.58	17.5	100	0
	278	832.5	471	45	646	675	31.8	0.83	2.49	40.5	99	1
	203	481.8	108	9	346	611	34.8	0.74	1.75	23.3	99	1
	68	134	61	52	113	240	30.2	1.23	2.43	27.0	99	1
Temuka	77	274	206	21	283	185	30.0	1.11	3.95	40.4	100	0
	49	110.5	47	3	61	60	31.8	0.58	1.31	42.3	100[1]	0
	51	128	49	12	122	269	30.7	1.05	2.63	26.8	100[1]	0
	12	19.5	5	1	36	66	33.5	1.90	3.08	11.9	100	0
Tengawai*	182	675	370	30	664	513	34.4	1.03	3.81	34.8	100	0
	97	288	83	7	170	171	33.4	0.61	1.82	31.9	100	0
	41	106	11	1	18	39	42.7	0.18	0.46	36.7	98[1]	2
	64	167.4	4	10	60	67	37.3	0.42	1.09	5.4	100	0
Waihi*	94	262	335	30	325	283	29.2	1.35	3.78	48.6	100	0
	46	131.5	76	2	125	126	30.1	0.97	2.76	37.4	100	0
	82	168	62	3	179	234	30.5	1.08	2.22	25.4	99	1
	7	16.5	2	0	9	221	30.0	0.55	1.29	18.2	100	0
					SOUTHLAND							
Aparima*	782	2647	1678	267	2973	2879	35.6	1.22	4.14	34.1	100[2]	0
	339	906	386	18	539	538	36.1	0.61	1.64	40.9	100[2]	0
	107	324.5	229	28	164	276	35.8	0.59	1.79	54.4	100[2]	0
	210	641	151	33	457	385	36.8	0.76	2.33	23.6	100	0
Hedgehope	29	126	24	3	142	139	36.6	1.15	5.00	14.2	100	0
	171	499	50	0	355	325	36.1	0.71	2.08	12.4	100[2]	0
	5	13	0	0	6	21	35.6	0.46	1.20	0	100[2]	0
	1	2	0	0	5	5	33.5	2.50	5.00	0	100	0
Lora	60	257	120	24	295	272	36.3	1.24	5.32	27.3	100[2]	0
	38	117.5	52	5	122	128	33.3	1.08	3.34	29.1	100[2]	0
	15	46.5	30	0	45	55	34.5	0.97	3.00	40.0	100	0
	1	1	0	0	1	-	-	1.00	1.00	0	100	0
Makarewa*	125	460	65	52	402	386	38.5	0.99	3.63	12.5	100[2]	0
	194	617.5	102	12	473	393	33.9	0.79	2.50	17.4	100[2]	0
	13	42	3	1	27	37	39.1	0.67	2.15	9.7	100[2]	0
	13	35	0	0	24	26	33.8	0.69	1.85	0	100[2]	0
Mararoa*	63	281	5	4	132	111	55.6	0.48	2.16	3.6	81	19
	35	177.5	11	2	41	40	52.2	0.24	1.23	20.4	77	23
	30	132.4	1	0	43	65	50.3	0.32	1.43	2.3	80	20
	74	273	52	9	115	155	45.2	0.45	1.68	29.6	83	17
Morley	79	362	97	0	238	238	39.6	0.66	3.01	29.0	98	2
	16	59	4	0	48	47	34.6	0.81	3.00	7.7	100[2]	0
	7	24	20	0	13	14	37.6	0.54	1.86	60.6	93	7
	15	38	22	0	31	22	37.1	0.82	2.07	41.5	100	0

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	
Orawia	162	618	172	16	725	723	38.9	1.20	4.57	18.8	99[2]	1
	62	170	37	0	178	178	37.4	1.05	2.87	17.2	97	3
	33	117.6	24	10	103	134	36.3	0.96	3.42	17.5	100	0
	7	17	5	2	12	9	42.9	0.82	2.00	26.3	100	0
Oreti*	487	2203	869	218	1457	1444	38.6	0.76	3.44	34.2	100	0
	429	1618.5	527	52	888	900	35.4	0.58	2.19	35.9	100[2]	0
	285	911.2	520	111	615	825	33.5	0.80	2.55	41.7	100[2]	0
	150	468.5	55	21	221	364	36.6	0.52	1.61	18.5	100[2]	0
Otamita	51	209	304	24	262	237	33.4	1.37	5.61	51.5	100	0
	44	130	83	3	75	104	32.2	0.60	1.77	51.6	100[2]	0
	7	27.5	26	2	13	22	37.1	0.55	2.14	63.4	100	0
	5	16	6	0	14	17	39.1	0.88	2.80	30.0	100	0
Otapiri*	52	200	135	25	250	251	33.5	1.38	5.29	32.9	100	0
	72	247	137	1	187	183	32.9	0.76	2.61	42.2	100[2]	0
	35	84	154	31	81	81	33.0	1.33	3.20	57.9	100	0
	22	83	11	7	72	69	33.0	0.95	3.59	12.2	100	0
Waiau*	1014	3438	369	56	2393	2332	44.4	0.71	2.42	13.1	79[6]	21
	197	724.5	33	8	336	345	44.3	0.47	1.75	8.8	74[2,6]	26
	216	851.7	110	19	419	465	39.9	0.51	2.03	20.1	55[2]	45
	151	554.5	71	40	259	238	41.6	0.54	1.98	19.2	52[6]	48
Waihopai	48	152	14	8	89	89	41.5	0.64	2.02	12.6	100	0
	4	21.5	1	0	2	2	38.1	0.09	0.50	33.3	100	0
	-	-	-	-	-	4	32.5	-	-	-	100	0
						no information						
Waimatuku*	54	238	13	2	163	163	40.4	0.69	3.06	7.3	100	0
	29	81	4	0	93	88	42.4	1.15	3.21	4.1	100[2]	0
	59	145.5	16	9	80	82	37.1	0.61	1.51	15.2	100	0
	11	18	0	0	8	8	35.8	0.44	0.73	0	100	0
Waimea	67	274	146	32	300	257	36.7	1.21	4.96	30.5	100	0
	10	26	11	5	30	19	31.3	1.35	3.50	23.9	100[2]	0
	3	6	12	0	3	3	33.5	0.50	1.00	80.0	100	0
						no information						

TARANAKI-HAWERA

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	
Kapuni*	94	186	101	21	144	132	40.5	0.89	1.76	38.0	99	1
	38	73	7	0	62	62	38.6	0.85	1.63	10.1	100	0
	32	88.5	12	3	47	47	40.1	0.56	1.56	19.4	100	0
	32	64	14	3	43	80	38.6	0.72	1.44	23.2	100	0
Kaupokonui*	118	384	35	18	222	182	45.9	0.63	2.03	12.7	92	8
	50	119	11	1	79	76	42.2	0.67	1.60	12.1	97	3
	56	143.5	5	0	48	64	45.7	0.33	0.86	9.4	95	5
	117	192.9	6	6	75	79	46.9	0.42	0.69	6.9	100	0

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	
Ouri	25	108	25	3	96	57	38.4	0.92	3.96	20.2	100	0
	1	3.5	0	0	6	0	-	1.71	6.00	0	100	0
	20	32.5	6	1	32	32	40.1	1.02	1.65	15.4	100	0
	1	5	0	0	3	3	37.3	0.60	3.00	0	100	0
Taungatara	37	207	51	4	110	106	45.5	0.56	3.08	30.9	100	0
	22	94.5	11	5	60	55	40.9	0.69	2.95	14.5	100	0
	26	96.5	8	5	30	29	40.9	0.36	1.35	18.6	100	0
						no information						
Waiaua	29	144	103	4	88	88	46.7	0.64	3.17	52.8	100	0
	35	100	12	2	40	40	39.0	0.42	1.20	22.2	98	2
	9	31	1	1	12	18	42.7	0.42	1.44	7.1	100	0
	19	39.8	5	1	24	26	42.2	0.63	1.32	16.7	100	0
Waiwakaiho*	485	1129	283	16	411	381	43.7	0.38	0.88	39.9	92	8
	258	654	107	5	245	247	42.8	0.38	0.97	30.0	90	10
	62	183	21	0	39	56	42.9	0.21	0.63	35.0	98	2
	8	12	0	0	4	2	40.6	0.33	0.50	0	100	0
						<u>WAIMARINO</u>						
Makara	119	191	16	0	140	138	40.5	0.73	1.18	10.3	100	0
						no information						
	1	2	0	0	1	1	33.0	0.50	1.00	0	100	0
						no information						
Makatuku	103	205	188	10	155	139	28.2	0.80	1.60	53.3	96	4
	31	78	27	1	64	63	41.3	0.83	2.10	29.4	100	0
	4	5.5	0	0	2	2	37.6	0.36	0.50	0	100	0
						no information						
Manganui-o-te-Ao	321	796	27	14	564	477	47.8	0.73	1.80	4.5	21	79
						no information						
	35	108.3	1	3	36	56	47.8	0.36	1.11	2.5	50	50
	2	3	0	0	3	5	54.9	1.00	1.50	0	67	33
Mangawhero*	607	1225	218	87	758	734	37.2	0.69	1.39	20.5	98	2
	54	108	31	4	109	107	35.4	1.05	2.09	21.5	100	0
	22	53.4	1	2	32	53	39.6	0.64	1.55	2.9	100	0
	11	26	6	0	20	27	34.5	0.77	1.82	23.1	100	0
Taonui*	112	212	52	8	185	155	39.2	0.91	1.72	21.2	100	0
	19	44.5	6	5	31	31	41.9	0.81	1.89	14.3	100	0
	17	34.5	3	4	17	20	43.2	0.61	1.24	12.5	100	0
						no information						
Whakapapa*	166	259	36	0	211	198	45.3	0.81	1.27	14.6	34	66
						no information						
	93	254.4	18	23	113	165	50.6	0.53	1.46	11.7	32	68
	42	52	2	3	67	84	46.9	1.35	1.67	2.8	72	28

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	
					WAITAKI							
Kakanui*	54	304	143	0	146	146	36.2	0.48	2.70	49.5	100	0
	107	312	52	11	115	124	32.3	0.40	1.18	29.2	100	0
	42	102.5	4	8	44	80	38.9	0.51	1.24	7.1	100	0
	21	42.5	36	9	52	51	47.5	1.44	2.90	37.1	100	0
					WELLINGTON							
Hautapu*	145	326	82	15	263	244	42.8	0.85	1.92	22.8	100	0
	23	35.5	6	3	28	30	46.1	0.87	1.35	16.2	100	0
	132	350	14	6	192	216	41.7	0.57	1.50	6.6	99	1
	42	52	3	13	46	73	48.3	1.13	1.40	4.8	100	0
Hutt*	92	200	56	9	105	92	39.2	0.57	1.24	32.9	100	0
	98	189.5	9	3	50	49	41.0	0.28	0.54	14.5	100	0
	430	1020	153	31	299	409	36.8	0.32	0.77	31.7	100	0
	147	309.1	9	5	120	150	37.3	0.40	0.85	6.7	100	0
Makakahi*	156	453	79	5	419	368	36.8	0.94	2.72	15.7	100	0
	222	506	44	8	353	349	40.5	0.71	1.63	10.9	100	0
	65	137.5	7	5	61	86	39.6	0.48	1.02	9.6	100	0
	7	38.5	0	0	14	47	45.2	0.36	2.00	0	100	0
Makuri	57	191	69	7	190	80	36.9	1.03	3.46	25.9	100	0
	12	47.5	5	0	13	13	35.3	0.27	1.08	27.8	100	0
	31	41.5	0	0	31	28	42.2	0.75	1.00	0	100	0
	-	-	-	-	-	9	43.2	-	-	-	100	0
Manawatu*	244	1026	124	2	463	389	39.9	0.45	1.91	21.2	100	0
	135	321	15	1	146	148	39.2	0.46	1.09	9.3	98	2
	249	642.6	8	9	192	266	42.2	0.31	0.81	3.8	99	1
	26	56	2	1	18	67	42.2	0.34	0.73	9.5	100	0
Mangatainoka*	382	1092	145	6	834	697	41.3	0.77	2.20	14.7	99	1
	375	1115	37	11	605	590	44.4	0.55	1.64	5.7	99	1
	340	985.3	8	19	330	434	42.7	0.35	1.03	2.2	99	1
	43	131.3	1	3	14	220	50.0	0.13	0.40	5.6	100	0
Otaki*	113	261	29	5	151	98	48.3	0.60	1.38	15.7	100	0
	10	31.5	1	1	8	8	73.3	0.29	0.90	10.0	100	0
	27	70	4	0	10	8	46.5	0.14	0.37	28.6	100	0
	14	56	0	0	5	12	37.3	0.09	0.76	0	100	0
Rangitikei*	198	882	85	14	405	411	41.6	0.48	2.12	16.9	19	81
	17	71.5	0	0	8	8	40.6	0.11	0.47	0	62	38
	226	835	68	20	232	281	38.0	0.30	1.12	21.3	21	79
	54	135.5	1	0	19	19	42.3	0.14	0.35	5.0	54	46
Ruamahanga*	178	625	97	1	319	235	39.0	0.51	1.80	23.3	100	0
	138	370.5	78	23	443	53	36.7	1.26	3.38	14.3	100[2]	0
	198	824.8	6	10	579	183	40.1	0.71	2.97	1.0	100[2]	0
	42	122.6	3	14	33	63	39.4	0.38	1.12	6.0	100[2]	0

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	
Waipoua*	85	141	217	8	132	99	34.8	0.99	1.65	60.8	100	0
	69	108.5	13	9	56	57	35.9	0.60	0.94	16.7	100	0
	37	53.5	25	4	24	33	36.3	0.52	0.76	47.2	100	0
	9	12	0	0	2	2	31.8	0.17	0.22	0	100	0
WEST COAST												
Arnold*	143	492	44	31	254	250	41.4	0.58	1.99	13.4	100	0
	57	140.5	5	1	107	107	45.0	0.77	1.89	4.4	100	0
	60	151.5	21	10	85	162	41.7	0.63	1.58	18.1	100	0
	6	20.5	0	0	4	68	44.2	0.20	0.67	0	100	0
Buller	54	139	1	0	76	77	43.3	0.55	1.41	1.3	100	0
	48	102	33	5	47	46	40.2	0.51	1.08	38.8	100	0
	2	4	1	0	0	10	36.6	0	0	100.0	100	0
	-	-	-	-	-	23	42.7	-	-	-	100	0
Crooked	25	101	1	5	79	77	43.9	0.83	3.36	1.2	100	0
	no information											
	31	92.5	1	0	53	54	53.1	0.57	1.71	1.9	100	0
	no information											
Grey*	261	713	87	19	345	332	43.8	0.51	1.39	19.3	100	0
	80	199	45	2	128	128	36.9	0.65	1.63	25.7	100	0
	121	362	138	15	228	322	41.1	0.67	2.01	36.2	100	0
	22	53	3	0	25	29	43.2	0.47	1.14	10.7	100	0
Ohikanui	27	119	1	0	59	60	56.5	0.50	2.19	1.7	100	0
	16	52	0	1	19	19	53.5	0.38	1.25	0	100	0
	18	75	0	0	25	25	59.4	0.33	1.39	0	100	0
	no information											
WESTLAND												
Hokitika*	44	120	6	0	65	57	43.9	0.54	1.48	8.5	100	0
	10	17	1	0	10	10	38.4	0.59	1.00	9.1	60	40
	23	50	6	3	22	29	42.9	0.50	1.09	19.4	66	34
	36	81	4	2	34	33	49.2	0.44	1.00	10.0	85	15
OTAGO-SOUTHLAND												
Mataura*	3 205	13 255	3 604	325	12 606	11 663	40.2	0.98	4.03	21.8	100	0
	1 045	3 709	812	75	2 273	2 449	38.9	0.63	2.25	25.7	100[2]	0
	1 072	3 711.7	1 084	189	2 146	2 854	40.2	0.63	2.18	31.7	100[2]	0
	318	1 201.5	176	66	637	539	40.5	0.59	2.21	20.0	100[2]	0

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	
						ASHBURTON-NORTH CANTERBURY						
Rakaia*	120	494	14	0	182	122	50.5	0.37	1.52	7.1	97[1]	3
	63	247	1	2	81	59B	47.4B	0.34	1.32	1.2	100[1]	0
						25Q	65.1Q					
	87	450	9	0	65	48B	45.9B	0.14	0.75	12.2	98[1]	2
						45Q	74.7Q					
	150	775.8	5	6	147	55B	41.9B	0.20	1.02	3.2	77[1]	23
						7R	46.5R					
						116Q	77.5Q					
						AUCKLAND-WAIMARINO						
Wanganui*	1004	1826	751	22	1575	1394	40.2	0.87	1.59	32.0	58	42
	21	27	0	8	29	29	45.3	1.37	1.76	0	-	-
	332	786.5	237	28	426	545	40.4	0.58	1.37	34.3	68	32
	29	51.3	0	1	19	38	41.2	0.39	0.69	0	34	66

NOTE

(1) Code numbers as Allen and Cunningham (1957) p. 139. For each water: first line - scheme to 1952 (some values corrected), second line 1957-58, third 1962-63, fourth 1967-68.

(2) * = Waters studied for trends in fish size and anglers' catch rates.

(3) Angling effort and catch are for men's whole season licence holders only and therefore may differ from the records for all diarists published in the district reports.

(4) B = brown trout, R = rainbow trout, Q = quinnat salmon.