

Fisheries Environmental Report No. 42

**The relative value of
Hawke's Bay rivers to
New Zealand anglers**

**Fisheries Research Division
Ministry of Agriculture and Fisheries
Wellington**

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The relative value of
Hawke's Bay rivers
to New Zealand anglers

by

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FISHERIES ENVIRONMENTAL REPORTS

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PREFACE

The rivers and streams of New Zealand, many of which support salmon or trout fisheries, are the subject of frequent water management decisions. Some of these decisions result in significant alterations to existing fish habitat, thereby reducing angling opportunities. Any case presented by fisheries interests to either the regional water board or the National Water and Soil Conservation Authority (NWASCA), in support of a particular river, will obviously be strengthened by the inclusion of information about the angling experience afforded by that river. As hydro-electric, irrigation, and other river developments place increasing demands on the remaining freshwater resource, the need for up to date information on current angling usage has become acute. Specifically, there is a need for comparative data about the relative importance and highly valued aspects of the angling experience offered by a particular river. Such information will enable water managers to take into account the angling value of a river in a regional or national context, rather than in isolation as tends to happen at present.

In 1979, Fisheries Research Division (FRD) of the Ministry of Agriculture and Fisheries (MAF), with the New Zealand acclimatisation societies, began a postal survey of anglers in all acclimatisation districts with significant sales of fishing licences. The survey had four major objectives:

1. To collect, directly from the adult angling population of New Zealand, quantitative and comparative information on every river supporting a significant sports fishery.
2. To identify those attributes which characterise rivers of importance.

3. To determine from this information rivers which constitute fisheries of national, regional, and local importance.
4. To obtain a data base for future work.

Lake fisheries were deliberately excluded from the survey because it was considered impractical to design a single questionnaire capable of coping adequately with the full range of lake and river fisheries.

A questionnaire booklet, containing a list of rivers within a given acclimatisation district, was mailed to anglers in each society. Anglers were asked to identify rivers which they had fished over 3-5 years and to assess for each river its importance to them (on a 1-5 scale) and the relative importance of seven listed qualities (distance from home, access, area of fishable water, scenic beauty, feelings of peace and solitude, catch rate, and size of fish) in determining why they fished that river. Information was also requested on average number of visits, stretch of water fished, fishing method used, and any associated recreational activity.

Of more than 10 700 anglers contacted, about 4000 completed their booklets, which provided over 20 500 individual assessments of more than 800 rivers and streams throughout the country. The present series of reports uses these assessments to identify, in each acclimatisation society district, rivers which are regionally and locally important. Nationally important angling rivers have already been identified by Teirney, Unwin, Rowe, McDowall, and Graynoth (1982), but are also discussed in this series. Because of the sheer volume of data collected, and the amount of detailed information contained within the data, a full analysis of every river was not possible and for some rivers only the raw data are presented.

1. INTRODUCTION

The Hawke's Bay Acclimatisation Society district is on the east coast of the North Island around Hawke Bay and extends south to Cape Turnagain (Fig. 1). The district is bordered by Central North Island Wildlife Conservancy (CNIWC) to the north and Wellington Acclimatisation Society district to the south and west. Source streams of Hawke's Bay rivers are in the inland North Island ranges (the Ruahines, Kaimanawas, Kawekas, and Ahimanawas) and, apart from the Manawatu and the Rangitikei, the rivers flow east into Hawke Bay.

Between the inland ranges and Hawke Bay lie the fertile Heretaunga Plains. Intensive fat lamb production takes place on these flat to rolling plains, but near Napier and Hastings, pasture gives way to market gardens, orchards, and vineyards. Pockets of dairying occur close to the main ranges in the Manawatu valley.

Hawke's Bay is one of the driest regions of the North Island, with an annual rainfall of 700-1000 mm, most of which falls during winter (Wards 1976). This, with the upland catchment modifications and the intensive land development of the Heretaunga Plains, affects the rivers in several ways. During heavy rainfall the rivers are prone to rapid flooding, and this has created serious aggradation problems as bed material has been moved downstream. In their lower reaches, large rivers such as the Tukituki, Waipawa, Ngaruroro, and Tutaekuri meander over wide shingle beds, which are flanked by stopbanks to contain floodwater. Work is underway, or proposed, to improve channels, raise

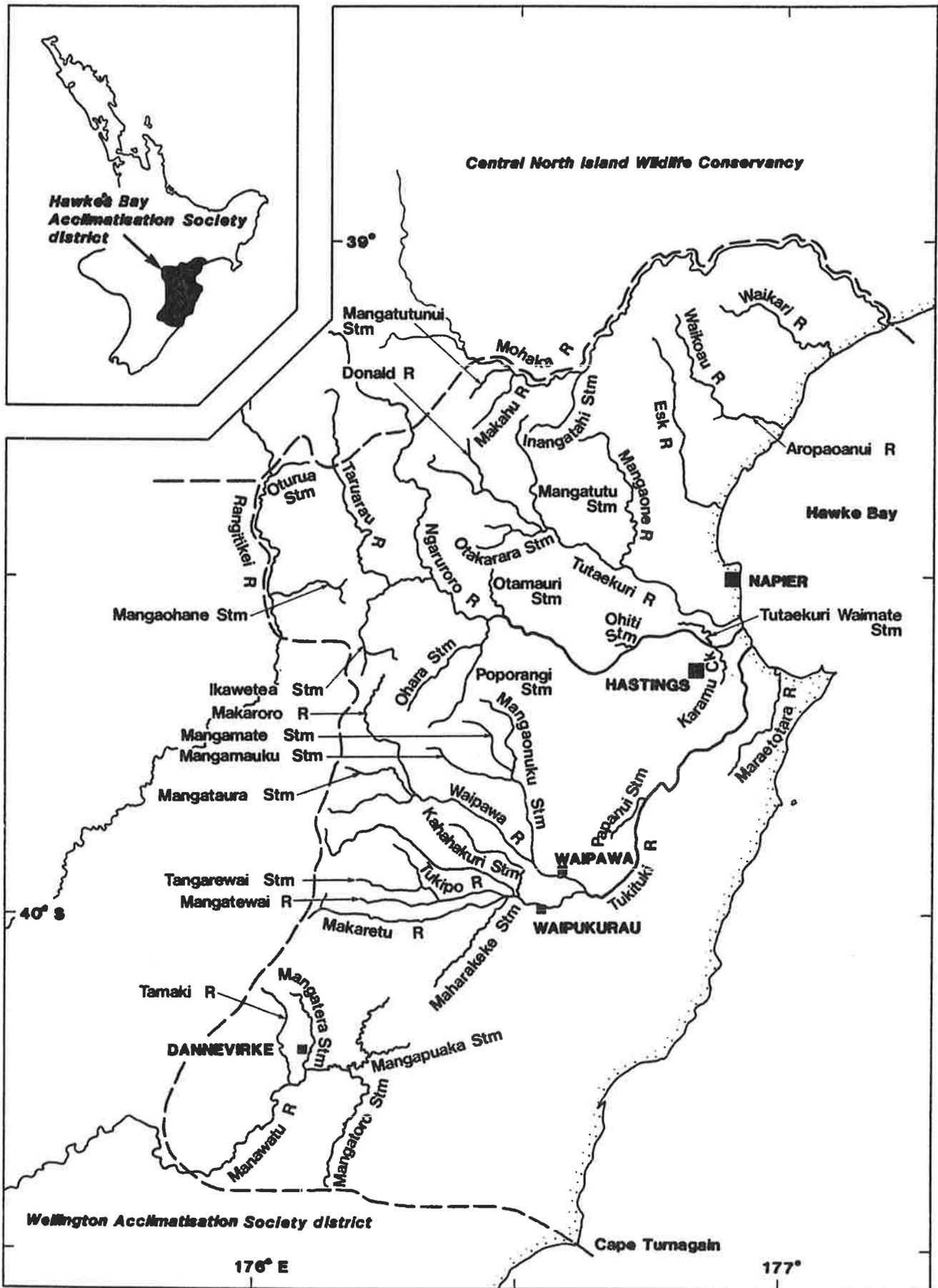


FIGURE 1. The Hawke's Bay Acclimatisation Society district.

stopbanks, and plant trees on the Tukituki, Waipawa, and Manawatu (L.W. Spooner pers. comm.).

In summer extreme low flows and high water temperatures result in reports of many fish mortalities. Some rivers dry up in sections during summer (the Tukituki, Waipawa, and Mangaonuku), and minimal flow conditions have recently been observed in others (the Tukipo, Manawatu, Maharakeke, and Ngaruroro) (L.W. Spooner pers. comm.). Although no Hawke's Bay rivers have large scale abstractions for irrigation, this district has the highest number of irrigated hectares in the North Island (N.Z. Department of Statistics 1981a).

The Hawke's Bay Regional Water Board is preparing water allocation plans for the Tukituki and the Waipawa; the Ngaruroro has been under investigation for both irrigation and hydro-electric development. Similarly, the Mohaka has recently been proposed for a state hydro-electric power scheme. Input about the fisheries values of these rivers is vital at the early planning stages.

Brown trout were the first salmonids to be introduced into Hawke's Bay rivers and streams late last century (Graynoth 1973). Rainbow trout were not liberated until 10 years later, but are now the predominant species caught in all but the Manawatu and the Maraetotara. Although quinnat salmon have been liberated many times, there are no existing runs of adult salmon in the region's rivers.

The main population centres of Hawke's Bay are Napier (population 48 136) and Hastings (35 770). Most of the rest of the population is rural and serviced by small townships such as Dannevirke (5668), Waipukurau (3644), and Waipawa (1752) (N.Z. Department of Statistics 1981b).

Fishing licence sales have increased since the mid 1970s, and 2125 adult whole season licences were sold during the 1979/80 season. In September 1980 survey questionnaires (in the form of small booklets) were mailed to 403 anglers selected at random from the 1979/80 licence holders. An example of the booklet is included as Appendix I.

From the responses, estimates were made of the angling usage of the major river fisheries. The analysis was complicated by a fairly high non-response rate and by the existence of several groups of licence holders with different fishing habits. Details of the method of estimating angler usage are given in Appendix II.

A space was provided at the end of each booklet for anglers to enter details of additional rivers they fished. Thus, anglers who held licences in other districts also provided information on Hawke's Bay rivers. Data for those rivers for which there were sufficient responses from outside anglers have been incorporated into this report.

2. RESULTS

Two measures of importance were used to assess the relative value of Hawke's Bay rivers to anglers. In the first the raw data were tabulated to show the number of respondents who fished each river. Both the number of respondents who fished a river and the total number of visits were taken as an indication of the relative use made of the river. Individual rivers were then selected for further analysis if they were fished by 10 or more respondents.

The second was based on individual angler's ratings, on a 1-5 scale, of the importance of each river they fished, and it took into account

the whole angling experience. Histograms showing the percentage-frequency distribution of the 1-5 ratings were made for each river (Appendix III). A grade between 1 and 5 was then assigned to each river on the basis of these histograms. Grade 1 indicated that the river was generally not highly valued by anglers who fished there; grade 5 indicated that the river was generally very highly valued. Histograms were made for all rivers with 10 or more respondents, but grades were assigned only to those rivers with 15 or more responses. Although this method provided an objective basis for allocating gradings, the final choices were necessarily partly subjective.

Hawke's Bay rivers which were fished by more than one respondent are listed in Table 1, which shows the number of respondents who fished each river, the number of visits they made annually, and the average number of visits per respondent. The importance grade is also given for the 15 rivers which were fished by 15 or more respondents. Data on a further eight Hawke's Bay streams were provided by single respondents. This does not necessarily indicate that the value of these streams is low from a fisheries viewpoint; some may provide spawning grounds or extra summer water for fisheries supported by other rivers.

To investigate the relationship between usage of each river and the value of the river to anglers who fished there, rivers which attracted more than 15 respondents were ordered according to the estimated number of anglers who fished them (Table 2). The two rivers which attracted the most anglers (Tukituki and Ngaruroro) were also highly valued by those who fished them. However, there was no consistent relationship between usage and importance grade for the other rivers. For example, though the Taruarau and Tukipo were visited by the same number of anglers, the Taruarau received a much higher importance grade.

TABLE 1. Measures of angler use and importance grade, or value, of Hawke's Bay rivers.

River	No. of respondents	% of respondents	No. of visits	Visits per respondent	Importance grade*
Mohaka†	82	51.9	484	5.9	4
Inangatahi	6	3.8	33	‡	-
Makahu	9	5.7	19	-	-
Walkari	12	7.6	23	-	-
Aropaoagui§	15				
Waikoau§	9	15.2	47	2.0	2
Esk	47	29.7	265	5.6	3
Tutaekuri	82	51.9	947	11.5	3
Mangaone	45	28.5	262	5.8	3
Mangatutu	14	8.9	56	-	-
Donald	9	5.7	14	-	-
Ngaruroro	88	55.7	704	8.0	4
Karamu	3	1.9	7	-	-
Tutaekuri Waimate	18	11.4	79	4.4	3
Ohiti	13	8.2	59	-	-
Otamauri	4	2.5	16	-	-
Ohara	21	13.3	95	4.5	3
Poporangi	4	2.5	16	-	-
Taruarau	17	10.8	56	3.3	5
Ikawetea	4	2.5	9	-	-
Tukituki	111	70.2	1192	10.7	5
Waipawa	20	12.6	225	11.2	5
Mangaonuku	16	10.1	123	7.7	4
Makaroro	12	7.6	36	-	-
Kahahakuri	3	1.9	13	-	-
Tukipo	17	10.8	63	3.7	3
Makaretu	4	2.5	7	-	-
Maharakeke	10	6.3	25	-	-
Maraetotara	31	19.6	198	6.4	4
Manawatu ¶	24	15.2	536	12-22**	4
Tamaki	2	1.3	12	-	-
Mangatoro	4	2.5	53	-	-
Mangapuaka	2	1.3	2	-	-
Rangitikei ††	9	5.7	22	-	-
Mangaohane	5	3.2	28	-	-

* 1 = not highly valued, 5 = very highly valued.

† The Mohaka River forms the boundary with the CNIWC. The headwaters are in the CNIWC.

‡ Too few responses to analyse.

§ Comments from the society indicate that there is some confusion amongst anglers as to the boundaries of these two rivers. Therefore, results from both rivers have been combined in this report.

|| The extreme headwaters of the Ngaruroro River are in the CNIWC.

¶ Below map reference N149 275396 the Manawatu is in the Wellington Acclimatisation Society district.

** Four respondents made a disproportionate contribution to the effort on the Manawatu. The lower figure represents the frequency of visits with data from these four anglers omitted.

†† Only a short section of the Rangitikei (approximately between Waingakia and Reporoa Streams) occurs as a boundary between the Wellington and Hawke's Bay districts.

TABLE 2. Estimates of angler use and importance grade, or value, of 15 Hawke's Bay rivers. (All estimates are rounded to two significant figures.)

River	No. of anglers	No. of visits	Importance grade*
Tukituki	1 100	12 000	5
Ngaruroro	880	7 200	4
Tutaekuri	820	9 600	3
Mohaka	820	4 900	4
Esk	470	2 700	3
Mangaone	450	2 700	3
Maraetotara	310	2 000	4
Manawatu	240	2 500-5 400†	4
Aropaoanui-Waikoau	240	470	2
Ohara	210	950	3
Waipawa	200	2 300	5
Tutaekuri Waimate	180	800	3
Tukipo	170	630	3
Taruarau	170	560	5
Mangaonuku	160	1 200	4

* 1 = not highly valued, 5 = very highly valued.

† Four respondents made a disproportionate contribution to the fishing effort on the Manawatu. The lower figure represents the estimated effort with data from these four anglers omitted.

Except for the Mangaone, the first seven rivers in Table 2 are mainstem rivers which discharge directly into Hawke Bay. The Manawatu, the eighth river listed in the table, is also a mainstem river, but it discharges into the Tasman Sea on the west coast of the North Island. Although the size of a river and its associated flow regime were attributes which were not incorporated in this analysis, this result suggests that anglers value big river fisheries.

To investigate why some rivers were more highly valued than others, the anglers' assessments of seven factors (listed in the questionnaire), which contribute to the angling experience on each river, were considered. As with importance grades, each factor was assigned a grade between 1 and 5, based on the frequency-distribution histograms of anglers' ratings for each river (Appendix III). Again, assigning individual grades was partly subjective. Only those rivers with 15 or more respondents were assigned grades for the seven factors.

The results of this analysis are summarised in Table 3. The rivers have been ordered according to the anglers' assessments of distance from home, rather than geographically, because several trends in the data are more readily discussed in terms of distance from home or travelling time. Despite some ambiguity in the data for the Manawatu River (see Appendix III), this river was fished predominantly by local anglers and has been listed as such in Table 3.

The 15 rivers listed in the table encompass a wide range of river type. Rivers such as the Tutaekuri, Tukituki, and Ngaruroro, which were regarded as being close to anglers' homes, were highly regarded for both access and area of fishable water. The more remote rivers, such as the Mohaka, were poorly rated for access, but received high ratings

TABLE 3. Assessment by anglers of seven factors (listed in the questionnaire) which contribute to the angling experience provided by 15 Hawke's Bay rivers.

River	Distance	Access	Area fishable	Scenic beauty	Solitude	Catch rate	Size of fish
Tutaekuri	●●●●●	●●●●●	●●●●●	●●●	●●	●●	●●
Manawatu	●●●●●	●●●●●	●●●●	●●●	●●●●	●●●	●●●
Tutaekuri Waimate	●●●●●	●●●	●●●	●●	●●	●●	●●
Tukituki	●●●●	●●●●●	●●●●	●●●	●●●	●●●	●●●
Ngaruroro	●●●●	●●●●	●●●●●	●●●●	●●●●	●●●	●●●
Mangaonuku	●●●	●●●●	●●●●	●●●●	●●●	●●●	●●
Esk	●●●	●●●●	●●●●	●●●●	●●●●	●	●●●
Maraetotara	●●●	●●●	●●	●●●	●●●●	●	●●●
Waipawa	●●●	●●●●	●●●●	●●●	●●●●	●●●●	●●●
Mangaone	●●●	●●●	●●●	●●●	●●●●●	●●	●●●
Tukipo	●●●	●●●	●●●	●●●	●●●	●●	●●●
Aropaoanui Waikoau	●●	●●●	●●●	●●●●	●●●●●	●●	●●
Ohara	●●	●●●	●●●	●●●●	●●●●●	●●●	●●
Mohaka	●	●●●	●●●●	●●●●●	●●●●●	●●●	●●●
Taruarau	●	●	●●●	●●●●●	●●●●●	●●●	●●●●

Grade	●	●●●●●
Distance:	remote	close
Access:	difficult	easy
Area fishable:	restricted	extensive
Scenic beauty:	low	high
Solitude:	low	high
Catch rate:	low	high
Size of fish:	small	large

for scenic beauty and solitude. Catch rate and size of fish showed significant variation between rivers, but were not obviously correlated with any of the other attributes.

A notable feature of the Hawke's Bay river fisheries was that wet flies were by far the most popular lure used (Table 4). Of 147 respondents who provided data on their preferred fishing methods for each river, 107 (73%) used wet flies at least once, and only 20 (14%) did not use artificial flies of any kind. Artificial spinners, nymphs, and dry flies were all about equally popular, being used by 84 (57%), 81 (55%), and 72 (49%) of the respondents respectively. Live bait, which is legal only in the Manawatu River below Weber Road bridge, was virtually unused (listed by only 6(4%) of the respondents) and has not been included in Table 4.

3. CHARACTERISTICS OF 20 HAWKE'S BAY RIVERS

The following summarises the survey results in relation to each of the 20 Hawke's Bay rivers listed in Table 4. In addition to the information in Appendix III and Table 3, use has been made of the anglers' responses on which reaches of each river were fished (Table 5), details of preferred fishing methods (Table 4), and participation in other recreational activities associated with each river (Table 6). Reaches were not geographically defined in the questionnaire booklet, but anglers were asked to indicate which length of river they fished (headwaters, middle reaches, and lower reaches). Many anglers also provided written comments, which have been included, as received, for those rivers which elicited more than two or three comments. The rivers are dealt with from north to south, and the tributaries of the mainstem rivers are in order of increasing distance upstream.

TABLE 4. Preferred angling methods used on 20 Hawke's Bay rivers.

River	Dry fly	Wet fly	Nymph	Spinner
Mohaka	●●	●●●	●●●	●●●
Waikari	●●	●●●	●●●●	●●●
Aropaoanui-Waikoau	●	●●●	●●●●	●
Esk	●	●●●●	●●●	●●
Tutaekuri	●●	●●●●	●●●	●●●
Mangaone*	●●	●●●●	●●●●	-
Mangatutu	●●	●●●●	●●●	●●
Ngaruroro	●	●●●●	●●●	●●●
Tutaekuri Waimate	●●	●●●●	●●●	●●
Ohiti	●●●	●●	●●●●	●●
Ohara	●●	●●●●	●●●	●●
Taruarau	●	●●●	●●●	●●●●
Tukituki	●●●	●●●●	●●●	●●
Waipawa	●●●	●●●●	●●●	●●●
Mangaonuku*	●●●●	●●●	●●●●	●
Makaroro	●●●	●●●●	●●●	●●●
Tukipo*	●●●●	●●●	●●●●	-
Maharakeke*	●●●●	●●	●●	-
Maraetotara*	●●●	●●	●●●●	-
Manawatu	●●●●	●●	●●●●	●●

* Artificial fly only (acclimatisation society regulations).

Percent of respondents using each method:

-	< 5%
●	5-20%
●●	21-40%
●●●	41-60%
●●●●	61-80%
●●●●●	81-100%

TABLE 5. Popularity of individual reaches of 20 Hawke's Bay rivers.

River	Headwaters	Middle reaches	Lower reaches
Mohaka*	●●●	●●●●●	-
Waikari	●	●●●●●	●●
Aropaoanui-Waikoau	●●	●●●●	●●
Esk	●●	●●●●	●●
Tutaekuri	●●	●●●●	●●●
Mangaone	●	●●●●	●●●
Mangatutu	●●	●●●●	●●●●●
Ngaruroro*	●●●	●●●●	●●●
Tutaekuri Waimate	●	●●●●	●●●
Ohiti	●	●●●	●●●●
Ohara	●●●	●●●●	●●●
Taruarau	●●	●●●●	●●●
Tukituki	●	●●●●	●●●
Waipawa	●	●●●●●	●●●
Mangaonuku	●	●●●●	●●●●●
Makaroro	●●●	●●●●	●●●
Tukipo	●	●●●●	●●●●
Maharakeke	●	●●●	●●●●
Maraetotara	●	●●●●●	●
Manawatu†	●●	●●●●	●

* Headwaters are in the CNIWC.

† Lower and middle reaches are in the Wellington district.

Percent of respondents fishing each reach:

-	< 5%
●	5-20%
●●	21-40%
●●●	41-60%
●●●●	61-80%
●●●●●	81-100%

TABLE 6. Participation in other recreational activities associated with angling on 20 Hawke's Bay rivers.

River	Enjoying the scenery	Picnicking	Swimming	Rafting	Camping	Tramping	Shooting
Mohaka	●●●●●	●●	●	●	●●●●	●●	●●
Waikari	●●●	-	-	-	-	●	-
Aropaoanui-Waikoau	●●	●	-	-	-	-	-
Esk	●●●●	●●●	●●	-	●●	-	-
Tutaekuri	●●●	●●●	●	-	-	●	-
Mangaone	●●●●	●●	●	-	-	●	-
Mangatutu	●●●●●	●●●	-	-	-	●●●●	-
Ngaruroro	●●●●	●●●	●	●	●●	●	●●
Tutaekuri Waimate	●	●	-	-	-	-	-
Ohiti	●●	●	-	-	-	-	●
Ohara	●●●	●●●●	●	-	●	-	-
Taruarau	●●●●●	-	●●	●	●●●●●	●●●	●●●●
Tukituki	●●●●	●●●●	●●●	-	●	-	-
Waipawa	●●●●	●●●	●●●	-	●●	-	●
Mangaonuku	●●●●●	●●	●●	-	●	-	●
Makaroro	●●	●	●	-	●●	●	●●
Tukipo	●●●●	●●	●	-	-	-	-
Maharakeke	●●●●	●●	-	-	-	-	-
Maraetotara	●●●●●	●●	●	-	-	-	-
Manawatu	●●●●	●●●	●	-	-	-	●

Percent of respondents participating in each activity:

- <10%
- 10-19%
- 20-29%
- 30-39%
- 40-49%
- ≥50%

Two Hawke's Bay rivers - the Mohaka and the Ngaruroro (and their headwater tributaries) - are partly in the CNIWC. Both rivers were therefore listed in the CNIWC survey questionnaire and in the Hawke's Bay booklet. In addition, both rivers were fished by anglers from other acclimatisation societies, including some in the South Island. For the purposes of this report, all the data on these rivers have been combined. Estimates of total annual usage for the two rivers are given in Table 2, but these figures apply only to anglers with Hawke's Bay licences. Estimates of the angling effort expended by anglers from the CNIWC and elsewhere have not been attempted. Any such estimates would be incomplete, particularly for the CNIWC, because part season licence holders (who were not sampled) make up a high proportion of the angling population. The figures in Table 2 are therefore underestimates.

3.1 Mohaka River

The Mohaka has its source high in the Kaimanawa Mountains and flows 100 km through steep gorges to Hawke Bay. Although there has been some agricultural and forestry development in the catchment, the river does not suffer from pollution or substantial nutrient enrichment, and it supports a mixed population of brown and rainbow trout. Brown trout predominate in the headwaters, but there are similar numbers of both species in the middle reaches (Wellwood 1968). However, rainbow trout are more easily caught. They made up 83% of the total catch reported by Graynoth (1973). A total of 133 respondents provided data on the Mohaka River. Of these, 82 (62%) were from Hawke's Bay, 33 (25%) from the CNIWC, and 18 (13%) from other acclimatisation society districts.

Owing to the steep mountainous nature of the surrounding country, access to the Mohaka is limited. Despite this, and the river's

distance from any population centres, over 40% of the respondents rated its overall importance as exceptional. Anglers were able to fish large areas of water in the midst of exceptional scenic beauty and solitude, and a good catch rate of fairly large trout was reported.

The most popular section of the Mohaka, the middle reaches, was not as highly valued as the headwaters, particularly in terms of its scenic beauty, feelings of solitude, and size of fish. However, access to the middle reaches was much easier, and respondents reported a slightly higher catch rate. Less than 5% of the respondents visited the lower reaches.

Wet flies, nymphs, and spinners were all commonly used by anglers; dry flies were used to a lesser extent. Camping and enjoying the scenery were unusually popular activities associated with angling on the Mohaka, and it was one of the few rivers in New Zealand where all the recreational activities listed in the questionnaire were engaged in by anglers. Anglers' comments included:

- *very good for natural trout*
- *Hawke's Bay's best, most beautiful river*
- *must rate as one of New Zealand's best*
- *definitely a river for a fit person who can swim*
- *very important river*
- *a great river*
- *stable river*
- *horrified to learn of possible dam on Mohaka*
- *excellent river*
- *best river for combined recreational usage*
- *excellent browns and occasional rainbows - all in superb condition.*

Recently the Mohaka has come under investigation for its hydro-electric development potential. Interest has centred on three dam sites in the lower reaches and three additional sites in the middle reaches (Galloway 1980). Although the pre-feasibility report is still some time away, FRD, Wildlife Service (Department of Internal Affairs), and the Hawke's Bay Acclimatisation Society initiated the first part of a joint investigation programme in February 1983, so that impacts of the proposed scheme could be adequately assessed and minimised if necessary. Results from the initial survey provided the basis for recommendations about further impact assessment studies (R.R. Strickland in prep.). Fisheries Research Division believes the headwaters and middle reaches of the Mohaka support a nationally important trout fishery (Teirney *et al.* 1982), and so some protection is desirable for at least that part of the Mohaka.

3.2 Waikari River

This small and remote coastal river was fished by a few respondents. Almost all the angling took place in the middle reaches, where the river flows through deep, narrow, papa gorges (Egarr and Egarr 1981). Although the gorge walls contribute to the scenic aspects of this river, they also prevent anglers from combining other activities such as picnicking or camping with their fishing visits. Anglers used all the artificial fishing methods on the Waikari, but nymphs were most popular.

3.3 Aropaoanui-Waikoau River

Because of the confusion about the boundary between these two rivers (the State Highway 2 bridge), the results for both have been combined. The Waikoau begins in the Maungaharuru Range and

the Aropaoanui flows into Hawke Bay, midway between the Mohaka River mouth and Napier. These rivers attracted a few anglers, about 16% of respondents. Although both scenic beauty and solitude were rated highly, the overall importance value was below average, probably partly due to the small fish and low catch rate reported. Virtually all the angling occurred in the middle reaches; the headwaters and lower reaches are fairly inaccessible by road. Respondents preferred to use nymphs and wet flies, but a few also used dry flies or spinners.

3.4 Esk River

The Esk River was fished by nearly 30% of the Hawke's Bay respondents. Its high use, particularly in the middle reaches, can be attributed to its proximity to Napier, easy access, scenic qualities, and large area of fishable water. Although the overall importance of the angling experience was judged to be average, the catch rate was one of the lowest in the district. However, the society reports that anglers' catches have improved recently (H.M. Swinburn pers. comm.). As with almost all the Hawke's Bay rivers, wet flies were preferred by anglers, and picnicking was a popular associated activity. Anglers' comments indicated that, though the catch rate was low, the river was still valued. Comments included:

- *peace and beauty of this river make it tops*
- *motorbikes, rubbish, and shingle works have spoilt this river*
- *very clean river but not many trout*
- *very disappointing for such lovely water.*

3.5 Tutaekuri River

The Tutaekuri is the smallest of the three main rivers which flow over the Heretaunga Plains into Hawke Bay. It also ranked third behind the Tukituki and Ngaruroro in terms of number of respondents. The river's proximity to Napier and Hastings, very easy access, and large area of fishable water combined to give it the second highest number of visits in the district. In addition, anglers thought the overall importance of the river was about average, even though some of the individual factors were given below average ratings.

Anglers fished mainly in the middle and lower reaches. The lower reaches, though closer to home, were not as scenically attractive as the middle, and the catch rate and size of fish were both lower. Spinners were most popular in the lower reaches, then wet flies and nymphs. In contrast, wet flies were the most popular lure in the middle reaches. More anglers enjoyed picnicking and swimming on their visits to the lower reaches, whereas camping, tramping, and shooting were exclusive to the middle reaches and headwaters.

3.5.1 Mangaone River

This short stable tributary of the Tutaekuri was the only non-mainstem river in Hawke's Bay that attracted more than 15% of the respondents; it was fished by nearly 30%. Apart from feelings of peace and solitude, other aspects of the angling experience and overall importance were thought to be average or below average. In particular, the catch rate was low, a feature which has not altered since a study of angler diaries collected during the 1950s and 1960s (Graynoth 1973).

The most popular fishing reaches, the middle and lower, were valued about equally by anglers. Feelings of peace and solitude, and catch

rate, were a little lower in value in the lower reaches. Apart from enjoying the scenery and picnicking, anglers only rarely combined their visits with other recreational activities. The Mangaone is reserved for fly fishing, and wet flies and nymphs were used more frequently than dry flies. This river is also thought to be a good spawning stream, and it supports mainly rainbow trout (Graynoth 1973).

3.5.2 Mangatutu Stream

Although the Mangatutu was not heavily fished, it was regarded as one of the most scenic rivers in the district, and it also gave anglers excellent opportunities for fishing in peace and solitude. Ten of the 14 respondents combined enjoying the scenery with fishing, and 6 noted tramping. A reasonable catch rate was obtained by anglers, who preferred wet flies and nymphs.

3.6 Ngaruroro River

The Ngaruroro begins in the Kaimanawa Mountains and is the second largest river which flows across the Heretaunga Plains. It shares a common mouth with the Tutaekuri, just south of Napier. Data on the river were supplied by 112 respondents, of whom 88 (79%) were from Hawke's Bay and 24 (21%) were from the CNIWC or elsewhere.

Overall, the respondents valued the river very highly, and access, area of fishable water, scenic beauty, and solitude were all thought to be above average. Anglers fished the whole length of the Ngaruroro, though the middle reaches were the most popular. The lower reaches were fished almost exclusively by Hawke's Bay anglers, whereas the headwaters and middle reaches were fished by anglers from the CNIWC and elsewhere, as well as from Hawke's Bay.

The middle reaches of the Ngaruroro, which extend up to about the Ohara Stream confluence, were visited by over 60% of the respondents. Although these reaches were a little further from anglers' homes and had more difficult access than the lower reaches, they were thought to be superior in every other aspect. Wet flies were the most frequently used artificial lure, then spinners, nymphs, and dry flies. Picnicking was often combined with fishing in the middle reaches, and camping, tramping, and shooting were popular activities.

The headwaters were thought to be of exceptional quality and have been identified as a nationally important wilderness trout fishery by Teirney *et al.* (1982). In addition to Hawke's Bay and CNIWC respondents, anglers from Wanganui and Wellington districts also visited the headwaters, and over 50% of these anglers awarded this section the highest value for overall importance. Access to these remote headwaters was thought to be very difficult, but those anglers who made the effort were rewarded by the peace and solitude associated with fishing this remarkably scenic stretch of water. In addition, the respondents reported a good catch rate of large trout. Nymphs and wet flies were the preferred angling methods, and over 50% of the anglers combined camping and shooting with their visits; tramping was also unusually popular.

The rest of the river is also important to Hawke's Bay anglers. Although none of the tributaries or other lengths of the river met the criteria for national importance, they are all integral to the Ngaruroro fishery and may be important for maintaining its fish stocks. Therefore, any development of part of the catchment which might affect the headwater fishery would be of concern from a fisheries viewpoint.

3.6.1 Tutaekuri Waimate Stream

This tributary of the Ngaruroro meanders through the countryside between Napier and Hastings. A large percentage of its flow is thought to come via groundwater sources from the Tutaekuri River (Grant n.d.). Although fairly small, it attracted over 11% of the respondents because of its proximity to the two main population centres of Hawke's Bay. Ease of access and the area of fishable water were positive qualities of the Tutaekuri Waimate, but scenic beauty and feelings of solitude were given some of the lowest ratings in the district. In addition, catch rate and size of fish were below average. Angling usually took place in the middle and lower reaches of this stream, and all artificial lures were used. Dense aquatic weed growth covers much of the surface during summer (L.W. Spooner pers. comm.), and it seems likely that the Tutaekuri Waimate is fished mainly early in the season.

3.6.2 Ohiti Stream

The Ohiti is another very small tributary of the Ngaruroro. Few Hawke's Bay respondents visited this spring-fed stream, and the overall value of the angling experience was below average. In contrast to most other Hawke's Bay rivers, nymphs were most frequently used, then dry flies, wet flies, and spinners. However, a very low catch rate was reported. Anglers' comments about the Ohiti included:

- *flows mostly through private land*
- *remains clear when others are dirty so is somewhere to fish*
- *spring fed - clean when other rivers are in flood.*

3.6.3 Ohara Stream

The Ohara drains into the Ngaruroro, and it attracted nearly 15% of the respondents. All reaches of this short stream were fished, but access to them was judged to be fairly difficult. However, once on the riverbed, anglers were able to fish reasonable areas of water, while enjoying surroundings of high scenic beauty and solitude. The catch rate was average for the Hawke's Bay district, but the trout landed were slightly smaller than average. Graynoth (1973), from an analysis of anglers' diaries, reported that the Ohara appeared to hold only rainbow trout. Wet flies were preferred, but nymphs were also commonly used. Almost 50% of the respondents indicated picnicking was a popular activity which was combined with their visits to the Ohara.

3.6.4 Taruarau River

One of the most remote and inaccessible rivers in the district, the Taruarau nevertheless attracted 11% of the respondents. Despite a fairly low catch rate, over 40% of the respondents awarded the Taruarau the highest possible grade for overall importance and, of the other attributes listed in the questionnaire, both scenic beauty and solitude were thought exceptional. In addition, trout landed from this river were reported to be the largest in the district.

Road access occurs at only one point, where the river is crossed by the Napier-Taihape road. However, anglers indicated that they fished the whole length of the river and often combined camping and tramping with their visits. Shooting was also very popular, and nearly 66% of the respondents noted enjoying the scenery while angling. Unusually for Hawke's Bay, spinners were most popular, then nymphs, wet flies, and dry

flies. Anglers' comments reflected the high regard they have for this river. They included:

- *magnificent water. Quite a bit of opposition from landowners however, who say they own rivers and fishermen are not allowed to walk up*
- *excellent fighting trout taken here*
- *stable river conditions*
- *leave this river alone*

3.7 Tukituki River

From its origin in the Ruahine Range, the Tukituki flows over a wide shingle bed for most of its length. It is the largest of the Hawke's Bay rivers which flow across the Heretaunga Plains, and it enters the sea east of Hastings. Over 70% of the respondents visited the Tukituki; so it was the most highly fished river in the region. Although three other rivers (Manawatu, Tutaekuri, and Waipawa) had a higher frequency of visits, the Tukituki was one of only three rivers in Hawke's Bay to receive a grade of 5 for overall importance.

Because of the Tukituki's proximity to the major population centres of Hawke's Bay, both ease of access and closeness to home were very highly valued. The river was also highly rated for its area of fishable water. As is characteristic of rivers close to population centres, the Tukituki was not highly valued for either scenic beauty or the opportunity of fishing in peace and solitude.

Virtually all the fishing occurred in the middle and lower reaches, which anglers thought were of almost equal value. All the artificial lures were used, and reasonably sized trout were landed. The Tukituki

is thought to be mainly a rainbow trout fishery (Wellwood 1968), but large brown trout occur in the lower reaches (Graynoth 1973). Picnicking and swimming were the two most popular activities associated with angling.

The Tukituki was also visited by 10 respondents from outside the Hawke's Bay district. These anglers came from various acclimatisation society districts, including Tauranga, Stratford, Wanganui, Wellington, Waitaki Valley, and Otago. The outside respondents also fished mainly in the middle and lower reaches, and they used all the artificial lures.

3.7.1 Waipawa River

The Waipawa is the largest tributary of the Tukituki and is similar in its physical characteristics. It attracted only 13% of the respondents, but had a fairly high frequency of visits and was also awarded an overall importance grade of 5. Most of the angling was in the middle reaches. All the attributes listed in the questionnaire were given an average or above average value, and the Waipawa was highly regarded for its high catch rate and good sized trout. All the artificial lures were used, but wet flies were most common. As with the Tukituki, picnicking and swimming were popular with the anglers.

The Hawke's Bay Regional Water Board is preparing water allocation plans for the Waipawa and the Tukituki. Water from the Waipawa contributes at least 50% of the flow to the mainstem section of the Tukituki (Egarr and Egarr 1981). Although both rivers suffer from erosion and bed movement during floods, and in summer they are affected by weed growth and high water temperatures and they dry up in parts, they continue to support highly valued trout fisheries and are obviously

important to Hawke's Bay anglers. The setting of minimum flows on these rivers should recognise the requirements of the fisheries on these significant recreational resources.

3.7.2 Mangaonuku Stream

The Mangaonuku, a tributary of the Waipawa, is mainly spring fed and has a fairly constant flow. It is not subject to discoloration or excessive flooding (Wellwood 1968), and it provides an opportunity for fishing when nearby rivers are in flood or badly affected by low flows. It attracted almost the same percentage of respondents as the Waipawa and, like the mainstem, access and area of fishable water were very good. The Mangaonuku is reserved for fly fishing only, and it had the highest catch rate of all the streams reserved as such in Hawke's Bay. These attributes, and its scenic beauty, gave this stream an above average importance grade. Virtually all the angling took place in the lower and middle reaches, and activities associated with angling included enjoying the scenery, picnicking, and swimming.

3.7.3 Makaroro River

This remote tributary of the Waipawa was not highly valued as an angling river. Its small size and gorged, inaccessible nature meant that few Hawke's Bay anglers were attracted to it, despite fairly high scenic and solitude qualities. However, as the largest tributary of the Waipawa, it is important for its flow contribution, especially during dry spells. Wet flies were most frequently used on the Makaroro.

3.7.4 Tukipo River

The Tukipo drains the rolling farmland between the Ruahine Range and Waipukurau. Although more remote than the Waipawa, it attracted nearly as many anglers. However, it was not as highly valued and had less than one-third the number of visits. As is characteristic of "fly only" rivers, the catch rate was fairly low. In addition, the river did not stand out in respect to any of its other attributes. In the middle and lower reaches, which received about equal fishing pressure, enjoying the scenery, picnicking, and swimming were the only activities combined with fishing.

3.7.5 Maharakeke Stream

This spring-fed tributary of the Tukipo enters the mainstem just west of Waipukurau. It flows mainly through farmland and has dense beds of aquatic macrophytes along its edges. The Maharakeke contains both rainbow and brown trout (Wellwood 1968). Angling effort was confined mainly to the lower and middle reaches, where the value of the angling experience was thought to be about average. Otherwise, this river had the same attributes as the Tukipo. Dry flies, wet flies, and nymphs were all used by anglers on this "fly only" stream. Anglers rarely combined their visits to the Maharakeke with other recreational activities, which were limited to enjoying the scenery and picnicking.

3.8 Maraetotara River

This short, coastal river, which enters Hawke Bay south of the Tukituki, has a narrow, deep, water course containing clear, cold water. It is one of the few rivers in the region that has brown trout only

(Graynoth 1973). Nearly 20% of the respondents were attracted to this river, and the overall value of the angling experience was fairly high. Apart from a low catch rate (the river is "fly only") and small area of fishable water (which may be partly due to the profusion of willow trees which grow along the river's banks), other attributes were judged to be average or better in quality. The river is well known locally for its beauty and wildlife values (Wellwood 1968), and over 50% of the respondents indicated that they combined enjoying the scenery with their visits. Angling was confined virtually to the middle reaches, where nymphs and dry flies were almost equally used. Anglers' comments reflected their positive feelings towards this river and included:

- *not easy fishing, good though*
- *has deteriorated over past year. Most fish returned*
- *most beautiful river in the world*
- *the best fishing and trout in the Bay but hard to catch.*

3.9 Manawatu River

From its source in the Ruahine Range, the Manawatu flows for 182 km, mostly through pastoral country. Only the first 80 km of the river (from its source to the Manawatu Gorge) are in the Hawke's Bay district. The rest of the river flows through the Wellington district, and a more complete discussion of the river is in Richardson, Teirney, and Unwin 1984. The Manawatu holds mainly brown trout, but a few rainbows have been reported (H.M. Swinburn pers. comm.).

Although only 15% of the respondents fished the Manawatu, it was very popular with a few anglers; three respondents indicated that they fished the river over 50 times a year. Although this may have artificially inflated the estimated annual use of the river, the river

is heavily fished by local anglers from in and around Dannevirke. Very easy access and a large area of fishable water, combined with pleasant surroundings and feelings of solitude, made the overall angling experience highly valued. Dry flies and nymphs were most popular, but all types of artificial lures were used by anglers, who reported a good catch rate and landed some of the largest fish in the district. Almost all the angling occurred between the gorge and Dannevirke, where anglers sometimes combined picnics, swimming, or shooting with their visits. One angler commented that pollution was becoming a problem in the river, and another noted that willow growth hindered his fishing.

4. DISCUSSION

Of the rivers examined in this report, two contained sections which were included on FRD's list of nationally important angling rivers, and five others are believed to be of importance at a regional or local level (Table 7). These rivers have been classified as recreational, scenic, or wilderness fisheries by use of criteria described by Teirney *et al.* 1982.

The headwaters and middle reaches of the Mohaka River, and the headwaters of the Ngaruroro River, have both been identified as nationally important fisheries (Teirney *et al.* 1982). Although the Mohaka headwaters have some of the characteristics of a wilderness fishery (for example, exceptional ratings for scenic beauty, solitude, and size of fish), the limited road access, and the existence of some farming developments in the catchment, make a scenic classification more appropriate. The middle reaches of the river are the most heavily fished and are best classified as supporting a recreational fishery.

TABLE 7. Hawke's Bay rivers of national, regional, or local importance.

River	Importance	Classification	Outstanding characteristics
Mohaka (headwaters and middle reaches)	National	Recreational/ scenic	High use Exceptional overall importance, scenic beauty, and solitude Fairly large trout Other recreational opportunities
Ngaruroro (headwaters)	National	Wilderness	Exceptional overall importance, scenic beauty, and solitude Large area of fishable water Large trout
Ngaruroro (middle and lower reaches)	Regional	Recreational	High use Good access, close to home Large area of fishable water
Tukituki	Regional	Recreational	High use Exceptional overall importance and access Large area of fishable water Close to home
Tutaekuri	Local	Recreational	High use Exceptional access and area fishable Close to home
Esk	Local	Recreational	High use Excellent access and area fishable High scenic beauty and solitude
Waipawa	Local	Recreational	Moderate use Exceptional overall importance, good access, solitude Large area of fishable water High catch rate
Taruarau	Local	Wilderness	Exceptional overall importance, scenic beauty, and solitude Large trout

Respondents' comments on the Mohaka, and the range of recreational activities supported by it, indicate that the river appeals not only to anglers, but also to outdoor recreationalists in general.

The headwaters of the Ngaruroro, which flow through a remote wilderness area south and west of the Kaweka Range, were rated as exceptional for both scenic beauty and solitude and were also believed to support large trout. As with the upper Mohaka, anglers engaged in a variety of recreational pursuits, particularly camping, tramping, and shooting.

The rest of the Ngaruroro is thought to be of regional importance. Unlike the headwaters, the lower and middle reaches attracted few anglers from outside Hawke's Bay, but were very popular with local anglers. Access to these reaches was better than in the headwaters, though the fishery was not rated as highly overall.

The Tukituki River, easily the river most heavily fished by Hawke's Bay anglers, is of at least regional importance. It was identified as possibly of nationally important status by Teirney *et al.* (1982). Its location, in open farmland close to the major population centres of the region, makes it one of the most accessible rivers in the district. Although the Tukituki lacks the scenic and wilderness qualities that characterise the Mohaka and Ngaruroro headwaters, its very high rating for overall importance is a clear indication of its value to the regional angling population. It is probably one of the most suitable Hawke's Bay rivers for family outings, and swimming and/or picnicking were engaged in by more than 50% of the survey respondents.

The Tutaekuri and Esk Rivers were less highly regarded than the Tukituki, but still of local significance. The Tutaekuri was highly valued for its proximity to anglers' homes (the river flows through the

outskirts of Taradale, midway between Napier and Hastings) and for ease of access and area of fishable water. It was of average popularity as a fishery; although, like the Mohaka and Ngaruroro, it supported a wide range of other recreational activities, particularly in its headwaters. The Esk River - smaller and less accessible than the Tutaekuri - was fished by fewer anglers, but was valued for its scenic qualities.

Two further fisheries of local importance are on the Waipawa and Taruarau Rivers. Neither was heavily fished, but both were thought to be of exceptional value by the anglers who did fish them. The Waipawa was notable for its high catch rate, and the Taruarau for its wilderness attributes.

Hawke's Bay anglers are fortunate in having a wide range of angling rivers to choose from. Four rivers (Tukituki, Ngaruroro, Tutaekuri, and Mohaka) are significantly more popular than the other rivers in the district, though collectively they account for no more than 60% of the angling effort expended in the district. The remaining 40% of effort is distributed over less highly regarded, but still valuable, rivers. The Esk, Mangaone, Waipawa, Maraetotara, and upper Manawatu all make a substantial contribution to the regional fishery resource.

5. ACKNOWLEDGMENTS

We would like to thank the secretary, staff, and council members of the Hawke's Bay Acclimatisation Society for their help in conducting this survey. Constructive criticism of the draft manuscript was provided by society staff, the fish committee, A.D. Carruthers, E.J. Cudby, and R.R. Strickland. Finally, we would like to thank all those Hawke's Bay anglers who made the survey a success by taking the time to complete and return their questionnaires.

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HAWKE'S BAY ACCLIMATISATION SOCIETY

A Survey To Assess

THE RELATIVE VALUE OF NEW ZEALAND RIVERS TO THE RECREATIONAL ANGLER

Conducted in association with the Ministry of Agriculture and Fisheries

Dear Angler

Over the years numerous development schemes have substantially altered a large number of our rivers, resulting in a cumulative loss of high quality angling waters. It has become increasingly obvious that if we want to retain even a few valuable recreational fisheries, we must identify those rivers which, in our opinion, should not be modified, and be prepared to fight for them. To be able to do this we must understand the reasons why anglers value the various rivers they fish and be able to use this information when proposed developments threaten those rivers.

As you can see, this survey booklet, which has been designed to give us this information, applies specifically to the Hawke's Bay Acclimatisation Society district. The results from a pilot scheme carried out recently by Wellington Society anglers look very promising. I would therefore encourage you to fill in the booklet as soon as possible, and return it in the envelope provided.

For the results to be meaningful, every angler receiving a booklet must complete the questionnaire. Any angler who does not return the booklet or advise as to the inability to do so would affect the survey's random selection basis. Individual returns will be confidential to Fisheries Research Division staff who are responsible for analysing the results.

The information collected will be used to protect valuable angling water for the present anglers and those of the future. I cannot emphasise strongly enough the need for your co-operation.

Thanking you in advance for your valued assistance.

Best wishes and good fishing.



(A. W. Le Comte)
President

Explanation of categories used in the
recreational angling survey booklet

You should only fill in the categories if you have actually fished the river under consideration. In other words leave a blank beside those rivers you are not familiar with.

1. Importance of the river to you as an angler

This category relies on your own judgement and feelings about the rivers you fish. The score you give each river is not necessarily related to the amount of time you spend angling on it. You may for instance, value the headwaters of a remote river highly, because of the quality of the whole angling experience even although you only manage a trip every 2-3 years. On the other hand, you may value a river close to home as it allows you to go fishing frequently. One way of assessing the importance of a river to you is to imagine how you would feel if you no longer had the opportunity of fishing it.

2. Average number of visits you make to fish this river each year

You probably don't visit a river to fish it the same number of times each year and therefore your average should be taken over the past 3-5 years angling experience. If you stay at the river for more than 1 day in order to fish, then fill in the average number of days on which you fished during your stays. If you have difficulty remembering exactly how often you fished a river an approximation will do.

3. Stretch of water fished

You may fish the whole length of a particular river or you may have a preferred fishing locality. As the character of a river may alter from the headwaters to the middle and lower reaches, please tick which length of river you fish. If you fish the whole river then you would tick all three categories.

4. The aim of this section is to find out why you value each river you fish. Consider each river in isolation of the others and then grade each reason between 1-5. Most of the reasons are self explanatory.

- (a) Close to where you live would include rivers which can be reached by a short drive. 5 = closest
- (b) Easy access would include rivers which can be driven to, or that only involve a short walk to reach the river bed. 5 = easiest
- (c) Large area of water fishable incorporates the possibility of walking beside, or wading through long stretches of water, which may contain both pools and riffles in order to continue angling without having to leave the river.
- (d) Scenic beauty should include the river bed, the river, the river banks and surrounding views, either immediate or panoramic.
- (e) Feelings of solitude/peace may be gained without being in a wilderness area and will be influenced by the geography of the river. For instance, if fishing in a gorge, the existence of a road above may not detract from feelings of solitude if it is out of sight and the traffic noise cannot be heard.

(f) Good catch rate refers to the number of fish you catch in a certain amount of time. You may fish some rivers all day without success and yet catch several fish in the same time from another river.

(g) Size of fish: 1. smaller than 23 cm (9 inches)
2. 23 cm (9") - 38 cm (15")
3. 38 cm (15") - 53 cm (21")
4. 53 cm (21") - 65 cm (26")
5. larger than 65 cm (26")

5. Which methods do you usually use

Tick the appropriate categories for each river. Naturally the regulations will restrict the use of some methods from some waters and these will be taken into account in the analysis of results.

6. Other recreational activities

You may visit some rivers purely for the angling experience, but there are many other recreational activities which can be carried out in conjunction with angling and which may involve family and friends. You can indicate the other activities you participate in by ticking the appropriate categories.

Rivers outside of the Hawkes Bay Acclimatisation Society

You will notice at the end of the booklet that spaces have been left for you to fill in information about rivers outside of your society district which you may visit to fish. Fill in the categories in the same way as you did for the rivers in your own society district.

Average number of fish you catch each year

This is the total number of fish you catch from all the rivers you fish during the year. Once again you may like to take an average from your last 3-5 years of catches. If you find it difficult to remember exactly, an approximation will do.

Contacts within the Hawkes Bay Acclimatisation Society

If you have any queries about the survey or categories included in the booklet, or if you need some assistance to fill in the questionnaire, the people whose names, addresses and phone numbers are listed below will be only too willing to help you:

R. Harrington 31 Barnard Avenue Napier Ph. 435 367	L. Hicks 16 Warwick Cres. Taradale Ph. 447 743	M. Berkett 204 Windsor Ave. Hastings Ph. 88 819
G. Byford Christie Cres. Havelock North Ph. 775 798	R. Martin Onga Onga Ph. Waipuk 66 717	J. Gregory 17 Burns St Dannevirke Ph. 6001

APPENDIX II. Method of estimating angler usage.

When the National River Angling Survey (NAS) was initiated it was intended to estimate the level of angling usage associated with the various rivers in each acclimatisation society district from the survey data. Provided sampling is random, and non-response can be reduced to a minimum, standard techniques for estimating population totals, and the associated variances, from sample data (such as the number of anglers fishing a river) are readily available in the literature (for example, Cochran 1977). Surveys of this type have been used by FRD to estimate angler usage of rivers such as the Rakaia (Unwin and Davis 1983) and the Hurunui (Bonnett 1983).

However, direct application of these methods to the NAS data was complicated by three factors. Firstly, despite telephone call-backs to licence holders sampled who had not replied within 2 months of being sent their questionnaire, non-response was generally about 30%. For FRD's Rakaia surveys it was found that respondents who replied immediately to the first mailing had fished, on average, more frequently than those who replied after one or more call-backs, and the cumulative effect of call-backs was small (Unwin and Davis 1983). Secondly, though all individuals sampled had purchased a fishing licence for the season just ended, many of the respondents (15-20%) returned questionnaires which indicated that they had not fished at all. Others had fished only in lakes, and a few respondents indicated that they fished rivers so infrequently that they considered themselves too inexperienced to reliably fill in their questionnaires. Thirdly, many of the initial non-respondents who were subsequently contacted by telephone indicated that they were active anglers, but did not give any details on which rivers they fished.

Therefore, to compute usage estimates for any given river we had to recognise the existence of four distinct groups among the sample. These were:

1. Non-respondents (including licence holders who were deceased, overseas, unable to be contacted, or refused to help).
2. Respondents who did not fish rivers (included were those who did not fish at all and those who fished only lakes). The few respondents who considered themselves too inexperienced to help were also assigned to this category.
3. Respondents who fished rivers, but did not specify which rivers they visited.
4. Respondents who fished and specified all the rivers they had fished.

For the Hawke's Bay Acclimatisation Society district, the relevant figures were:

Total number of adult whole season licence holders (1979/80)	= 2125
Number of licence holders sampled	= 403 (19.0%)
Non-respondents	= 135 (33.5% of sample)
Total respondents	= 268 (66.5% of sample)
Respondents who did not fish rivers	= 69 (25.7% of respondents)
Respondents who fished, but did not specify which rivers	= 41 (15.3% of respondents)
Respondents who fished and specified which rivers	= 158 (59.0% of respondents)

The following example for the Mohaka River shows how usage estimates were derived from these figures:

Number of respondents who indicated they had fished the Mohaka River	= 82
	= 51.9% of the 158 respondents who specified the rivers they fished
Total number of respondents who fished rivers	= 199 (41 + 158)
Estimated number of respondents who fished the Mohaka	= 199 x 51.9%
	= 103
Percentage of respondents who fished the Mohaka	= 38.4% (100% x 103/268)
Estimated number of Hawke's Bay licence holders who fished the Mohaka	= 38.6% of 2125
	= 817
Rounded to 2 significant figures	= 820

Estimates of the total effort (that is, the number of visits) were made in a similar manner.

The major assumptions implicit in the above calculations are:

1. The 41 respondents who fished rivers, but did not specify which ones, distributed their effort among the various Hawke's Bay rivers in the same manner as the other 158 respondents who fished Hawke's Bay rivers.

2. The 135 non-respondents had the same average characteristics as the respondents.

Neither of these assumptions can be checked from the NAS data alone. However, a comparison between the NAS estimates for usage of the Rakaia and Hurunui Rivers, and those provided by other FRD surveys, shows that, at least for these two rivers, the NAS results are not seriously biased (Teirney *et al.* 1982). Moreover, we would emphasise that the main point of the NAS was to evaluate the relative usage of the rivers in each district, and that any inherent bias in the usage estimates is unlikely to favour one particular river.

There has been no attempt to make a rigorous evaluation, which took into account all the variables within each sample, of confidence limits for estimates made in the above manner. Apart from the statistical difficulties involved, any such confidence limits would be only approximate because of the two assumptions above.

A conservative estimate of the confidence limits associated with the estimated angler usage for any particular river can be derived by assuming that only the number of respondents fishing that river is subject to sampling error. In this instance, confidence limits based on the binomial distribution give a satisfactory result (Cochran 1977). For the above example, the standard error of the estimated angling usage of the Mohaka River is 817 ± 63 , which corresponds to 95% confidence limits of 823 ± 123 . In general, the percentage error of each estimate (or equivalently, the coefficient of variation) tends to decrease both with increasing sample size and with the number of respondents fishing each river. Therefore, the most precise estimates are those for the most heavily fished rivers, whereas for rivers fished by only a few

respondents the errors may be quite large. Thus, usage estimates generally have not been attempted for anglers fishing rivers outside their home district, because of the small numbers of respondents.

Similar calculations can be applied to the estimated angling effort on each river. Confidence limits derived in this way tend to be much broader than those for the usage estimates, mainly because of the skewed distributions typically seen (Unwin and Davis 1983). Of the two types of statistics presented in this report, angler usage (as measured by the number of anglers fishing a given river) is likely to be more reliable than total effort (as measured by the total number of visits).

References:

- Bonnett, M. 1983. Hurunui anglers surveyed. *Freshwater Catch No. 21*: 15-6.
- Cochran, W.G. 1977. "Sampling techniques." John Wiley and Sons, New York. 428 p.
- Unwin, M.J., and Davis, S.F. 1983. Recreational fisheries of the Rakaia River. *N.Z. Ministry of Agriculture and Fisheries, Fisheries Environmental Report No. 35*. 110 p.

APPENDIX III. Histograms of ratings assigned by respondents to the relative importance of the angling experience and seven other qualities (distance from home, access, area of fishable water, scenic beauty, feelings of peace and solitude, catch rate, and size of fish) for 20 rivers in the Hawke's Bay Acclimatisation Society district. Histograms of reach of river fished, fishing methods used, and associated recreational activities of anglers visiting each river are also shown. (Although some anglers did not respond to all questions, this has not been shown in the histograms.)

Key: 1 = insignificant

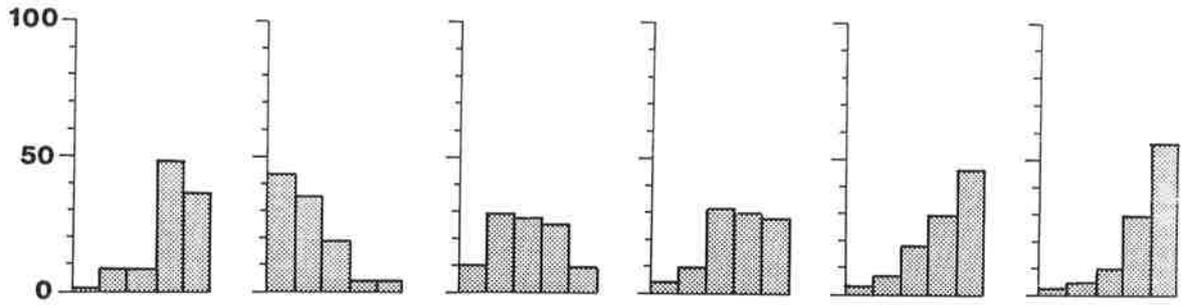
5 = exceptional

Stretch of river fished: H = headwaters
M = middle reaches
L = lower reaches

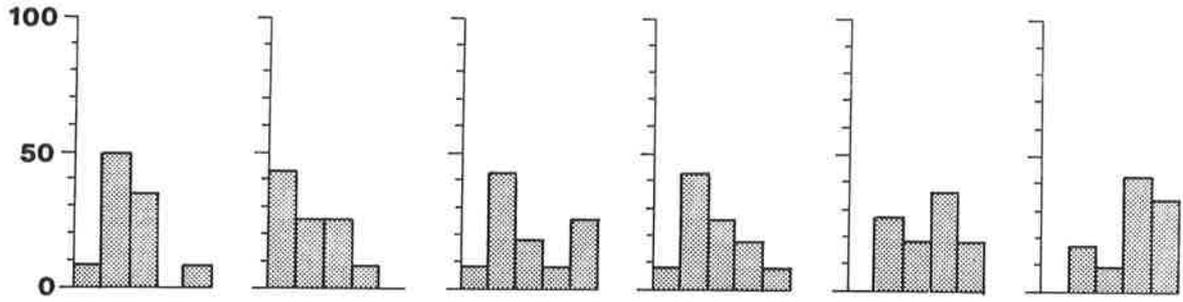
Fishing method used: D = dry fly
W = wet fly
N = nymph
B = live bait
S = spinner

Recreational activities: E = enjoying the scenery
P = picnicking
S = swimming
K = canoeing
R = rafting
C = camping
T = tramping
H = shooting

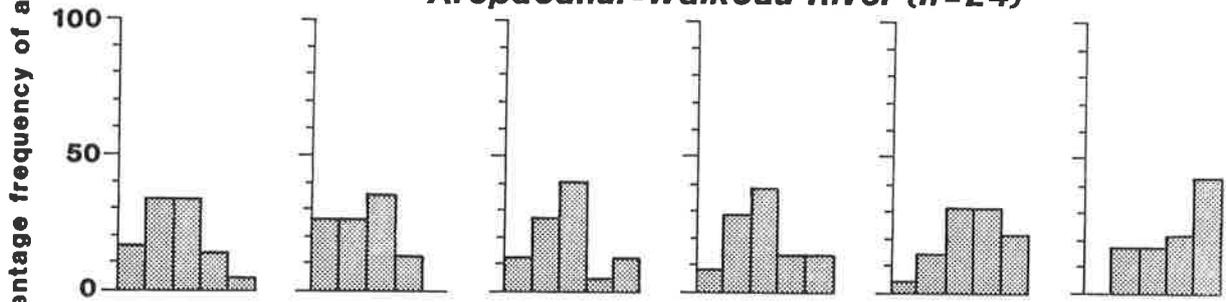
Mohaka River (n=82)



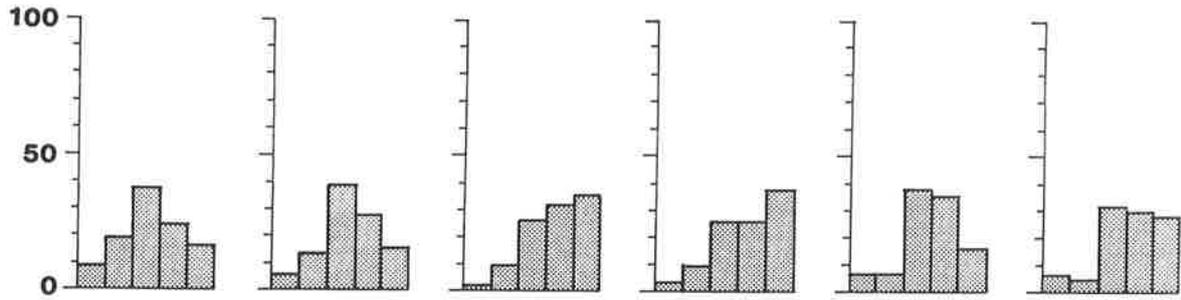
Waikari River (n=12)



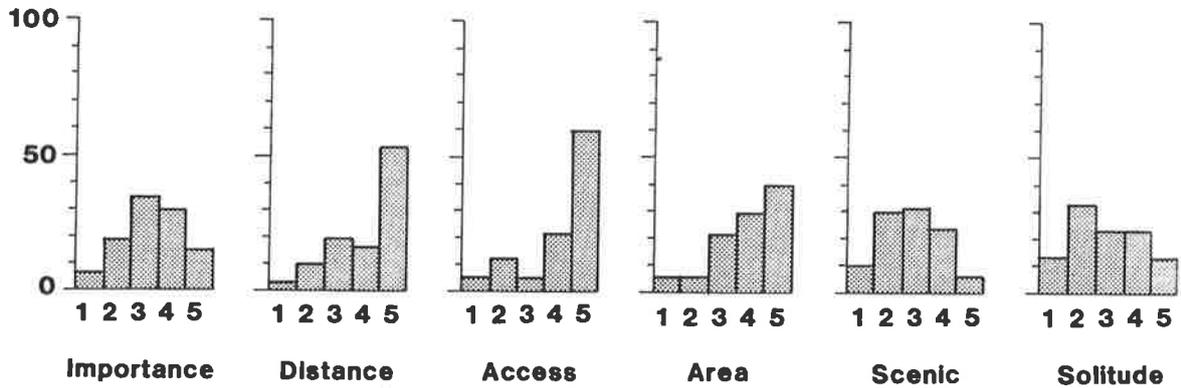
Aropoanui-Waikoau River (n=24)



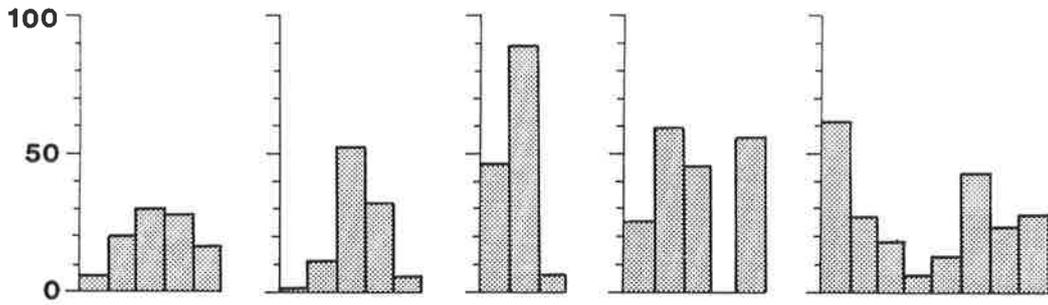
Esk River (n=47)



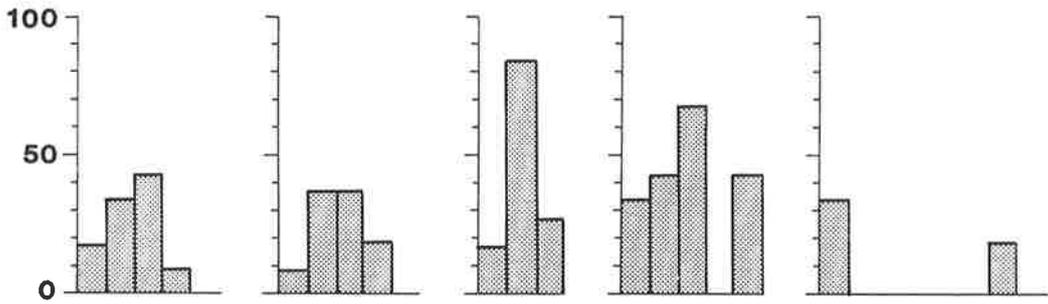
Tutaekuri River (n=82)



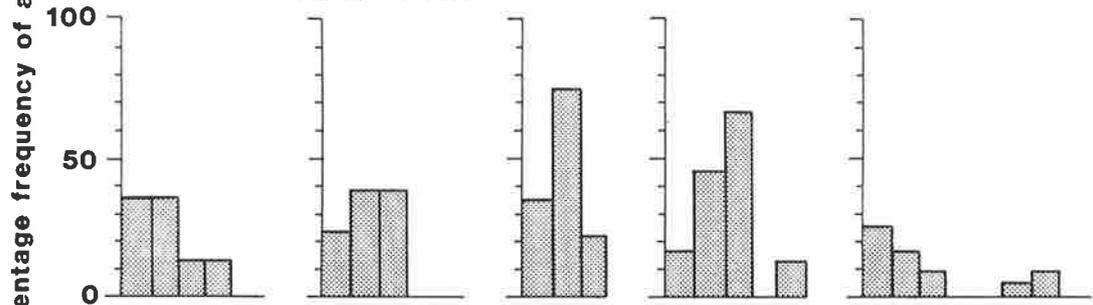
Mohaka River (n=82)



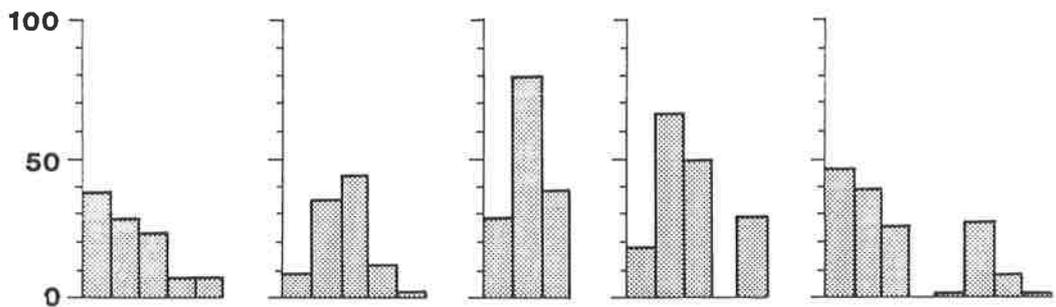
Waikari River (n=12)



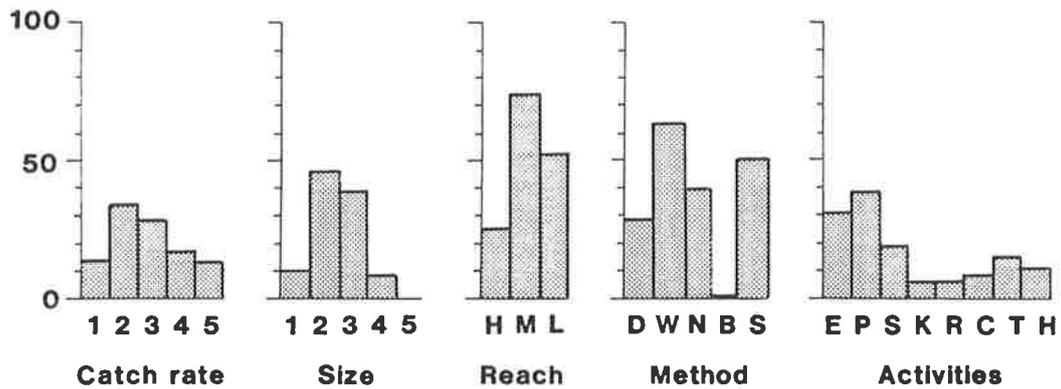
Aropaoanui -Waikoau River (n=24)



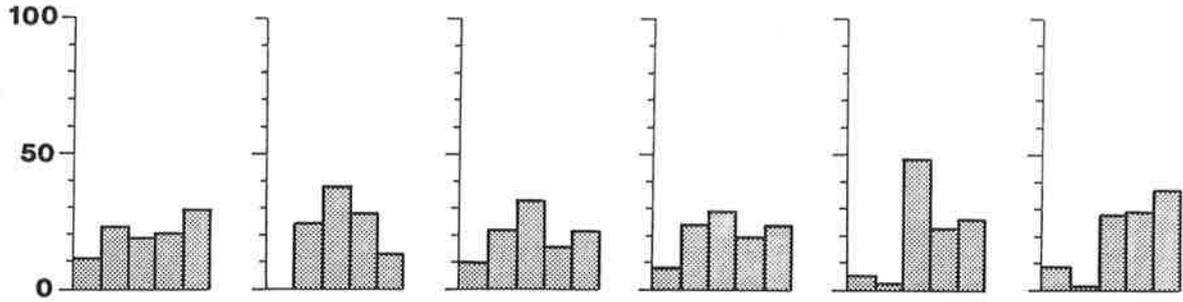
Esk River (n=47)



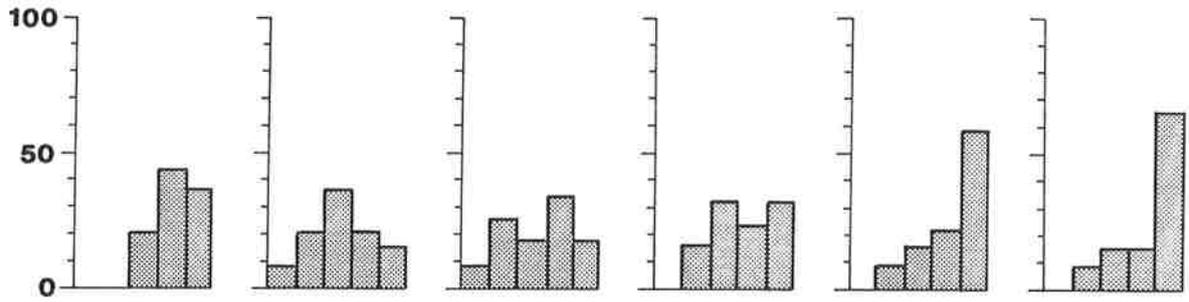
Tutaekuri River (n=82)



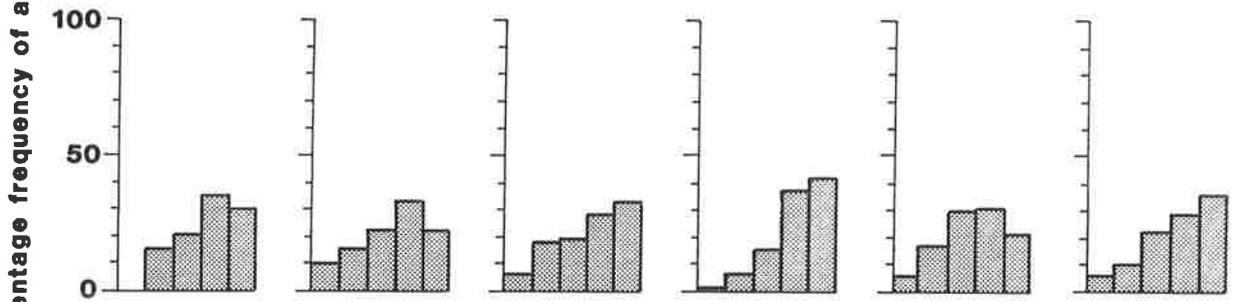
Mangaone River (n=45)



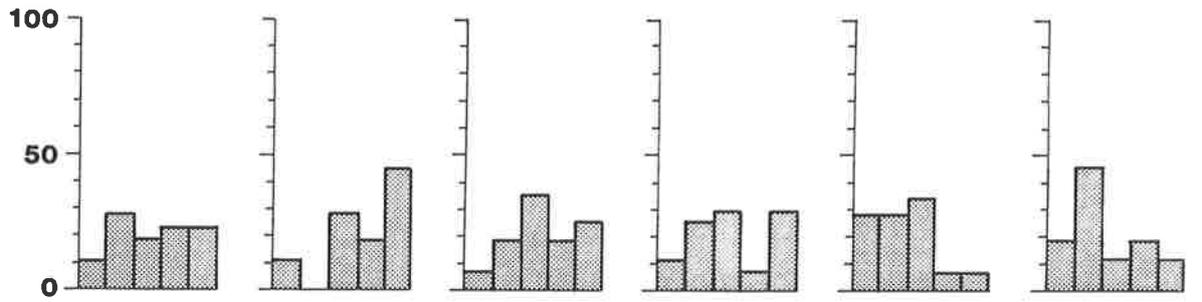
Mangatutu Stream (n=14)



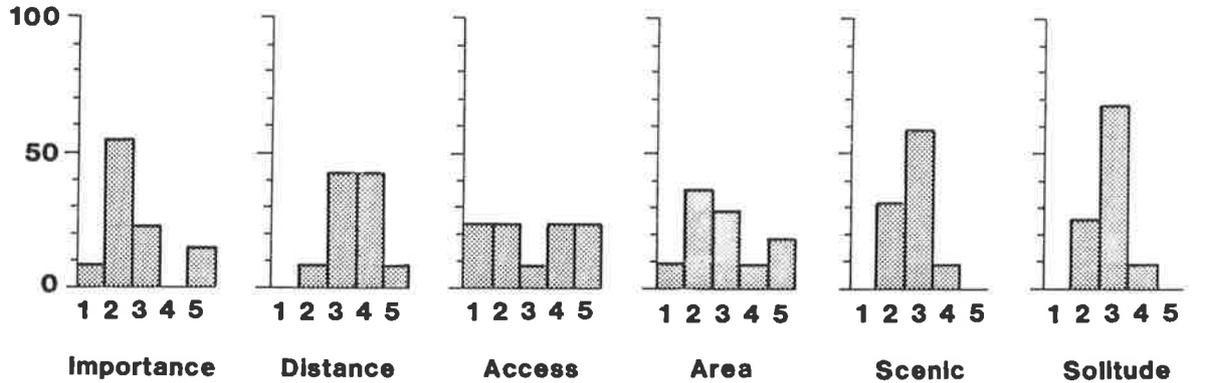
Ngaruroro River (n=88)



Tutaekuri Waimate Stream (n=18)



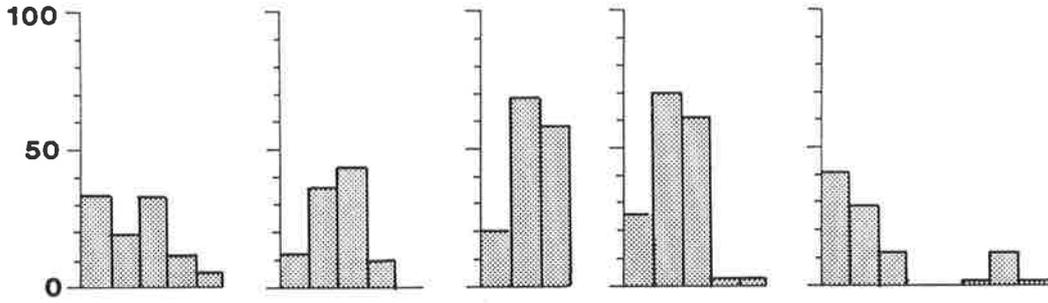
Ohiti Stream (n=13)



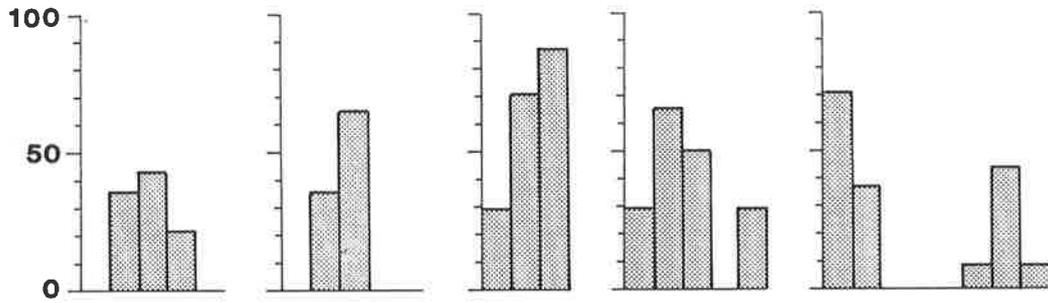
Percentage frequency of anglers

1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5
Importance Distance Access Area Scenic Solitude

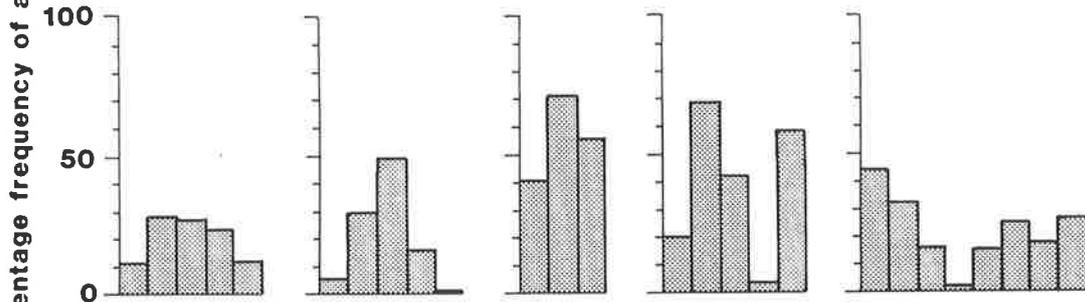
Mangaone River (n=45)



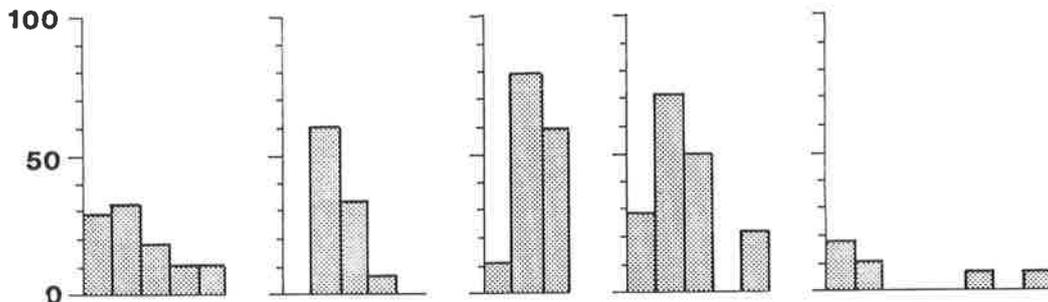
Mangatutu Stream (n=14)



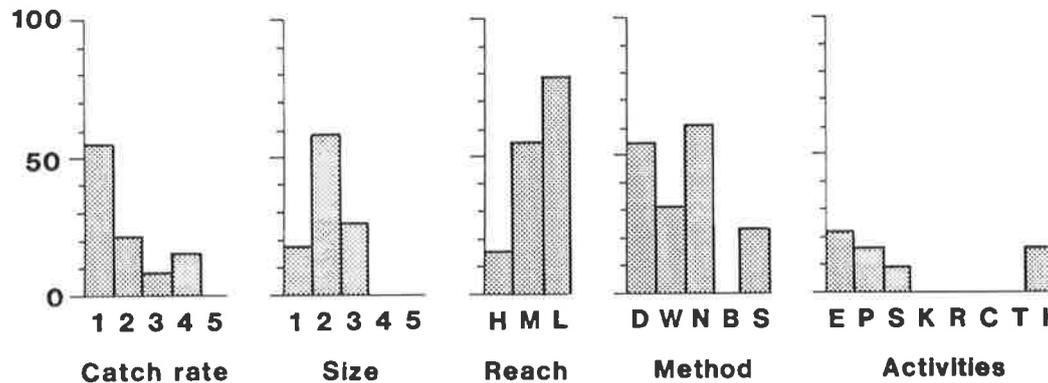
Ngaruroro River (n=88)

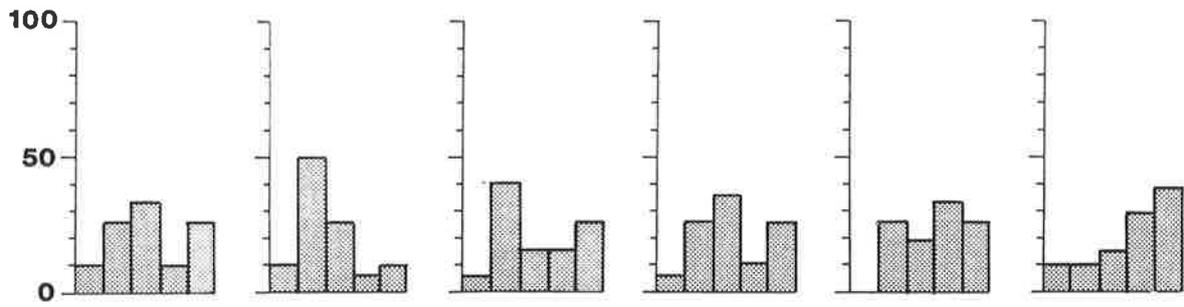
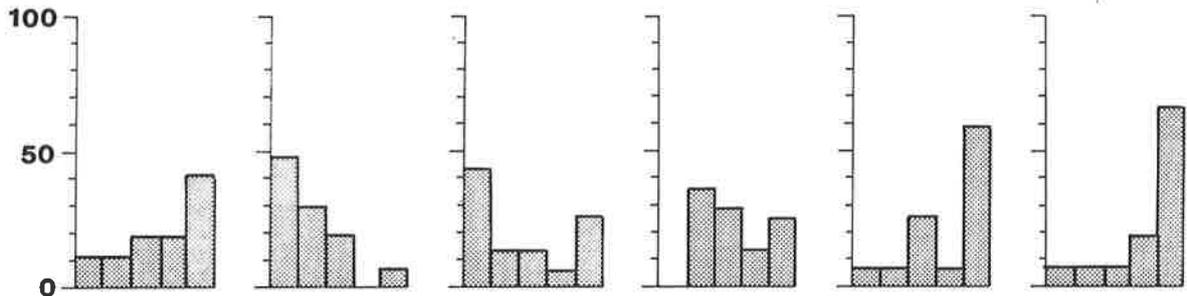
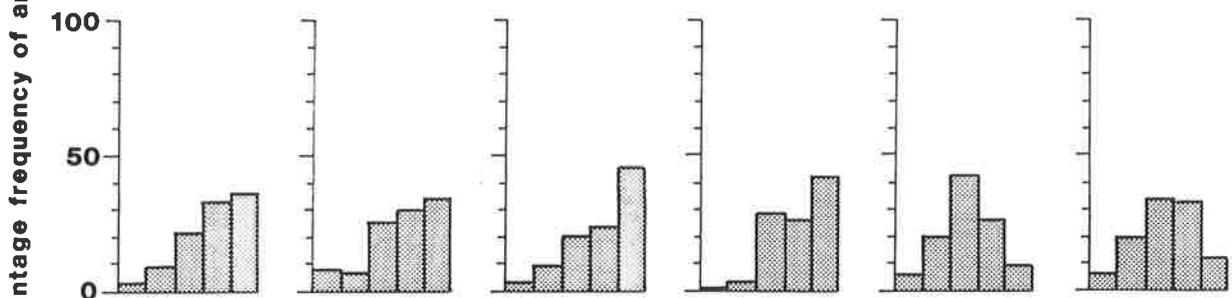
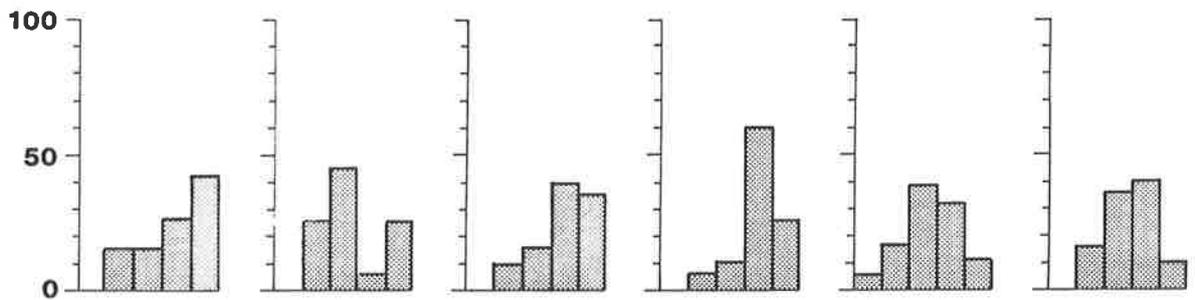
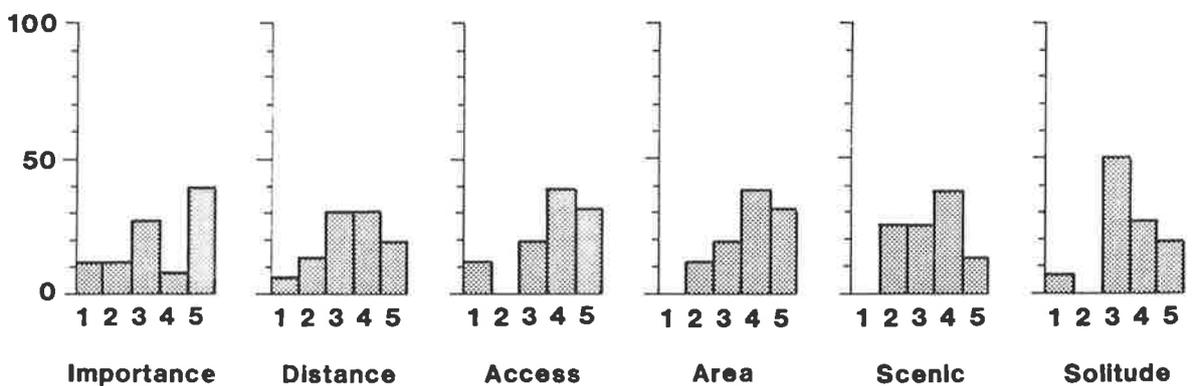


Tutaekuri Waimate Stream (n=18)

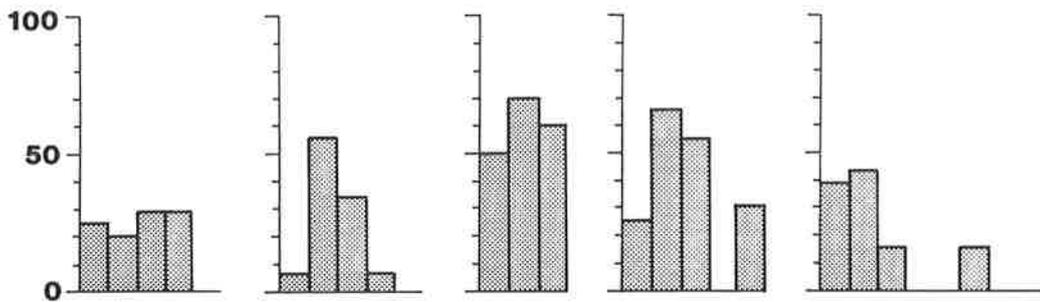


Ohiti Stream (n=13)

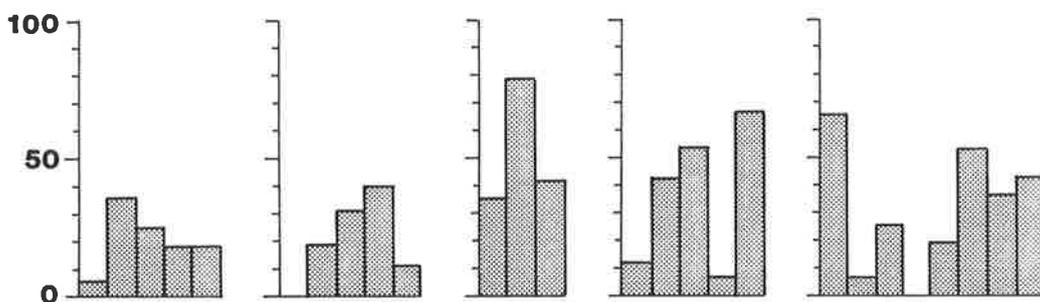


Ohara Stream (n=21)***Taruarau River (n=17)******Tukituki River (n=111)******Waipawa River (n=20)******Mangaonuku Stream (n=16)***

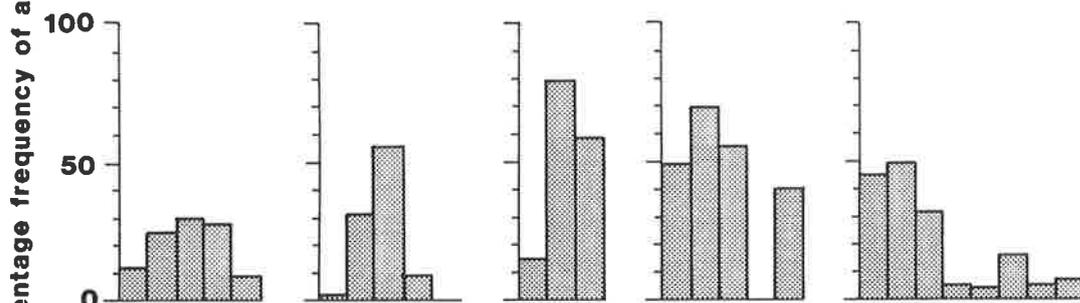
Ohara Stream (n=21)



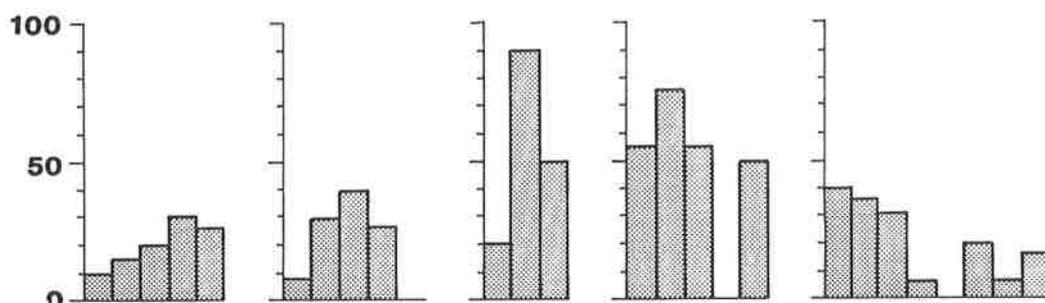
Taruarau River (n=17)



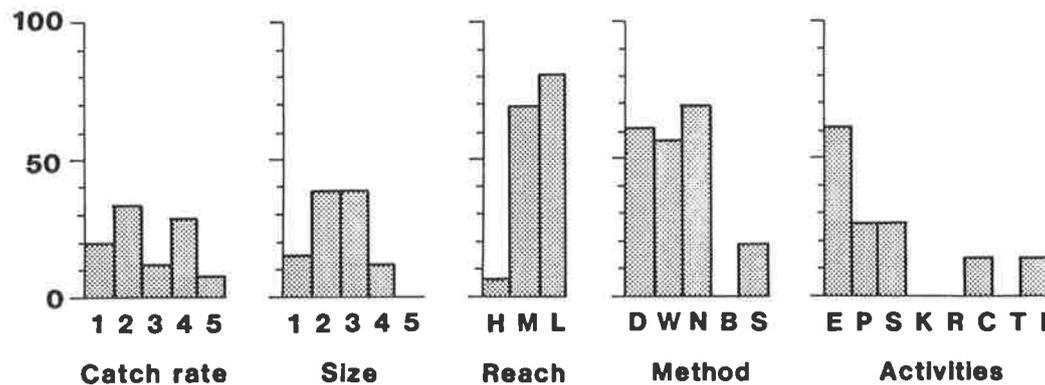
Tukituki River (n=111)

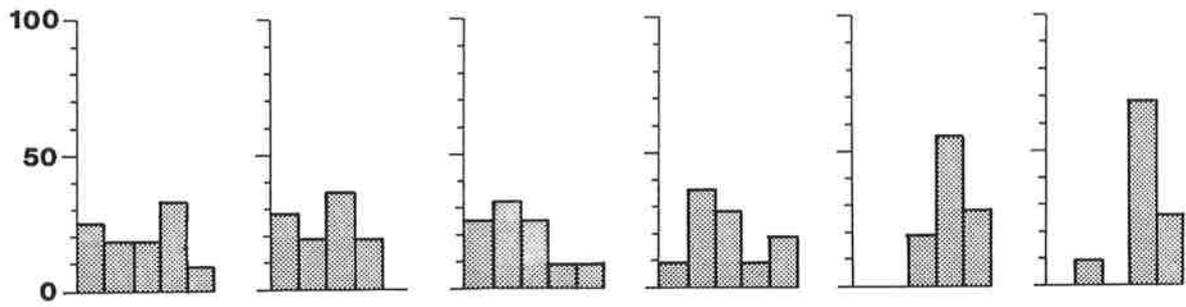
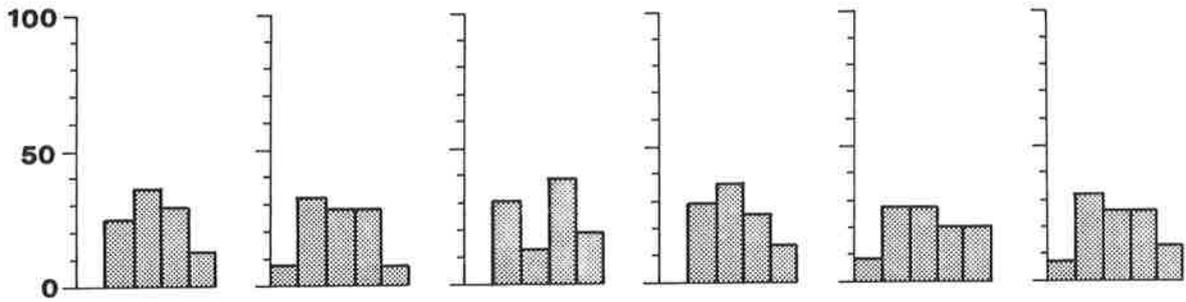
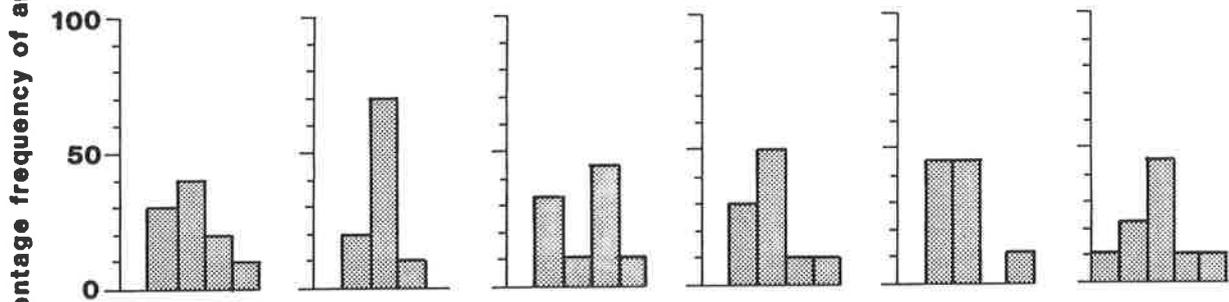
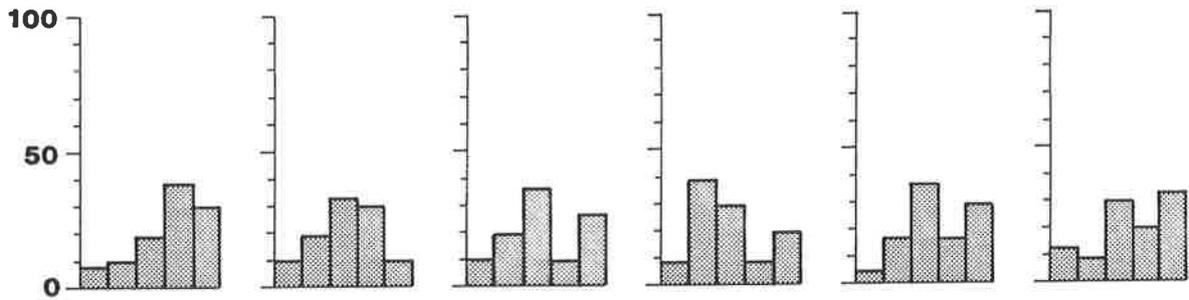
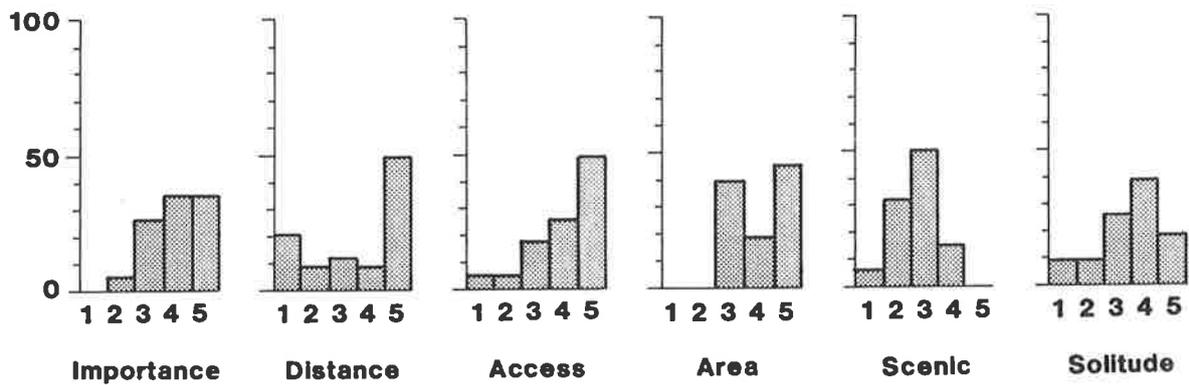


Waipawa River (n=20)



Mangaonuku Stream (n=16)

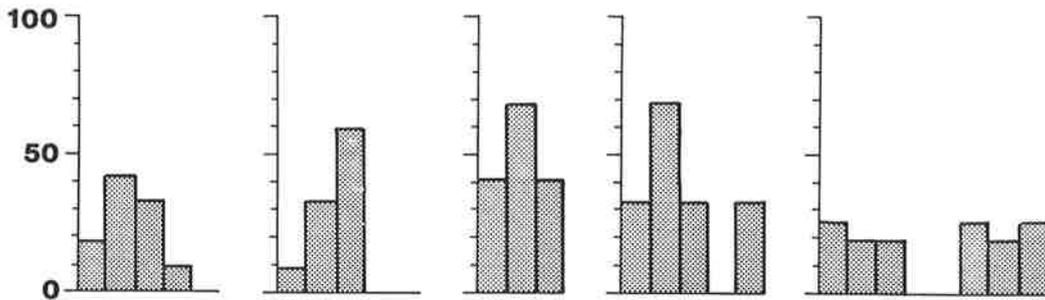


Makaroro River (n=12)**Tukipo River (n=17)****Maharakeke Stream (n=10)****Maraetotara River (n=31)****Manawatu River (n=24)**

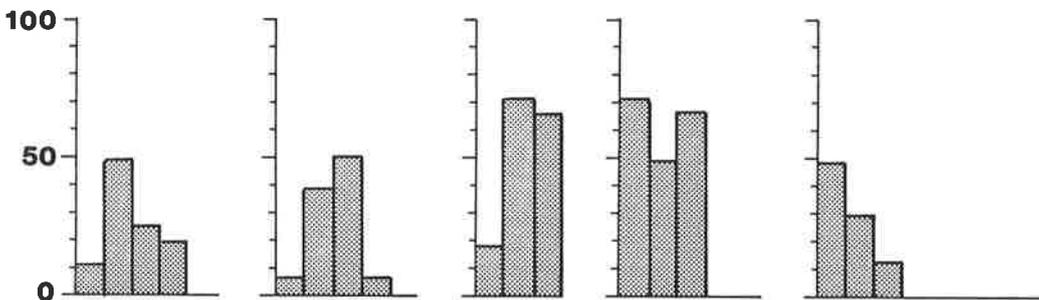
Percentage frequency of anglers

1 2 3 4 5
Importance1 2 3 4 5
Distance1 2 3 4 5
Access1 2 3 4 5
Area1 2 3 4 5
Scenic1 2 3 4 5
Solitude

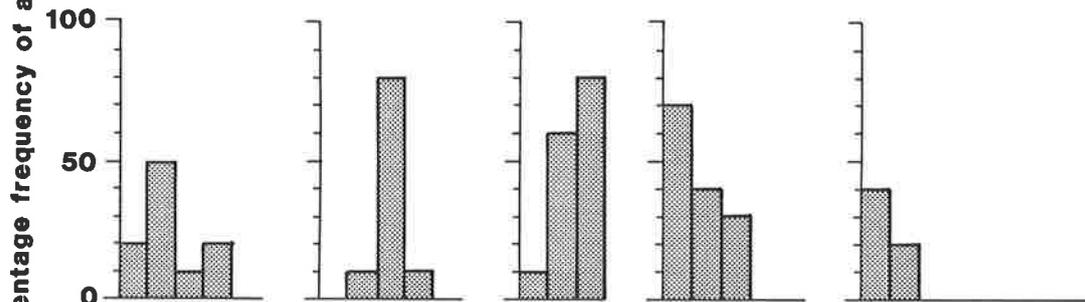
Makaroro River (n=12)



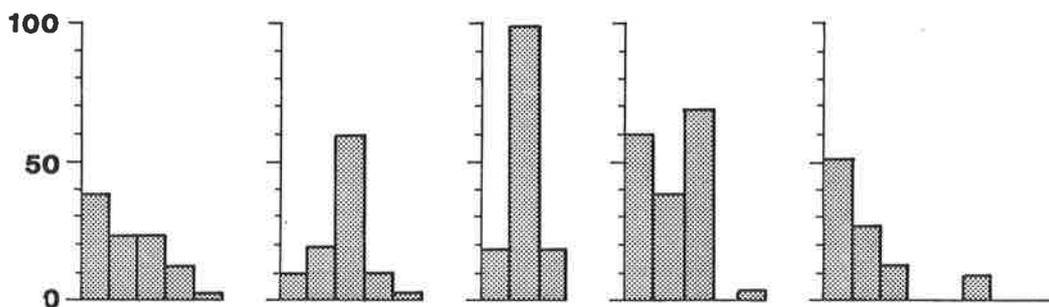
Tukipo River (n=17)



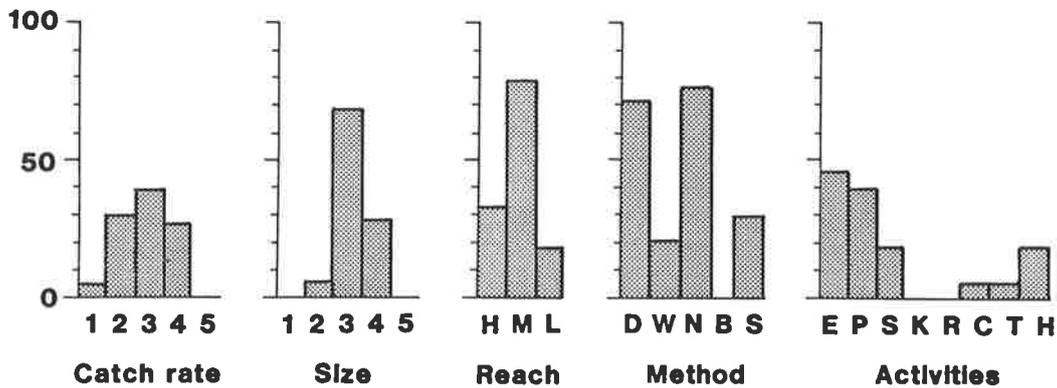
Maharakeke Stream (n=10)



Maraetotara River (n=31)



Manawatu River (n=24)



Fisheries Environmental Report No. 42

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Hawke's Bay rivers to
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**Fisheries Research Division
Ministry of Agriculture and Fisheries
Wellington**