

NEW ZEALAND FRESHWATER FISHERIES MISCELLANEOUS REPORT NO. 29

EVIDENCE PRESENTED TO A HEARING
IN RESPECT OF A NATIONAL WATER
CONSERVATION ORDER FOR THE
MATAURA RIVER

by

J.W. Hayes

Presented on behalf of N.Z. Paper Mills Ltd
Waitaki International Ltd
Southland Dairy Co-operative
Limited
Gore District Council

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MAF Fisheries

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Servicing freshwater fisheries and aquaculture

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NEW ZEALAND FRESHWATER FISHERIES MISCELLANEOUS REPORTS

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EVIDENCE OF
DR JOHN WILLIAMS HAYES
BEFORE THE PLANNING TRIBUNAL
IN RESPECT OF A DRAFT NATIONAL
WATER CONSERVATION ORDER FOR THE
MATAURA RIVER

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1 INTRODUCTION

I reside in Christchurch.

I hold Degrees of Bachelor of Science (Honours) in Zoology and Doctor of Philosophy in Zoology from Canterbury University. I have studied freshwater fish for the past ten years. I have been employed by the Freshwater Fisheries Centre, MAF Fisheries, for five years. I have specialised in salmonid ecology and also have experience with fish habitat modelling and fisheries environmental impact assessment.

2 SCOPE OF MY EVIDENCE

In my evidence I will present information on the trout fishery and the native fish of the Mataura River. I will first discuss the trout fishery, reviewing information on abundance and movements, and the quality of the fishery in a national context.

I will then address the longitudinal pattern of angler use along the river and changes in the trout fishery over time.

This will be followed by a discussion of the relationships between flow and trout habitat, and a comparison of the quality of trout habitat, between the Mataura and other rivers throughout the country.

Finally, I will describe the native fish which are found in the Mataura River and the fisheries which they support.

I append as Appendix I a list of the reports and articles which I have considered in the preparation of my evidence.

3 THE TROUT FISHERY

3.1 Fish Abundance

In the context of a National Water Conservation Order information on trout abundance in the Mataura River should be comparable with rivers in other districts.

Unfortunately, little such information exists. Mr Witherow and Dr Scott in 1984 carried out netting - and tagging and drift-

diving surveys in the Mataura River from 1976 to 1980. The former was regarded by the authors as inadequate for assessing the fish population. The report on these surveys was published by the Southland and Otago Acclimatisation Societies in 1984, under the title "The Mataura Trout Fishery", which is listed in Appendix I.

The results of their drift diving programme also have limited value, particularly from the lower reaches surveyed. This is because the three diver team gave inadequate coverage in the wider lower reaches. A multiplication factor, which was subjectively derived for some reaches, was applied to the data to roughly estimate populations. Even for those reaches where the multiplication factor was derived from a quasi "mark-recapture, (observe)" method involving netting, tagging and subsequent drift dive count of tagged versus untagged fish, the data, according to Mr Witherow and Dr Scott "... formed an inadequate basis for (population) assessment within known limits of confidence".

The study by Mr Witherow and Dr Scott shows the difficulties of assessing trout populations in large rivers. Where underwater visibility is good for at least 3 metres, trout populations can be assessed by drift diving, provided a large enough team of divers is used to suit the size of the river in question and provided the method is standardised. In Mr Witherow and Dr Scott's survey, too few divers were used for their method to give reliable results for the river downstream from Cattle Flat.

Moreover, the data of Mr Witherow and Dr Scott recorded at pages 31 to 32 of the 1984 report was relied on by Dr Scott in paragraph 12, page 5 of his Evidence in Chief. The data involved a multiplication factor derived from a quasi mark-recapture technique. The data were calculated by applying a ratio of the number of tagged fish seen by drift diving over the number of fish tagged and released after netting to the number of untagged fish seen by drift diving. Only about 5% of tagged fish in the study were later seen by drift diving. Mr Witherow and Dr Scott attribute this to a low proportion of the population counted by divers. However, a number of factors would cause an underestimate of the proportion of tagged versus untagged fish which would lead to an over-estimate of the population in the reach.

The ratio of tagged to untagged fish is dependent on the behaviour of tagged fish being the same as that of untagged fish.

It also depends on immigration into and emigration out of the reach being the same. Both of these assumptions may be wrong. The tagged fish may have been scared out of the reach or they may have hidden in cover after being handled. If so, then there would be a lower probability of their being seen by divers.

Furthermore, if untagged fish were difficult to see for counting, then it would have been even more difficult to see whether a fish was tagged. Mr Witherow and Dr Scott state in their 1984 report that the divers noticed no difference in the behaviour between tagged and untagged fish. They use this argument to support their claim that the ratio of tagged to untagged fish is a good estimate. However, if tagging had affected the behaviour of tagged fish, as by causing them to hide, then the divers would not have seen them. In this case, the very behaviour of the fish would make it impossible to tell if their behaviour was different from that of untagged fish.

On this point I am of the view that there can be no confidence in the multiplication factors which Mr Witherow and Dr Scott have used to calculate populations from drift dive counts downstream from Cattle Flat. The application of the factors to reaches above Otimita is further strained because these factors were arbitrarily chosen on the assumption that drift dive counts would be more accurate further upstream.

When drift diving is not suitable, an alternative method is to assess a trout population by netting. However, as Mr Witherow and Dr Scott's study demonstrates, this method is fraught with difficulties. Catches by netting are variable because catching efficiency is strongly dependent on river flow and morphology, both of which are highly variable.

It is because of these difficulties in assessing trout abundance in large rivers, and the tremendous effort required to do so, even for one river, that so little comparative data of this type is available.

Probably the best available comparative data on trout abundance are those from the 100 rivers project carried out by Mr I Jowett of MAF Fisheries, Christchurch. The results are contained in unpublished data which I produce in JWH 1. I also produce JWH 2. This map of the Mataura River shows the sites referred to in JWH 1.

Trout counts and biomass estimates for this project were obtained between 1985 and 1989 throughout the country using a standardised drift diving technique and the same team of divers. The results suggest that trout abundance, at least in the upper Maitai at Nokomai and in the Waikato river at Piano Flat, is at best only moderate by comparison with other rivers in New Zealand. I refer the Tribunal to JWH 1.

However, I would draw the Tribunal's attention to the fact that the drift dive at Nokomai on 10 March 1988, shown in JWH 1, was carried out at a marginal underwater visibility of 3 m. It is therefore subject to greater error than the dives in other rivers with clearer water. Nevertheless, the count made at Nokomai during the 100 rivers project in 1988, which gave a result of 36 fish per km, was similar to the mean number of fish per dive counted by Mr Witherow and Dr Scott between 1977 and 1980 at Nokomai, 40 fish per km.

No reliable comparative drift dive data are available from the Maitai River downstream from Nokomai or from the Waikato River downstream from Piano Flat. The only extensive data set that I am aware of is that of Mr Witherow and Dr Scott published in their 1984 report. As mentioned earlier, this is subject to an uncertain degree of error and was not standardised with drift dive surveys on other rivers.

3.2 Trout Movements

Mr Witherow and Dr Scott in their 1984 report present some information on trout movements but it is rather inconclusive. Their data were insufficient to confirm or disprove the existence of any general spawning migration, although netting returns were always higher in the upper reaches as at Nokomai, and during winter rather than at other times. Some fish did move considerable distances, and most of these movements encompassed the spawning period. But other fish were found, after intervals of up to two years in the same pools where they were tagged.

Mr Riddell in his 1984 report listed in Appendix I to my evidence states at page 96 that sea-run brown trout are caught in the lower tidal reach of the Maitai River but I have been unable to ascertain whether or not these fish migrate up-river in significant numbers.

3.3 Quality of the Trout Fishery

By world standards New Zealand has a very large number of excellent river and lake brown trout fisheries, with the South Island being particularly well endowed. Of these the Mataura River stands out as one of the best and certainly the most famous. The river has for many years enjoyed an international reputation as an outstanding brown trout fishery. This claim is substantiated, for example, in the Fisheries Environmental Report No. 28 of Ms Teirney and others, published in 1982 and listed in Appendix I to my evidence.

During 1979 and 1980 the usage and perceived qualities of the Mataura and other rivers throughout the country were quantified by the National River Angling Survey. This survey, the results of which are published in the 1982 report of Ms Teirney and others, provides the best comparative data for ranking river fisheries in New Zealand and it confirmed the reputation of the Mataura River as an outstanding brown trout fishery.

In terms of both total usage and the ratings on relative importance assigned by the survey respondents, the Mataura River completely dominated the Otago-Southland region. The Mataura was fished by over half the anglers in the Southland Acclimatisation Society district. The significance of this is seen in the fact that the Southland-Otago region sells more whole season fishing licences per head of population than any other district, excluding those districts which support major salmon fisheries.

I now present JWH 3. It shows that anglers from the Southland and Otago districts alone made over 56 000 visits to the river and over 16 000 visits to its tributaries in the 1979-1980 season. This level was equalled or exceeded only on the Waimakariri, Rakaia, Rangitata, and Waitaki Rivers, all of which support nationally important salmon fisheries. I produce JWH 4 which presents data taken from the 1982 report of Ms Teirney and others. This sets out the estimated angler usage of a number of South Island rivers.

In another more direct survey, involving interviews of anglers on the river bank, Mr Witherow and Dr Scott estimated in their 1984 report that the total angler usage of the river was 102 600 hours per season.

Research conducted by Ms Teirney and others was published in 1984 as the Fisheries Environmental Report No. 50. In that report, listed in Appendix I below, the authors stated that there is no other brown trout river in New Zealand which experiences such high usage and that it is the most fished trout river in the South Island. Therefore it was not surprising that Southland anglers valued it above all other rivers in the district.

The fishery also has a high catch rate. Mr Witherow and Dr Scott in 1984 reported a catch rate for the river of 0.22 fish per hour. This was higher than average for comparable rivers in Southland, Otago and Canterbury.

Ms Teirney and others also confirmed in their 1982 report the high catch rate on the Mataura. They found that except for the Tongariro River no other river in New Zealand was rated as highly for catch rate by anglers as the Mataura.

Ms Richardson and others, in their report of 1984 listed in Appendix I of my evidence, concluded that the Mataura is one of only two or three trout fisheries in the country that support both large fish and a high catch rate, while also sustaining high levels of use. While this statement is no doubt true for the level of use and probably for the catch rate, it is not accurate for size of fish. By New Zealand standards, the Mataura produces brown trout of only medium size for the angler.

Another noteworthy attribute of the Mataura River in terms of suitability for angling is the large area of accessible, fishable water. This is probably one of the main factors contributing to the high angler usage and catch.

Ms Teirney and others in their 1982 report listed in Appendix I below, set criteria for identifying rivers of national importance for angling. First, rivers were considered in terms of their overall importance, as assessed by the anglers who fished them.

Secondly, if anglers thought a river was of exceptional importance and ranked it overall as 5 on a scale of 1 to 5, then those rivers supporting high levels of usage were classified as nationally important angling rivers. On the basis of these criteria, the Mataura clearly qualified as a nationally important angling river. Because scenic qualities and solitude were secondary to catching fish by anglers fishing the Mataura, the

river was classified as recreational fishery rather than a wilderness or scenic fishery.

Ms Richardson and others in their 1984 report listed in Appendix I below, found that of the tributaries of the Maitava, the Waikaia River was ranked as the most highly fished and most highly valued according to the National Angler Survey. In this survey the Waikaia was identified as a regionally important scenic trout fishery.

3.4 Longitudinal Pattern of Usage

The most heavily fished parts of the Maitava River are the middle reaches. These correspond roughly to zones B and C in JWH 2. Ms Teirney and others showed in their 1984 report that 73% of Southland respondents and over 80% of those from Otago fished the river in the lower to middle reaches. In that report the boundaries of these reaches were not defined.

These results are consistent with those of Mr Witherow and Dr Scott in their 1984 report. They clearly defined areas or zones on the river. They found that about 77% of angling took place from just upstream of Gore to the sea, that is in Zones B and C shown in JWH 2, only 12% of angling took place downstream of Maitava Island.

I applied these percentages to the angler visit data of Ms Teirney and others in their 1984 report. The incidence of angling should have been similar in the two studies, as they were carried out concurrently. Of the 72 430 angler visits to the Maitava River and its tributaries recorded by Ms Teirney during 1979 and 1980, 48 440 visits were made to the mainstem and tributaries below Gore and 23 990 visits were made above Gore. Above Gore 15 120 visits were made to the mainstem of the Maitava.

This level of use above Gore, including that of the tributaries, is equalled or exceeded by several other brown trout rivers throughout the country including some in Southland and Otago. In this respect, I refer the Tribunal to JWH 3.

Therefore I conclude that it is the level of angler usage downstream from Gore which made the Maitava River stand out clearly above all other brown trout rivers in the country.

These lower to middle reaches were fished mainly by local anglers, whereas visitors spread their efforts further upstream. Mr Witherow and Dr Scott in their 1984 report recorded that bait was the most popular method, mainly early in the season. Fly fishing increased in importance as the season progressed and with distance upstream.

3.5 Changes in the Trout Fishery

Apart from a reduction in trout numbers attributable to a flood in 1978, which was referred to by Mr Witherow and Dr Scott in their 1984 report, I am unaware of any conclusive evidence of changes in the Mataura trout population.

In fact, Mr Witherow and Dr Scott state at page 6 of their 1984 report that since its establishment in the late 1800s, the quality of the fishery has remained consistently high.

Over the period 1947 to 1967, during which the National Angler Diary Scheme operated, Mr Graynoth and Mr Skrzyński reported in 1974, in Report No. 99 referred to in Appendix I below, that there were no overall trends in size of fish or catch rate in the Mataura fishery.

In recent years some concern has been expressed by anglers and the Southland Acclimatisation Society as to the effect of land use on the benthic fauna of the river and the fishery. While some deterioration in the benthic fauna appears to have been detected, no conclusive data documenting changes to the fishery have been gathered.

Both Dr Scott in a statement of evidence given in 1987 and listed in Appendix I below, and Kingett, Mitchell and Associates in their 1989 report, also listed in Appendix I, have reported a decline since 1980 in the Ephemeroptera:Oligochaete (mayfly:worm) ratio in the benthic fauna of the Mataura River below Gore. This ratio usually indicates an increase in the input of organic material into rivers.

The increase in oligochaetes relative to mayflies is also accompanied by an increase in chironomid larvae. Dr Scott in his 1987 statement of evidence suggested that the decline in the mayfly:worm ratio indicates a recent general deterioration in water quality of the river as a whole.

Kingett, Mitchell and Associates in their 1989 report suggested that this may have been brought about by changes in land use and river management practices rather than by organic discharges at Mataura.

Although mayflies appear to have declined below Gore this would not necessarily result in a decline in trout numbers. Trout are opportunistic feeders and their diet generally reflects the available food.

Support can be found for this assertion in the finding of Mr Witherow and Dr Scott, in their 1984 report at page 40, that in the Mataura there was a general correspondence between the composition of the bottom fauna and the composition of the trout diet, except for Oligochaetes and Elmid larvae which are not generally available to trout. Furthermore, the proportion of chironomids and mayflies in the diet increased and decreased, respectively, with distance downstream, simply reflecting the density of these organisms in the benthic fauna.

Whether or not mayflies or chironomids provide the better food base for the trout population is a matter for debate. Item for item, mayflies no doubt have a greater calorific value than chironomids merely by virtue of their greater size. However, it is conceivable that the much greater numbers of chironomids available to trout may compensate for their smaller individual size. In support of this, the 1984 report of Mr Witherow and Dr Scott showed that the most popular zones of the river for fishing were below Mataura and Gore. These were also the zones with low mayfly and high chironomid densities.

If chironomids, and other alternative foods are a poor substitute for mayflies, then this would more likely be expressed in poorer growth than in reduced numbers of trout. Backiel and Le Cren asserted in their review published in 1978, and listed in Appendix I below, that density-dependent factors such as food supply generally operate in fish populations after the fry stage through growth rather than through mortality or emigration.

Depressed mayfly densities below Gore may bring about a decline in the famous mayfly rises in the river which attract fly fishermen late in the season although trout may also rise freely to chironomids.

3.6 Relationships between Flow and Trout Habitat

The only study carried out to examine the relationships between flow and trout habitat was by Mr Riddell in 1984, in the work referred to in Appendix I below. He presented results from a fish habitat survey of the Mataura River at Nokomai and at Keown's Road, and in the Waikaia River at Waipounamu.

The technique used in this survey was the Instream Flow Incremental Methodology which I shall refer to as IFIM. This computer modelling procedure integrates simulated hydraulic conditions in rivers, that is, depths and velocities, with physical information on fish habitat requirements. Its purpose is to predict the amount of suitable habitat for particular species or life stages at specified discharges.

Hydraulic and morphological conditions are combined with habitat preference information to produce Weighed Usable Area, which I shall refer to as WUA. This is the area of the surveyed reach predicted as suitable for the life stage or activity in question.

The survey presented by Mr Riddell used the habitat preference information for salmonid food production as provided by R S Waters in his 1976 article listed in Appendix I below.

For brown trout fry, juvenile and adult life stages, the survey used data provided in the 1978 paper of K D Bovee listed in Appendix I below.

The IFIM technique has been criticised recently, as by D Mather and others in their 1985 paper listed in Appendix I below, where the assumptions upon which the technique was first based were questioned.

This technique has also been criticised as being a poor predictor of fish biomass, as by Drs Scott and Shirvell in their 1987 article listed in Appendix I below.

However, many of these criticisms have been countered, as in the papers of D J Orth of 1987 and of K D Bovee of 1989, both listed in Appendix I below.

Though even proponents of the IFIM technique acknowledge that in its present state it has many limitations, yet it remains the

best available method for examining the relationship between fish habitat and the flow regime.

It is my opinion and that of others such as Orth and Bovee in the articles referred to in paragraph 3.6.5 above, that IFIM is a useful tool to aid flow management decisions, so long as its limitations are taken into account, and its results interpreted in the light of the other factors that may affect fish populations.

Mr Riddell surveyed one reach at Nokomai, Keown's Road and Waipounamu. The hydraulic parameters of that survey are summarised in JWH 5 which I now produce. Seven cross sections or transects were measured at Keown's Road and nine cross sections at Nokomai during February 1984 when the river was at its lowest annual flow.

These two reaches had similar distributions of depths and velocities, and I refer you to JWH 6 which I now produce. Five cross sections were recorded in the Waikaia river, Waipounamu Reach, in November 1983 at a relatively high flow, being slightly less than the median recorded 20 kilometres upstream at Maher's Beach. These data were insufficient for hydraulic modelling. The two reaches on the Maitai River were considered by Mr Riddell to be reasonably representative of the middle and upper sections of the river.

In the absence of more data the results from these reaches probably can be applied to the section of the river between Nokomai and the Waikaia confluence.

Variations in WUA with flow for the two Maitai reaches are shown in JWH 7 and JWH 8 which I now produce. Optimum flow for WUA of food production and WUA of brown trout spawning are clearly defined. At Nokomai the optimum is about 7-11 m³/s and at Keown's Road about 10-13 m³/s. These flows are equivalent to slightly more than one half of the median flow in each reach.

JWH 7 and JWH 8 both indicate that optimum flows for WUA of other activities and life stages of brown trout are lower than those for WUA of food production and spawning. However, apart from WUAs for food production and spawning, WUAs for other activities and life stages of brown trout have been shown by Mr I Jowett of MAF Fisheries not to be correlated with brown trout abundance in New Zealand rivers.

Recent studies by Mr I Jowett and myself suggest that the preference data for adult brown trout and feeding brown trout under-estimate velocities used by the fish in New Zealand rivers. Consequently, the actual optimum flows for adult habitat and feeding in the two Mataura reaches probably occur somewhere between the optima shown for these in JWH 7 and 8 and the optimum for food producing WUA.

In summary, these results indicate that optimum WUA for food production and spawning in the Mataura River between Nokomai and Gore occur at flows equivalent to about one-half of the median flow. They also indicate that optimum flows for WUA of adult habitat and feeding may occur at lower flows, down to one-third of the median.

However, given the uncertainty over the reliability of WUAs other than for food producing water and spawning, a conservative approach to flow management should be taken. WUAs for fry and juvenile habitat peak at flows even lower than one-third of the median, but because the demands of adult fish must be met simultaneously, a conservative approach would require maintenance of half the median flow. JWH 9 which I now produce gives flows of one-half the median for several locations along the Mataura River.

Mr Riddell in his 1984 survey referred to in Appendix I below, made a relevant statement at page 113 concerning the interpretation of IFIM results. He said that instream habitat is just one of many factors influencing trout populations. Other factors include the flow regime, sediment transport, water temperature and water quality. The interaction between these factors and their overall effect on trout stocks is not known and this should be borne in mind when making flow recommendations.

3.7 Low Flow Effects on the Fishery

Three life stages are generally recognised for trout. These are spawning, juvenile rearing, and adult rearing. Each of these stages, but particularly spawning and juvenile rearing, may or may not be critical, depending upon what factors are limiting a trout population in a particular river. Such information is not available for the Mataura River. Nevertheless neither spawning or juvenile rearing are likely to be under stress from low flows.

According to Mr Witherow and Dr Scott in their 1984 report, at pages 36 and 37, spawning takes place in the winter from late April to August whereas according to Mr Riddell's 1984 report at page 69, low flows occur in the summer and autumn from December to April. The fry and juvenile stages extend from September to April, which includes the period of low flows in the river, but JWH 7 and JWH 8 show that WUAs for these stages peak at low flows.

Generally floods are a greater threat to spawning and juveniles than are low flows.

Low flows would have most effect on food producing habitat and adult trout habitat. However, the effect on the trout population of varying periods of low flows is not known other than at flows less than one-half of the median, WUA of food producing habitat and probably adult habitat becomes suboptimal.

Less than optimal flows may retard growth, and indirectly lower fecundity. In extreme cases, such as the 20-year return period 7-day low flows referred to by Dr McKerchar in his evidence at page 9, they might increase mortality through predation.

Prolonged periods of low flow may also have a direct adverse effect on angling. Some anglers may find the fish ore difficult to catch, and excessive growths of periphyton will interfere with angling gear.

However, to my knowledge no information is available that has identified preferred flows for trout angling in the Mataura River. A survey of expert anglers was carried out to achieve this aim by Ms S Davis of MAF Fisheries in the 1985-1986 season. The results are not yet available.

The magnitude of these low flow effects will increase with the duration of the low flow event but it would require a detailed study to quantify them.

3.8 Relative Quality of Trout Habitat in the Mataura River

WUAs of habitat have been surveyed and calculated for other rivers throughout the country. When standardised by calculating them at median flow for each river they are a useful comparative measure of quality of trout habitat. JWH 10 and 11, which I now produce, show WUAs standardised by median flow for food producing

habitat and brown trout spawning habitat for several brown trout and brown and rainbow trout rivers throughout the country in order of increasing percentage of area of reach surveyed.

JWH 10 and 11 show that the Matakura has a very high percentage of WUA of food producing habitat compared with other rivers and a moderate amount of WUA of brown trout spawning habitat.

The study from which the data in JWH 10 and 11 comes from was not designed to assess whether rivers were outstanding on a national or regional basis with respect to WUA of habitat.

3.9 Water Quality

Water quality issues pertaining to the trout fishery become an important consideration downstream of Matakura at low flows. These issues have been presented in the evidence in chief of Mr Stephen Nicholls of Kingett, Mitchell and Associates.

THE NATIVE FISHERY

The native fishery of most significance to the Matakura River is the whitebait fishery. Ms Riddell and others show in their 1988 report listed in Appendix I below that the lower river and Toetoes Harbour are renowned in this respect. Although catch data are not available, the Southland Acclimatisation Society considers that the area supports by far the most important whitebait fishery in Southland. Ms Davis, in her 1987 report listed in Appendix I below, at page 33, considered it to be of national importance.

In the 1987 report of Ms Davis, also listed in Appendix I, it is recognised by MAF Fisheries that the Matakura River estuary is a wetland of outstanding importance for fisheries. This recognition is based largely on the importance of the whitebait and trout fisheries but also because of the diverse habitat provided for a wide range of native and exotic fishes.

Ms Riddell and others state in their 1988 report that in addition to whitebait, the lower Matakura River also supports a recreational/commercial eel fishery and recreational kahawai, mullet, and flounder fisheries.

These authors also state that there was a traditional Maori fishery for lamprey at Mataura Falls, although according to them, these fish are rarely exploited today. Adult lamprey are present in spring when they run up the river to spawn.

At least twelve native freshwater fish species and seven marine species have been recorded, or are known to be present, from the Mataura Catchment and Toetoes Harbour. JWH 12 which I now produce, lists the native fish and exotic fish other than trout that have been recorded from the Mataura River and Toetoes Harbour.

As a family the galaxiids are probably the most important native fish in the Mataura River because of their fishery and conservation value. The inanga no doubt forms the basis of the whitebait fishery. According to Ms Riddell and others in their 1988 report, inanga is known to be abundant in the lower Mataura and Toetoes Harbour.

Both the banded and giant kokopu and also whitebait species nowadays have a restricted distribution throughout New Zealand largely because of agricultural development, and they have a high conservation value. Dr McDowall, in his 1978 book listed in Appendix I below, believes that the giant kokopu in particular should be regarded and treated as a threatened species.

These fish are generally most abundant in waters where trout are absent and where there is plenty of riparian and instream cover. They have probably undergone a severe decline in the Mataura as a result of conversion of the catchment to pasture and consequent wetland drainage, and because of predation and competition from trout.

Very little is known about the water quality requirements of native fish. Inanga, common smelt, common bullies, and eels would make most use of the mainstem of the river below Mataura where organic enrichment is highest. All of these species appear to cope well in other organically enriched rivers, as for example, in the lower Waikato River.

Generally the 'rule of thumb' applied to water quality criteria for native fish is that if conditions are suitable for trout they will be suitable for native fish.

Similarly, little is known about the flow requirements of native fish. Providing that access to the river and its tributaries is maintained for native fish, flow regimes suitable for trout will usually take precedence, and be suitable also for native fish.

5 CONCLUSIONS

In terms of both total usage and relative importance, as assigned by anglers during 1979-1980, the Mataura River was ranked the highest of all brown trout rivers in New Zealand, and is considered a nationally important recreational trout fishery by MAF Fisheries.

The Waikaia River is considered by MAF Fisheries to be a regionally important scenic brown trout fishery.

The main factor contributing to the popularity of the Mataura River for angling is that it has a large area of accessible fishable water and a high catch rate.

Angling usage is highest from just above Gore to Mataura Island, despite the presence of industrial and domestic water pollution and flow diversions in this stretch of the river.

Compared to other rivers in New Zealand, the Mataura River has a high percentage of food producing habitat for trout and a moderate percentage of spawning habitat.

Low flows would have most effect on trout food producing habitat, adult brown trout habitat, and water quality, the latter of which is addressed by Mr S Nicholls in his evidence in chief.

The effect on the trout population of varying periods of low flow is not known, except that at flows of less than one-half of the median, WUA of trout food producing habitat, brown trout spawning habitat, and probably brown trout adult habitat become sub-optimal above the Waikaia confluence when flows are less than one-half of the median.

The lower Mataura River is considered by MAF Fisheries to have a regionally important, and possibly nationally important, whitebait fishery.

The Maitara River estuary is recognised by MAF Fisheries as a wetland of national importance for fisheries.

APPENDIX I.

- Blackiel, T., and Le Cren, E.D. 1978. Some density relationships for fish population parameters. pp. 279-302. In: Gerking, S.D. (Ed.). Ecology of Freshwater Fish Production, Blackwell Scientific Publications, Oxford.
- Bovee, K.D. 1978. Probability-of-use criteria for the Family Salmonidae. Instream Flow Information Paper No. 4, Co-operative Instream Flow Service Group, U.S. Fish and Wildlife Service, Fort Collins, U.S.A.
- Bovee, K.D. 1989. Everything I know about conducting IFIM validation studies. Instream Flow Chronical Vol. VI, No. 1: 1-3.
- Davis, S.F. 1987. Wetlands of national importance to fisheries. N.Z. Ministry of Agriculture and Fisheries, Fisheries Environmental Report No. 90.
- Graynoth, E., and Skrzynski, W. 1974. The Southland trout fishery. Ministry of Agriculture and Fisheries Technical Report No. 99.
- Kingett, Mitchell and Associates 1989. Mataura River benthic invertebrate and water quality investigations. Report prepared for Waitaki International Ltd, August 1989.
- Mather, D., Boson, W.H., Purdy, E.J., and Silver, C.A. 1985. A critique of the Instream Flow Methodology. Canadian Journal of Fisheries and Aquatic Sciences 42: 825-831.
- McDowall, R.M. 1978. New Zealand Freshwater Fisheries: A Guide and Natural History. Heinemann Educational Books Ltd, Auckland.
- Orth, D.J. 1987. Ecological considerations in the development and application of Instream Flow Habitat Models. Regulated Rivers 1. 171-181.
- Richardson, J., Unwin, M.J., and Teirney, L.D. 1984. The relative value of Otago rivers to New Zealand anglers. N.Z. Ministry of Agriculture and Fisheries, Fisheries Environmental Report No. 48.

- Riddell, D.C. 1984. Surface water hydrology of the Mataura River catchment, South Island, New Zealand. Southland Catchment Board and Regional Water Board.
- Riddell, J.M., Watson, N.R.N., and Davis, S.F. 1988. Fisheries investigations of the Ashers-Waituna, Benhar and Hawkdun Lignite Deposit Area. N.Z. Ministry of Agriculture and Fisheries, Freshwater Fisheries Report No. 94.
- Scott, D. 1987. Supplementary statement of evidence in the matter of an appeal against Water Right A931 granted by the Southland Regional Water Board.
- Scott, D., and Shirvell, C.S. 1987. A critique of the Instream Flow Incremental Methodology and observations on flow determinate in New Zealand. pp. 27-43. In: Craig, J.F. and Kemper, J.B. (Eds.). Regulated Streams. Plenum, New York.
- Shirvell, C.S., and Dungey, R.G. 1983. Microhabitats used by brown trout for feeding and spawning in rivers. Transactions of the American Fisheries Society 112: 355-367.
- Teirney, L.D., Unwin, M.J., Rowe, D.K., McDowall, R.M., and Graynoth, E. 1982. Submission on the draft inventory of wild and scenic rivers of national importance. N.Z. Ministry of Agriculture and Fisheries, Fisheries Environmental Report No. 28.
- Teirney, L.D., Unwin, M.J., and Richardson, J. 1984. The relative value of Southland rivers to New Zealand anglers. N.Z. Ministry of Agriculture and Fisheries, Fisheries Environmental Report No. 50.
- Teirney, L.D., Unwin, M.J., and Richardson, J. 1984. The relative value of Southland rivers to New Zealand anglers. N.Z. Ministry of Agriculture and Fisheries, Fisheries Environmental Report No. 50.
- Witherow, W.D., and Scott, D. 1984. The Mataura trout fishery. Published by the Southland and Otago Acclimatisation Societies.

Waters, R.S. 1976. A methodology for evaluating the effects of different stream flows on salmonid habitat. Instream Flow Needs, A.F.S. and A.S.C.E. Conference, Boise, Idaho. 1976.

JWH 1

TABLE 1. Comparison of trout abundances between New Zealand rivers as assessed by drift diving. Rivers are ordered by increasing biomass (kg/km) (I Jowett, MAF Fisheries, Freshwater Fisheries Centre, unpublished data).

Rank	River	Biomass	Rank	River	Biomass
1	Makaroro	0.038	41	Akatarawa	20.213
2	Tarawera	0.564	42	Opihi	20.831
3	Oroua	0.581	43	Mohaka	20.855
4	Tauranga/Taupo	1.033	44	Inangahua	21.428
5	Ahuriri	1.258	45	Mataura	21.958
6	Opihi	1.773	46	Taramakau	22.060
7	Waimana	1.785	47	Ruamahanga	22.228
8	Maerewhenua	1.963	48	Waingongoro	22.240
9	Waimakariri	2.547	49	Irthing	22.609
10	Waiohine	2.563	50	Mangatainoka	22.760
11	Ngaruroro	2.940	51	Wanganui	24.012
12	Otematata	3.067	52	Buller	25.507
13	Orari	3.371	53	Baton	26.525
14	Ruamahanga	3.691	54	Manuherikia	27.344
15	Ngaruroro	3.817	55	Hakataramea	27.703
16	Taipo	4.037	56	Mararoa	28.425
17	Wanganui	4.094	57	Wairoa	28.662
18	Tauhereinikau	4.138	58	Pelorus	30.592
19	Esk	4.314	59	Aorere	31.538
20	Taruarau	4.393	60	Oreti	36.460
21	Rangitaiki	4.831	61	Kakanui	38.342
22	Whakatiki	4.858	62	Ahaura	39.690
23	Kaupokonui	5.133	63	Mokihinui	40.110
24	Tony	6.296	64	Shag	40.569
25	Ohau	6.351	65	Karamea	44.507
26	Manganui	6.445	66	Inangahua	44.832
27	Pohangina	6.969	67	Tongariro	48.016
28	Waingawa	7.494	68	Maruia	59.707
29	Waiwakaiho	9.330	69	Aparima	63.475
30	Waimana	9.642	70	Mangles	67.188
31	Hautapu	10.344	71	Rai	70.170
32	Takaka	10.386	72	Hutt	80.331
33	Mangahao	11.136	73	Riwaka	89.457
34	Patea	14.116	74	Grey	92.430

TABLE 1. (contd)

Rank	River	Biomass	Rank	River	Biomass
35	Moawhango	15.082	75	Motueka	149.632
36	Otaki	15.940	76	Arnold	177.500
37	Ahuriri	16.100	77	Hurunui	178.594
38	Rangitikei	19.263	78	Gowan	191.950
39	Selwyn	19.375	79	Gowan	208.839
40	Waikaia	19.505	80	Clutha	214.678

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TABLE 2. Estimated angler use of the Mataura River and its tributaries and other rivers experiencing high use (from the National Angler survey 1979/80; a = above Gore, b = below Gore).

Site	Total no. of visits
Mataura below Gore	40 880
Mokoreta (b)	3 170
Mimihau (b)	2 320
Waikaka (b)	2 070
Mataura above Gore	15 120
Waikaia (a)	5 800
Otamita (a)	1 400
Waimea (a)	1 100
Tomogalak (a)	570
Taieri	35 000
Clutha	30 000
Pomahaka	11 000
Waipouri	6 000
Oreti	34 000
Waiau	12 000
Aparima	17 000
Manawatu	15 000
Motueka	12 000
Buller	10 000

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TABLE 3. Estimated angler usage (number of visits) of the Mataura River by Southland and Otago anglers compared with usage of the Waimakariri, Rakaia, Rangitata, and Waitaki Rivers by Canterbury and Waitaki anglers (from Teirney et al. 1982).

Acclimatisation district	Mataura	Waimakariri	Rakaia	Rangitata	Waitaki
Southland	42 000	-	-	-	2 600
Otago	14 000	-	-	-	7 200
North Canterbury	-	90 000	45 000	6 000	3 400
Ashburton	-	-	13 000	12 000	-
South Canterbury	-	-	-	33 000	4 500
Waitaki	-	-	-	-	37 800
TOTAL	56 000	90 000	58 000	51 000	55 500

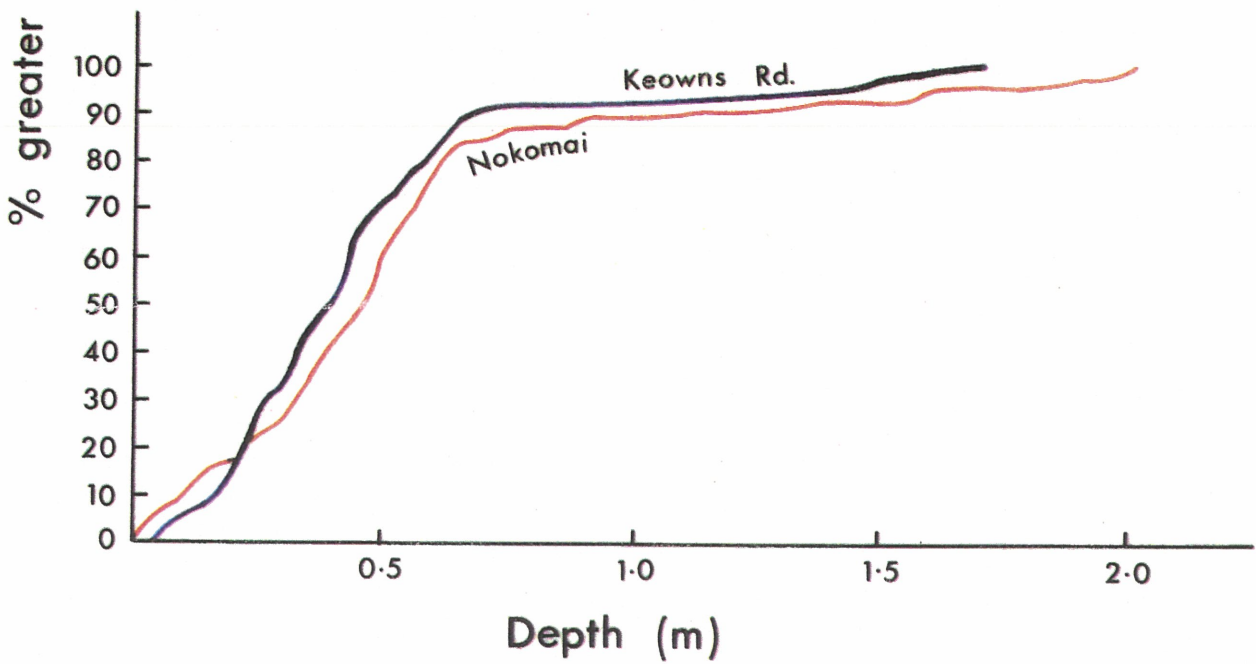
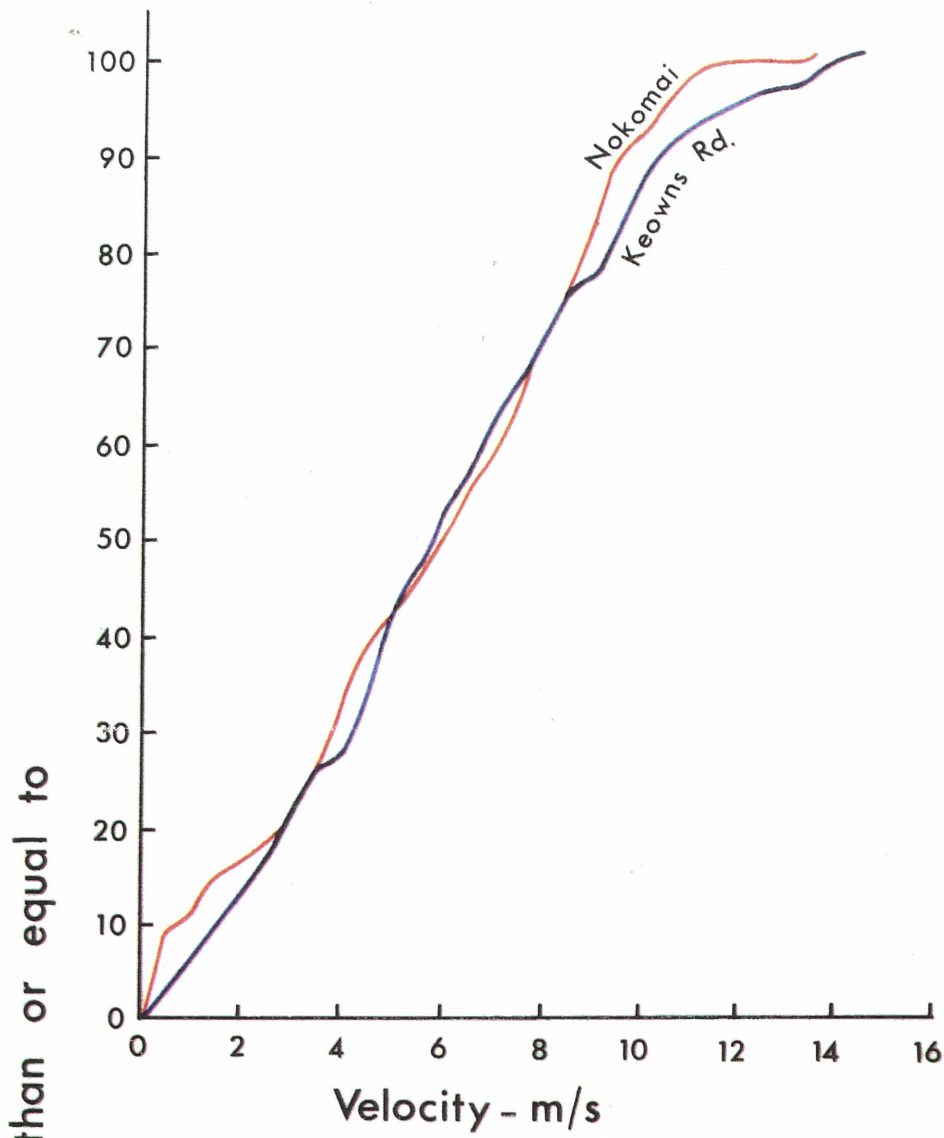
Note: The Waitaki total includes usage by Southland and Otago anglers.

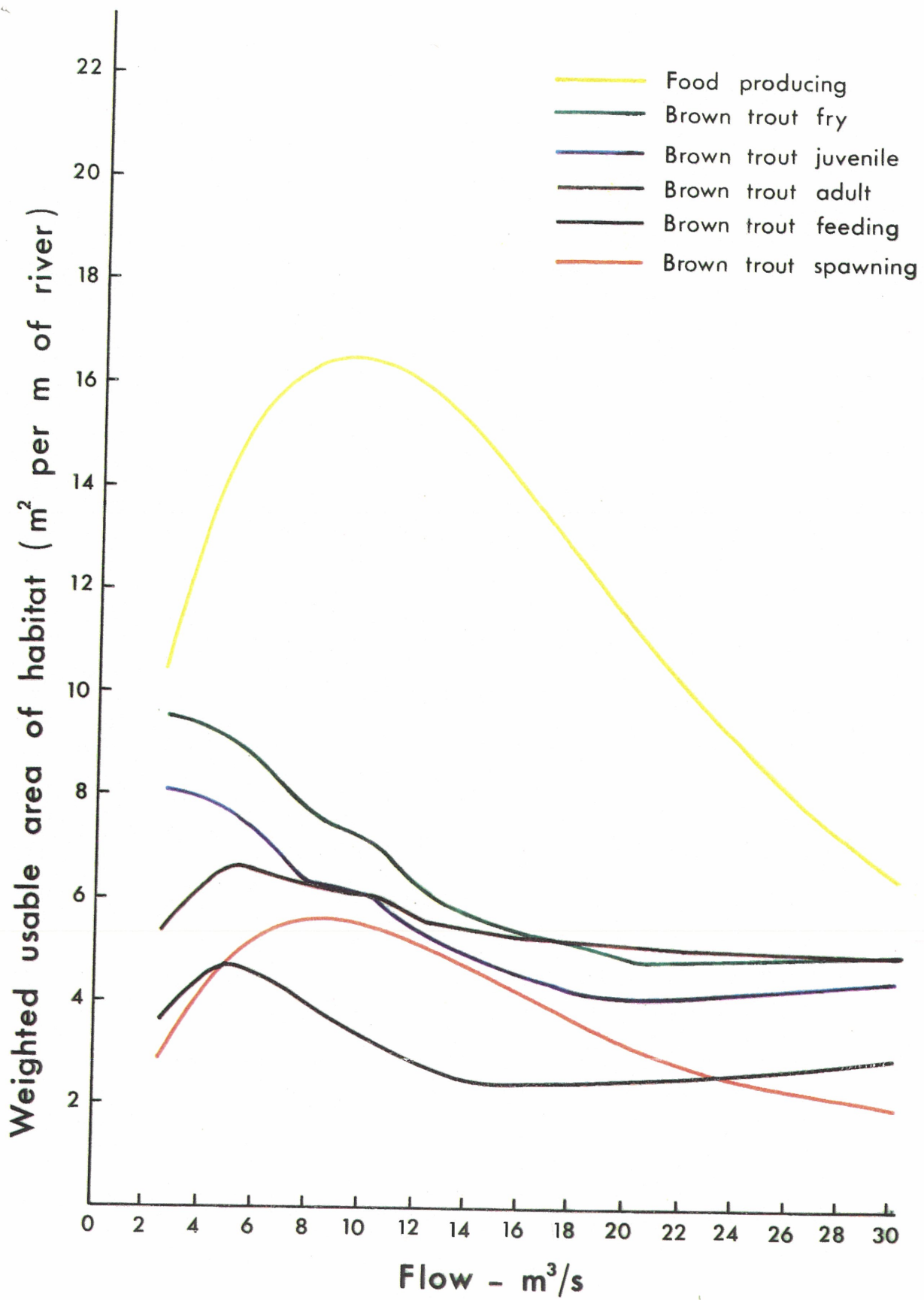
JWH 5

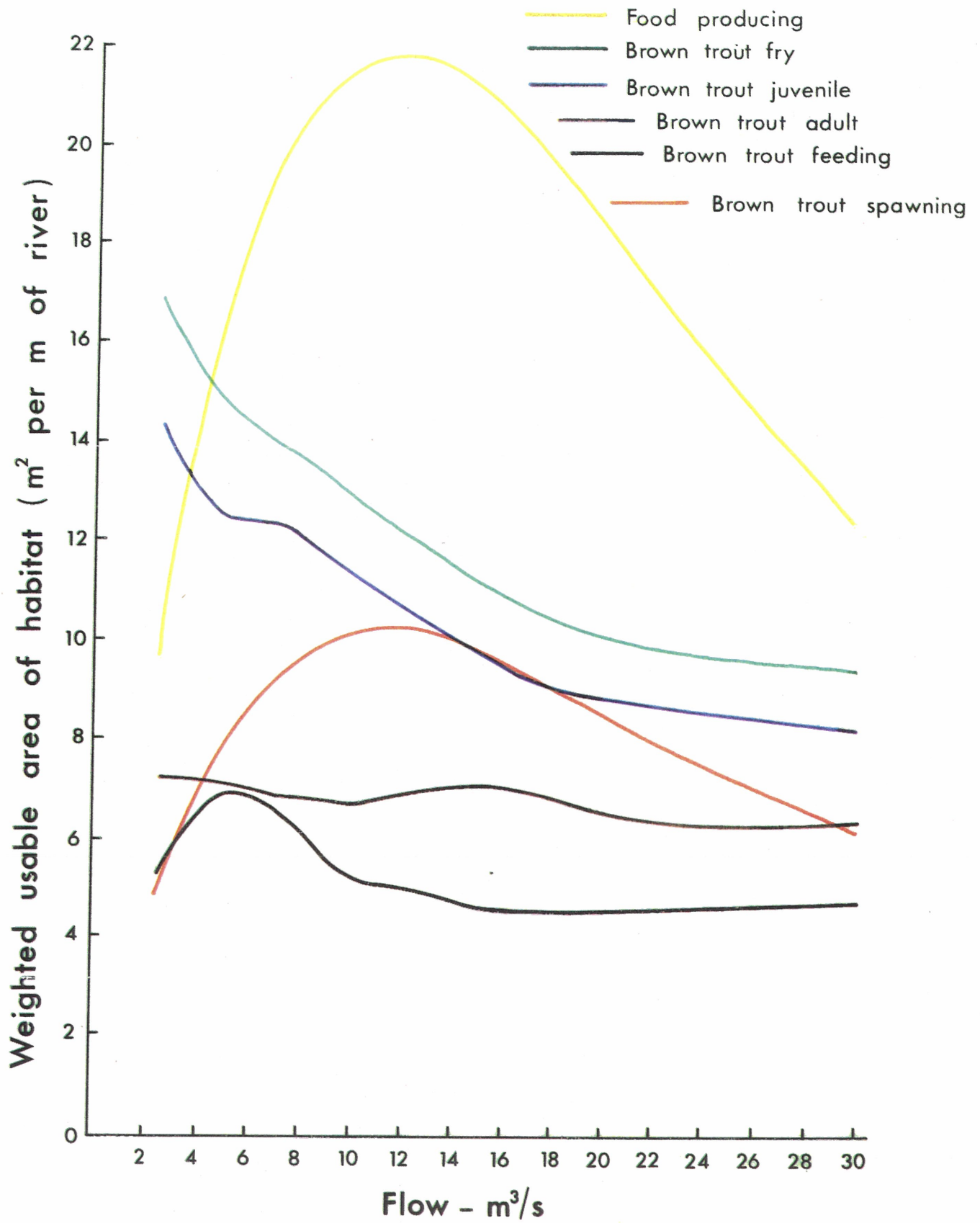
TABLE 4. Hydraulic parameters of reaches surveyed for fish habitat.

Reach	Flow m ³ /s	Length (m)	Average width (m)	Wetted area (m)	River gradient
Mataura River at Nokomai	7.6	542.0	26.6	14 441	.0019
Mataura River at Keowns Road	9.9	815.5	38.0	33 027	.0023
Waikaia River at Waipounamu	19.1	507.0	40.1	20.327	0

Reach	Depth (m)		Velocity (m/s)		Average substrate (%)			
	Average	Median	Average	Median	B	C	G	S
Mataura River at Hokimai	0.58	0.46	0.55	0.60	1	25	58	16
Mataura River at Keowns Road	0.47	0.39	0.55	0.59	0	25	66	0
Waikaia River at Waipounamu	0.65	0.71	0.64	0.63	-	-	-	-







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TABLE 5. One-half Mataura River median flows (from Riddell 1984).

Site	Period	Median flow m ³ /s	Half Median flow m ³ /s	%
Parawa	03.05.77-01.01.84	14.5	7.3	89
Keown's Road	23.04.74-29.09.82	19.5	9.8	81
Pyramid	22.02.74-01.01.84	48.5	24.3	81
Gore	18.05.77-01.01.84	62.0	31.0	84
Mataura Island	05.10.73-01.01.84	73.3	36.7	81

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TABLE 6. Comparison between rivers of percentage WUA for salmonid food producing habitat at median flow. Rivers ranked by order of increasing percentage WUA (I. Jowett, MAF Fisheries, Freshwater Fisheries Centre unpublished data).

Rank	River	% WUA	Rank	River	% WUA
1	Shag	10.242	34	Ohau	34.276
2	Waiari	11.270	35	Esk	34.738
3	Arnold	11.985	36	Takaka	35.042
4	Clutha	12.367	37	Waimana	35.115
5	Tutaekuri	16.057	38	Riwaka	35.862
6	Waihou	17.195	39	Waingongoro	36.574
7	Pelorus	18.182	40	Tauherenikau	36.574
8	Ruamahanga	18.240	41	Mangatainoka	36.657
9	Kakanui	18.572	42	Mangles	36.813
10	Taipo	20.463	43	Hakataramea	37.423
11	Pohangina	21.860	44	Mataura	37.729
12	Moawhango	21.002	45	Tongariro	37.975
13	Waimakariri	22.511	46	Stony	38.052
14	Oroua	24.242	47	Gowan	38.070
15	Kauaeranga	24.983	48	Waingawa	38.278
16	Tauranga-Taupo	26.527	49	Otematata	39.463
17	Ngaruroro	26.699	50	Motueka	39.782
18	Wairoa	27.108	51	Ahuriri	40.379
19	Aorere	27.661	52	Opihi	40.455
20	Whakatiki	27.929	53	Mataura	41.037
21	Otaki	28.796	54	Ahuriri	41.678
22	Selwyn	28.802	55	Hutt	41.741
23	Manganui	29.548	56	Ruamahanga	43.103
24	Waiohine	30.807	57	Baton	43.540
25	Opihi	31.091	58	Grey	45.159
26	Mararoa	31.447	59	Kaupokonui	46.178
27	Akatarawa	31.770	60	Inangahua	47.375
28	Oreti	31.900	61	Hurunui	47.631
29	Mangahao	33.258	62	Buller	47.993
30	Rai	33.383	63	Rangitikei	48.095
31	Orari	33.455	64	Wanganui	48.164
32	Waiwakaiho	33.925	65	Patea	51.364
33	Maerewhenua	34.212			

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TABLE 7. Comparison of percentage WUA on various rivers for brown trout spawning at median flow. Rivers ranked by order of increasing percentage WUA (I. Jowett, MAF Fisheries Freshwater Fisheries Centre, unpublished data.)

Rank	River	% WUA	Rank	River	% WUA
1	Waiari	0.000	34	Waiohine	4.273
2	Gowan	0.328	35	Hurunui	4.585
3	Clutha	0.344	36	Waingongoro	4.812
4	Arnold	0.436	37	Ruamahanga	4.963
5	Waiwakaiho	0.522	38	Tauranga-Taupo	5.005
6	Waimakariri	0.866	39	Tauherenikau	5.093
7	Taipo	0.903	40	Grey	5.180
8	Waihou	0.905	41	Takaka	5.191
9	Motueka	1.126	42	Mararoa	5.432
10	Aorere	1.132	43	Orari	5.474
11	Ngaruroro	1.214	44	Kaupokonui	5.573
12	Stony	1.522	45	Tutaekuri	5.650
13	Patea	1.605	46	Rangitikei	6.215
14	Inangahua	1.707	47	Opihi	6.218
15	Pelorus	1.743	48	Ahuriri	6.445
16	Shag	1.862	49	Mataura	6.479
17	Moawhango	1.940	50	Mangatainoka	6.542
18	Ruamahanga	2.146	51	Akatarawa	6.556
19	Manganui	2.317	52	Waimana	6.633
20	Ahuriri	2.552	53	Opihi	7.355
21	Buller	2.618	54	Ohau	7.712
22	Tongariro	2.665	55	Kakanui	8.012
23	Baton	2.840	56	Kauaeranga	8.328
24	Rai	2.967	57	Whakatiki	8.534
25	Wanganui	3.010	58	Otematata	8.682
26	Wairoa	3.012	59	Oreti	9.511
27	Waingawa	3.190	60	Mangahoa	10.147
28	Pohangina	3.577	61	Riwaka	11.034
29	Otaki	3.599	62	Maerewhenua	11.404
30	Hutt	3.924	63	Esk	11.546
31	Mangles	4.034	64	Hakataramea	11.656
32	Oroua	4.040	65	Selwyn	15.533
33	Mataura	4.231			

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TABLE 8. Native fish species recorded and known to be present from the lower Mataura River and Toetoes Harbour and their relative abundance (from Riddell *et al.* 1988).

Species	Relative abundance
Longfinned eel	*****
Shortfinned eel	***
Lamprey	**
Common bully	***
Upland bully	P
Inanga	*****
Giant kokopu	*
Banded kokopu	*
Common river galaxias	P
Common smelt	***
Torrentfish	P
Black flounder	***
Yellowbelly flounder	****
Sand flounder	**
Cockabully	**
Yelloweyed mullet	**
Kahawai	**
Stargazer	**
Parrotfish	*

***** = abundant
 **** = common
 *** = frequent
 ** = occasional
 * = rare
 P = present