Fish survey of the Wairaurahiri River, western Southland

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prepared for the Waiau River Working Party

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EXECUTIVE SUMMARY

A survey of the fish fauna of the Wairaurahiri River was undertaken in October 1995. At that time of the year, active immigration of the juveniles of many of the fish species likely to be present is taking place. As a result there should have been about the maximum number of species present in the lower river, including high abundance of their juveniles. Twenty-three sites in the river's mainstem and tributaries were surveyed, and there are historic records from seven sites, several of these about the same as those surveyed in 1995. Eleven species of indigenous fish, one introduced fish and one macrocrustacean were recorded from the river. None of these species was unexpected, on the basis of knowledge of the fish faunas of other Southland and Fiordland rivers. Abundance of all species was low apart from modest abundance of recently-migrated juveniles in the lower kilometre of the river. Common smelt, inanga, banded kokopu and common bully were found only in this lower kilometre, most fish being juveniles that had just left the sea. Shortfinned eel was found only on one mid-river tributary. Lamprey, and koura were present widely but very spasmodically. Koaro, torrentfish, redfinned bully, and bluegilled bully were present widely through the river and/or its tributaries, but almost always rarely. Longfinned eel and brown trout were widespread, but also generally in low abundance.

The sparseness of the fish in the river, both abundance and species richness at survey sites, is consistent with records from the nearby Waiau River, though the two rivers are very different. The Waiau has low gradient and frequent pools and runs, much greater flow variability, has scarcely any riparian or catchment forest, and most forest is beech (*Nothofagus* spp.). By contrast, the Wairaurahiri has steep gradient, no pools and few runs, is heavily forested throughout both the riparian zone and catchment, and the forest includes a high proportion of podocarps. Both rivers, however, flow into Foveaux Strait, where the oceanographic conditions, particularly current flows, may contribute to poor recruitment of the small juveniles of some of the sea-migratory species found in the two rivers. Absence of adults of banded kokopu, given their significant proportion in the whitebait sample taken from the river, is perplexing. Adults of this species, too, were not found in the Waiau. The Wairaurahiri River has none of the non sea-migratory fish species that are characteristic of the rivers of the Southland Plains, and which spread no further west than the Waiau. It appears that none of these species has been able to reach the Wairaurahiri River since this valley was carved out during the Pleistocene glaciation which formed Lake Hauroko, whose water provides most of the river's flow.

1.0 INTRODUCTION

This report provides an account of the fish fauna of the Wairaurahiri River, commissioned by the Waiau River Working Party, convened by Electricity Corporation of New Zealand. The fauna of the river was surveyed during late October 1995.

The Wairaurahiri River drains Lake Hauroko in western Southland (Fig. 1). Lake Hauroko, New Zealand's deepest lake (462 m–Spigel and Viner 1992), is of glacial origins and its surface is at elevation ca. 157 m above sea level. It has area of about 68 km^2, and has catchment area of 554 km^2 most of this area (>69%) in steep (26-35°) or very steep (>35°) topography (Livingston, *et al.* 1986). The lake and upper reaches of the river lie in the eastern Fiordland National Park, but beyond about 3.8 km downstream from the Lake Hauroko outlet, the river passes from the National Park into the Waitutu Forest Park which is under the administrative jurisdiction of the Department of Conservation. The lowest 5.8 km of the river pass through land in private Maori ownership on the true left (east) bank, and for 3.4 km on the true right bank. Within these various land tenures the catchment of the river (including the entire catchment of Lake Hauroko above the river and the river itself), lies in indigenous vegetation, mostly forest (58%), with extensive tussock grasslands at higher elevations (29%). Catchment and riparian forest associated with the river itself is a mixture of podocarps (f. Podocarpaceae) and southern beech (*Nothofagus*). This forest is largely unexploited and unmodified apart from the impacts of red deer and other introduced mammals. The proportions of these two vegetation categories changes down stream, with the podocarps increasing in abundance closer to the sea and becoming dominant in the lower reaches.

The Wairaurahiri River is about 35 km long (lake outlet to sea), and consists of a single channel virtually throughout–there are occasional forested islands where the river forms two channels, but there is no braiding into unstable, shifting, multiple channels. Banks vary from low and grading to substantial cliffs, and at times the channel is deeply incised between cliffs on both sides. It falls 157 m in these 35 km, the fall being relatively even along the length of the river (Fig. 2). Steepness is considerable; superficial comparison suggests a rate of fall similar to the lower Rakaia River in central Canterbury (Fig. 2). However, whereas the Rakaia River winds laterally, back and forth, across its broad flood plain, the Wairaurahiri River essentially has no flood plain but is narrowly confined between its banks, and the actual rate of descent is much greater than in the Rakaia. This results in very rapid flows, and the river is virtually a continuous riffle/rapid from the lake to the sea. There is no water that remotely resembles a pool, though some of the water might be categorised as a swift run. At times there are continuous reaches of rapid with broken, white-water surface and standing waves up to 0.5 m or more. There are virtually no sandy river beaches except at the small deltas of influent tributaries, and even grading gravel beaches are rare. In spite of the rapid fall of the river, there

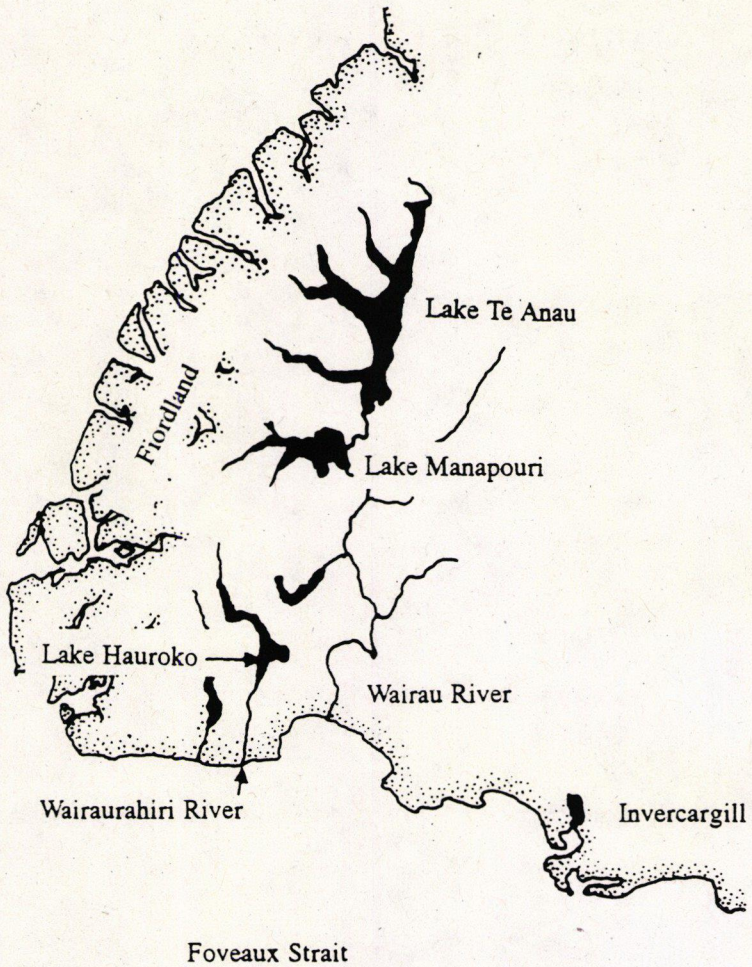


FIGURE 1 Map of Wairaurahiri River and environs in western Southland and Fiordland.

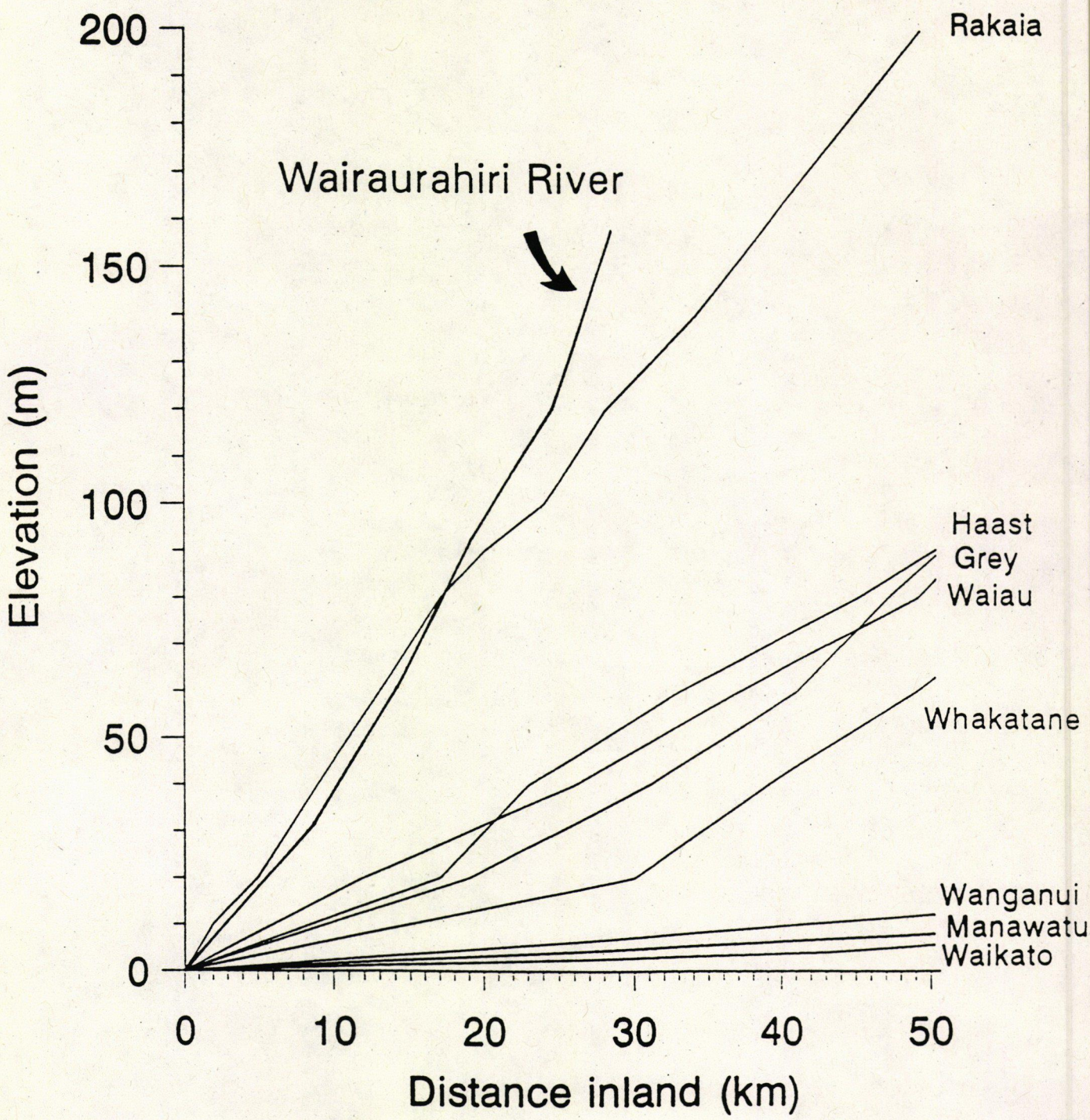


FIGURE 2 Gradient of Wairaurahiri River and assorted other New Zealand rivers.

are no major, explicit barriers to upstream migration by fish, such as falls, chutes, or torrents. Mostly the river flows between forest-clad banks, its water a deep green colour. There is no real estuary, and the river's fall continues to the mouth, where the flows plunge into the sea. Though we did not observe the lower river during diverse flows and tidal phases, reversal of flow directions at high tides (even high spring tides) probably does not take place, and even significant backing-up of water for any distance into the lower reaches of the river at the highest tides seems unlikely.

Gauging of flows has been undertaken only close to the lake outlet, with records available from May 1967 to December 1978 (water level recording site No. 80901–Walter 1994). During this interval, flows in the river varied from a minimum of 14.1 cumecs (cubic metres per second) to a maximum of 151.3 cumecs. Median flow was 40.3 cumecs. Flows were rarely less than 20 cumecs or above 100 cumecs, and were between about 26 cumecs and 62 cumecs for 60% of the time (Fig. 3). Topographical maps show upwards of 25 tributaries joining the river (Fig. 1), but even the largest of these is small (estimated as much less than a cumec at the time of visit), and most of them are tiny. By far the greatest volume of water in the river therefore derives directly from the lake, and flow volume probably does not increase significantly from source to sea. Because of this predominance of lake origins of the water, the river's flows are relatively stable, fluctuating less and more slowly than rivers originating primarily in surface flows. Furthermore the river is likely subject to less variability in the quantities of sediment carried and probably never becomes greatly turbid. Any sediment/turbidity in the flows comes from the tributaries, several of which had moderate sedimentation of otherwise boulder/cobble substrates. Lack of major flow perturbations likely results also in greater substrate stability.

2.0 METHODS

Access to the river is possible only by water or air, and we used a jet boat to reach and travel on the river, and a Department of Conservation hut on the lower river as an overnight base. We attempted to fish as widely as possible in both the river's mainstem and its tributaries. The depth and extreme swiftness of the river and the paucity of wadeable, grading, gravel margins severely restricted the number of locations in the mainstem that were fishable, and it is noticeable that the proportion of mainstem sites sampled declines in the upper river, where current velocities seemed greatest and fishable sites increasingly rare (Table 2). During the first day traps and nets were set in suitable locations in the lower river. Traps used consisted of:

1 A "Southland sock" whitebait net that was set along the margins of the lower river within about 300 m of the river mouth.

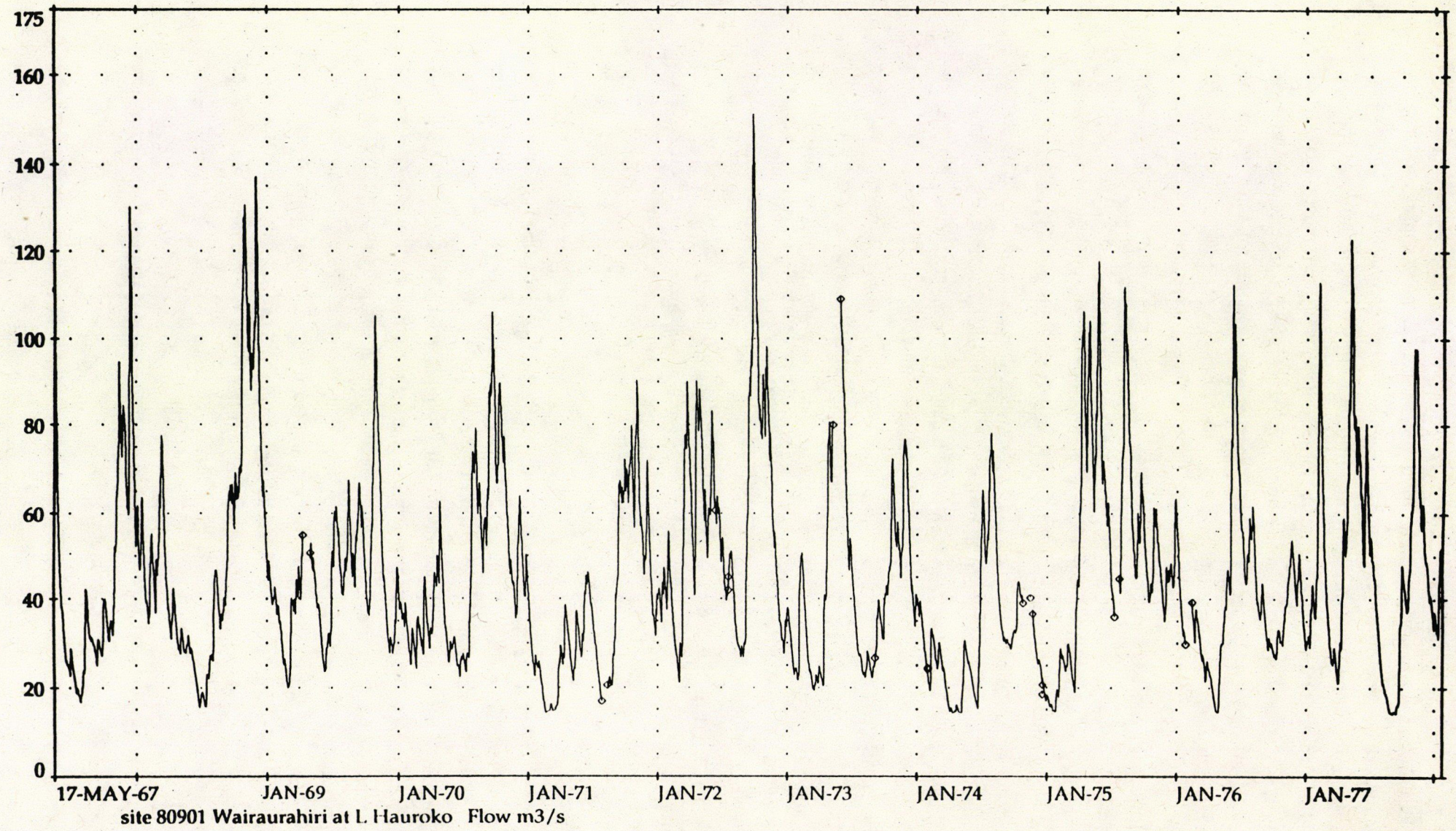


FIGURE 3 Hydrograph of Wairaurahiri River May 1967 to December 1978.

2 Fyke nets that were set in still edges or deeper water associated with tributaries close to the mainstem, baited with perforated vials of "Marmite" (Allibone and Chadderton 1992), and which were set, where possible, across likely paths of movement by fish.

3 "G-minnow" traps, also baited with perforated vials of "Marmite", which were tethered alongside still, deeper water inaccessible by wading. Setting these various traps was very much a matter of exploiting any suitable opportunities, which were few.

Tributaries and accessible locations in the mainstem (most often either shallows around the few islands, or boulder/gravel fans at confluences with tributaries) were also fished using battery-powered, back-portable, pulsed DC, electric fishing gear. This was used primarily by working downstream onto a hand-held stop net. All water electric-fished in the mainstem, and most of that in the tributaries, was riffle/rapid habitat. On the second day, traps were recovered and cleared in the lower river, and occasional margins and accessible tributaries of the upper river were then electric fished. During electric fishing, no fixed area of water was fished and no attempt was made to obtain explicitly quantitative estimates of fish densities. In general, locations were fished until it was our judgement that habitats available had been thoroughly explored and that capture of species additional to those already noted was unlikely. Scientific and common names of species captured are listed in Table 1. Common names are otherwise used throughout this report.

3.0 PAST RECORDS OF FISH IN THE RIVER

The Wairaurahiri River was fished by staff of the former Fisheries Research Division of the Ministry of Agriculture and Fisheries (MAF) in May 1972, as part of the investigation of fish faunas of streams likely to be affected by a proposed programme of exploitation of West Coast and Southland beech forests (McDowall *et al.* 1977). The lower reaches of three tributaries of the river were fished using electric fishing gear, and three fish species were recorded. The Wildlife Service of the Department of Internal Affairs (DIA) also undertook sampling in the river in January 1984, sampling one mainstem site in the lower river and two tributaries; eight species were recorded (Table 2). Records of these surveys are available in the NIWA New Zealand Freshwater Fish Database (NZFFD), and data are included in this account. There are no other previous records of fish from the river known to us.

TABLE 1 Familial allocation and scientific and common names of species discussed in text.

Family Geotriidae	
Geotria australis	lamprey
Family Anguillidae	
Anguilla australis	shortfinned eel
Anguilla dieffenbachii	longfinned eel
Family Retropinnidae	
Retropinna retropinna	common smelt
Family Galaxiidae	
Galaxias anomalus	roundhead galaxias
Galaxias argenteus	giant kokopu
Galaxias brevipinnis	koaro
Galaxias fasciatus	banded kokopu
Galaxias maculatus	inanga
Galaxias paucispondylus	alpine galaxias
Galaxias postvectis	shortjawed kokopu
Galaxias vulgaris	common river galaxias
Galaxias sp.	flathead galaxias
Family Pinguipedidae	
Cheimarrichthys fosteri	torrentfish
Family Eleotridae	
Gobiomorphus breviceps	upland bully
Gobiomorphus cotidianus	common bully
Gobiomorphus gobioides	giant bully
Gobiomorphus hubbsi	bluegilled bully
Gobiomorphus huttoni	redfinned bully
Family Pleuronectidae	
Rhombosolea retiaria	black flounder
Family Parastacidae	
Paranephrops zealandicus	koura
Family Salmonidae	
Salmo trutta	brown trout (introduced)

TABLE 2 Occurrence of fish species in Wairaurahiri River.

Site No.	Km upstream	Mainstem	Tributary	Method	Lamprey	Longfinned eel	Shortfinned eel	Common smelt	Inanga	Banded kokopu	Koaro	Torrentfish	Common bully	Redfinned bully	Bluegilled bully	Brown trout	Koura	No. of species
1	0.3	x		trap				o	c*	c*	c*							4
2	0.5		x	EF		✓								✓				2
3	0.5	x		EF	p	p			c		c*	c*	p	p	c*			8
4	1.0		x	trap		o		!					c			p		4
5	1.0		x	trap					o							p	o	3
6	1.6	x		EF		o						o		p	c	o		5
7	5.9		x	EF		o					c			p		c		4
8	6.8		x	EF		o												1
9	8.8	x		trap		o												1
10	8.9		x	EF		p	p											2
11	9.1	x		EF	✓	✓					✓		?	✓	✓	✓	✓	8
12	9.6	x		EF		p						c			o			3
13	9.7		x	EF	o	c										o		3
14	11.6	x		EF							p							1
15	12.4	x		EF											o			1
16	12.5		x	EF							o	p		p		c		4
17	12.8		x	EF												o	p	2
18	16.4	x		EF		p										o		2
19	16.9	x		EF											o			1
20	17.0		x	EF		p					o					c		3
20	17.0		x	EF							✓	✓				✓	✓	4
20	17.0		x	EF												✓		1
21	19.4	x		EF											c	p		2
22	23.5	x		EF								p			p	p		3
23	23.6	x		EF	o	o								p		o		4
24	24.8	x		EF												o		1
25	24.8		x	EF		o					o					o		3
26	26.8		x	EF							p					o		2
26	26.8		x	EF		✓										✓		2
27	28.4		x	EF		✓										✓		2
28	30.4		x	EF												o		1
28	30.4		x	EF		✓										✓		2
29	32.4		x	EF												o		1
30	34.0		x	EF												o		1
Occurrence in mainstem					3	7	0	2	2	1	4	4	2	4	8	7	1	
Occurrence in tributaries					1	11	1	0	1	0	5	2	1	3	0	13	3	
Total					4	18	1	2	3	1	9	6	3	7	8	20	4	

* = juveniles and whitebait
✓ = NZFFD records
! = probable (seen in water)
? = dubious

p = present
o = occasional
c = common

4.0 RESULTS

The fish survey was undertaken in October 1995. Being mid-spring, many of the diadromous fish species that seasonally enter New Zealand rivers from the sea should have been present in the river (McDowall 1995). At the time of sampling, the Wairaurahiri River and all its tributaries were running clear. The flows in the river can be estimated from lake level based on historic gaugings of the river, and on 28 October, flows in the river were estimated as about 77 cumecs (E. Baddock, pers. comm.).

A summary of catches taken at 27 locations in the mainstem and tributaries of the Wairaurahiri River is provided in Table 2. Eleven species of indigenous fish and one macrocrustacean, plus the introduced brown trout, have been taken from the river. All indigenous fish species in this river are diadromous, and normally must spend a part of their lives at sea. Hence, access through the river mouth and upstream into suitable habitats is critical to their use of these habitats, and to understanding their distributions. Numbers of fish in all instances were quite low. Absolute abundance was not determined, but occurrence was informally classified as either:

Present (one of species encountered);
Occasional (several of species encountered); or
Common (one or more of species repeatedly taken in sweeps of the electric-fishing electrode).

4.1 Species found in river

Lamprey: Only the larval ammocoete stage was collected, at three sites, and as far upstream as site 23 (23.6 km upstream–Fig. 4; Table 2), always from marginal sandy/silty shallows. Sites included both mainstem and a tributary. There is also an historic NZFFD (DIA) record, when numerous ammocoetes were reported from a side channel of the mainstem river. Ammocoetes are difficult to catch, requiring high powered electric fishing machines and considerable attention to suitable habitats. Consequently, we have no doubt that the lamprey is much more widespread than our records indicate.

Longfinned eel: Longfinned eels were taken widely in the river, at 13 sites, as far as 24.8 km up stream. NZFFD (MAF) records extend the range as far as 30.5 km up stream (Fig. 5; Table 2). Though we have no records, we predict occurrence of longfinned eel in Lake Hauroko. This is probably the most ubiquitous indigenous fish in the New Zealand fauna (McDowall 1990), so that its wide occurrence in the Wairaurahiri River is not surprising. However, it was never common, and mostly occurred as one or two individuals at many of the sampling sites. It

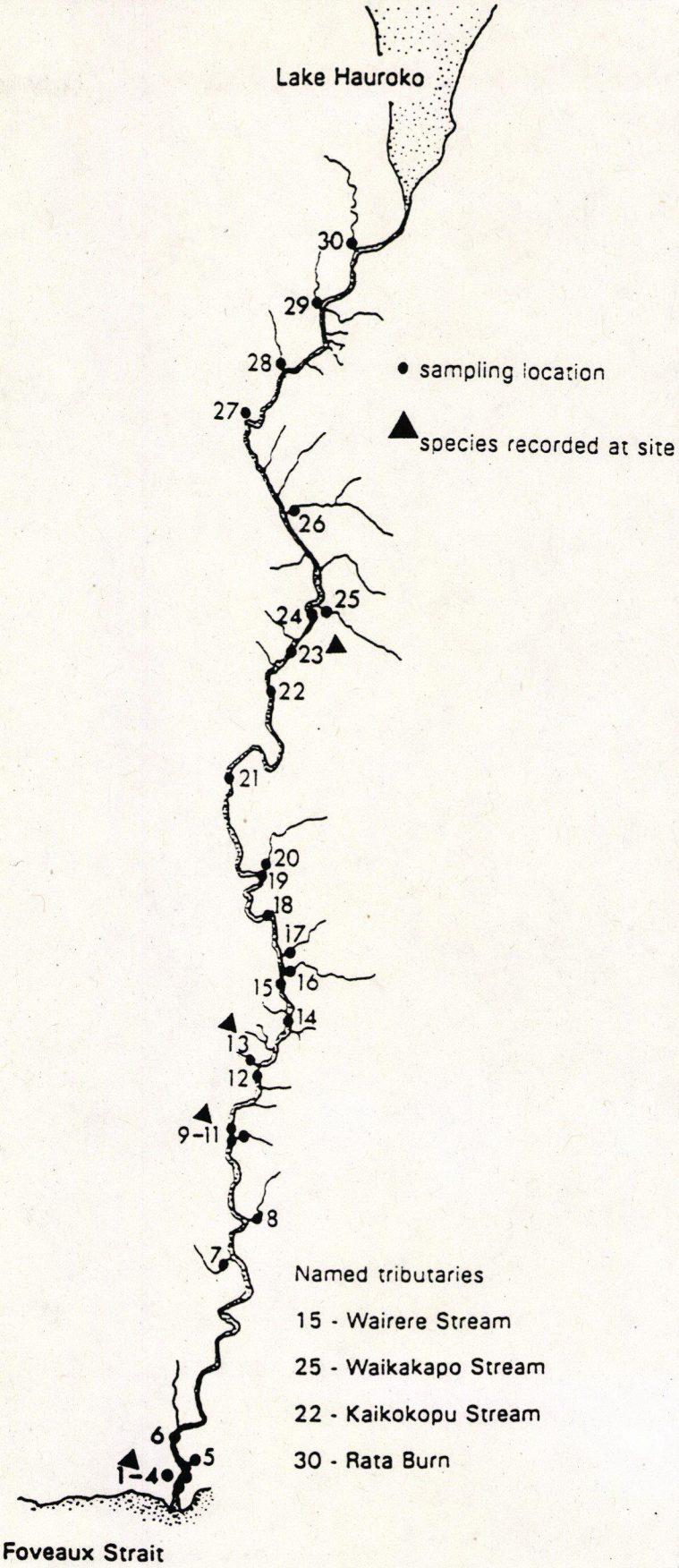


FIGURE 4 Distribution of lamprey, *Geotria australis*, in the Wairaurahiri River.

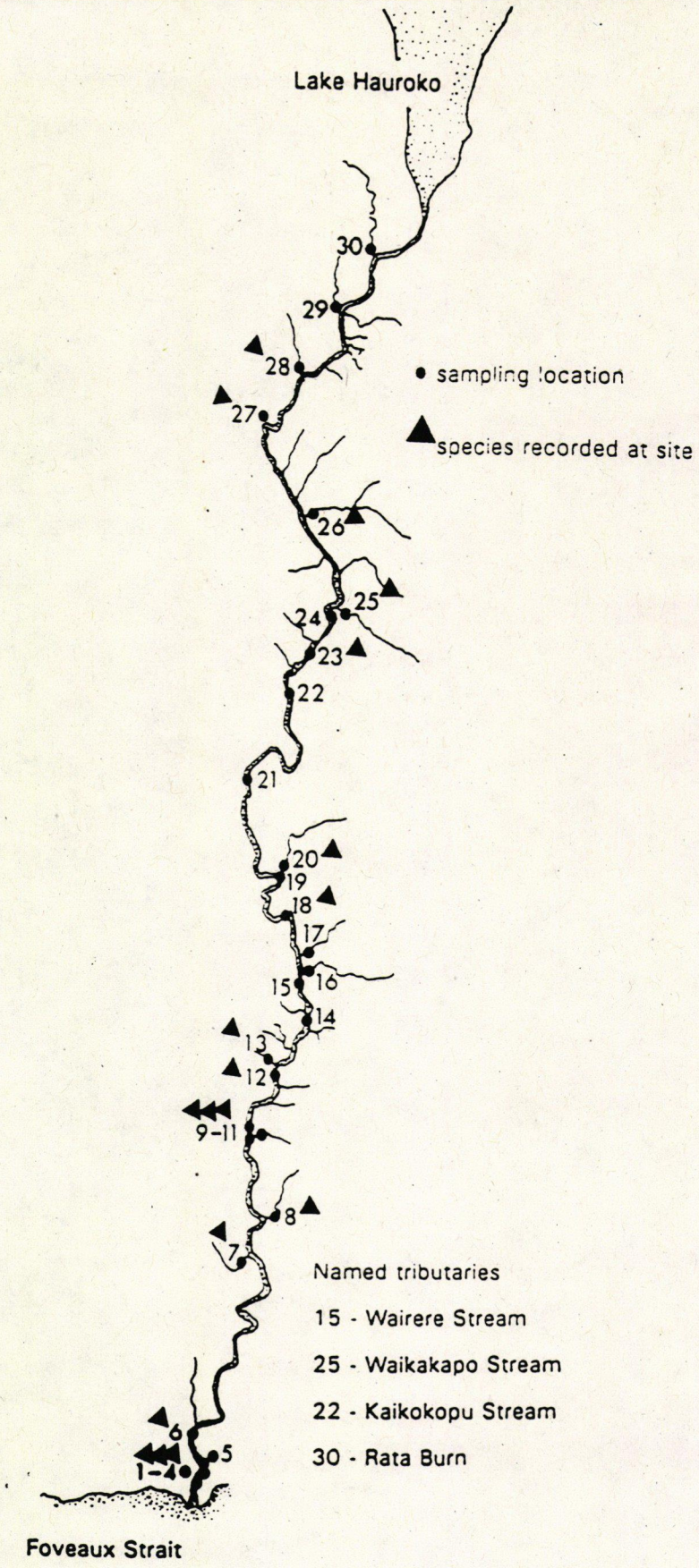


FIGURE 5 Distribution of longfinned eel, *Anguilla dieffenbachii*, in the Wairaurahiri River.

occurred very sparsely as small juveniles in riffles in the lower river, a common habitat for small longfinned eels in other rivers (Davis *et al.* 1983).

Shortfinned eel: Only one shortfinned eel was identified, at 8.9 km up stream in a tributary (Fig. 6; Table 2). The distribution of shortfinned eels in southern New Zealand is sporadic (McDowall 1990 1994); this, and the general lack of suitable, low elevation, swampy and lake margin habitats in the Wairaurahiri, means that low occurrence of shortfinned eels in the river is no surprise.

Common smelt: Common smelt were taken only in a whitebait net set at the margins of the lower river (0.3 km up stream); we also observed a small shoal of fish that we tentatively identified as smelt a little further up stream (1.0 km–Fig. 7; Table 2). There is very little pool and backwater habitat in the lower Wairaurahiri River suitable for common smelt, and though the species is known to migrate from the sea into rivers during the spring and summer, general absence from this river was no surprise owing to the sparseness of suitable habitat.

Inanga: Inanga were taken from three sites in the lower river (as far 1.0 km up stream–Fig. 8; Table 2); one of these sites was a very small, boggy, lowland tributary (site 3, Table 2). Apart from a sample of inanga whitebait taken by whitebait net, in which the species comprised only 8.8% of the catch, it was rarely encountered, probably for the same reasons as discussed above for smelt, viz. the sparseness of suitable slow-flowing pool and backwater habitat.

Banded kokopu: Banded kokopu were taken only at the whitebait stage, in a whitebait net near the river mouth (0.3 km up stream–Fig.9; Table 2) (see "Wairaurahiri River whitebait fishery", below). The species comprised 12.4% of a whitebait sample, so is obviously entering the river in significant numbers, but we found no sub-adults or adults anywhere in the river. Some of the small, forested tributaries that we examined appeared suitable for banded kokopu.

Koaro: Koaro occurred at eight sites widely throughout the river and about as often in the mainstem as in tributaries (as far as 26.8 km up stream–Fig. 10; Table 2). An NZFFD (DIA) record brings locations known for this species in the river to nine, making it the second most widespread native fish in the river. The species was almost always very sparsely present, except at the whitebait/post-whitebait stage at the river mouth and lower river–where it was by far the predominant species in the whitebait sample we obtained (78.9%). It was otherwise also quite common at the post-whitebait stage in the riffles of the lower river. It was about as often present in mainstem riffles as in the tributaries. A voluntarily lake-limited population of koaro probably occupies Lake Hauroko, as is true of most of the cool sub-montane lakes of the eastern South Island (McDowall 1990), and some of the koaro in tributaries of the Wairaurahiri River may be derived by downstream movement of stock from the lake.

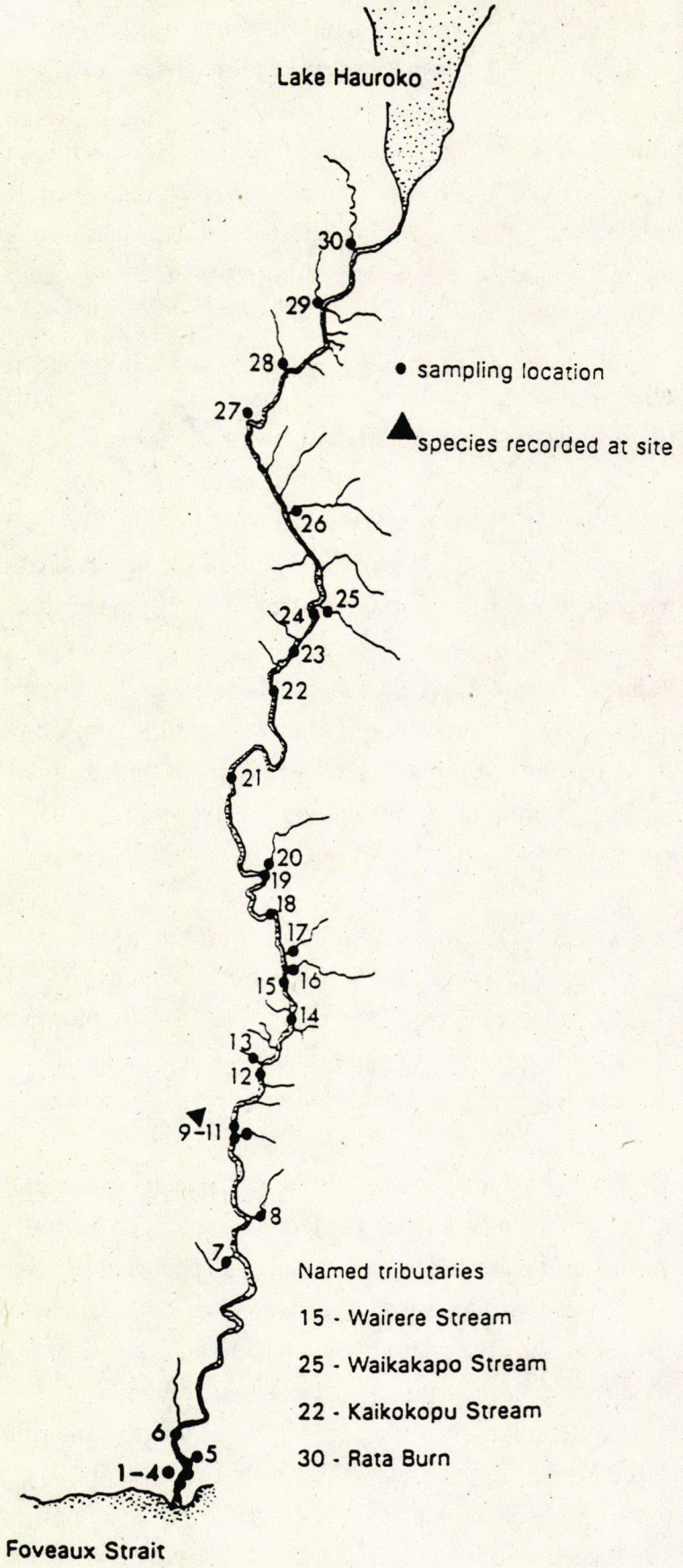


FIGURE 6 Distribution of shortfinned eel, *Anguilla australis*, in the Wairaurahiri River.

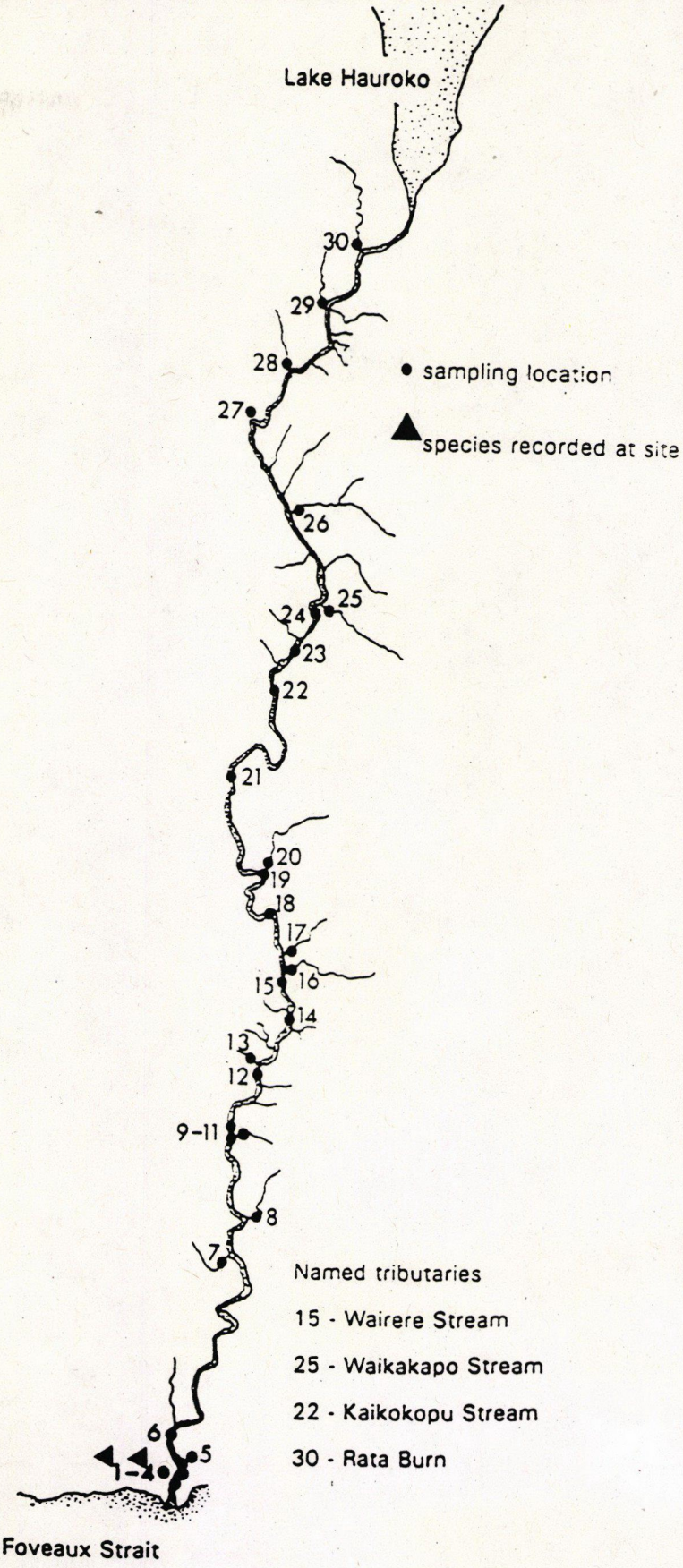


FIGURE 7 Distribution of common smelt, *Retropinna retropinna*, in the Wairaurahiri River.

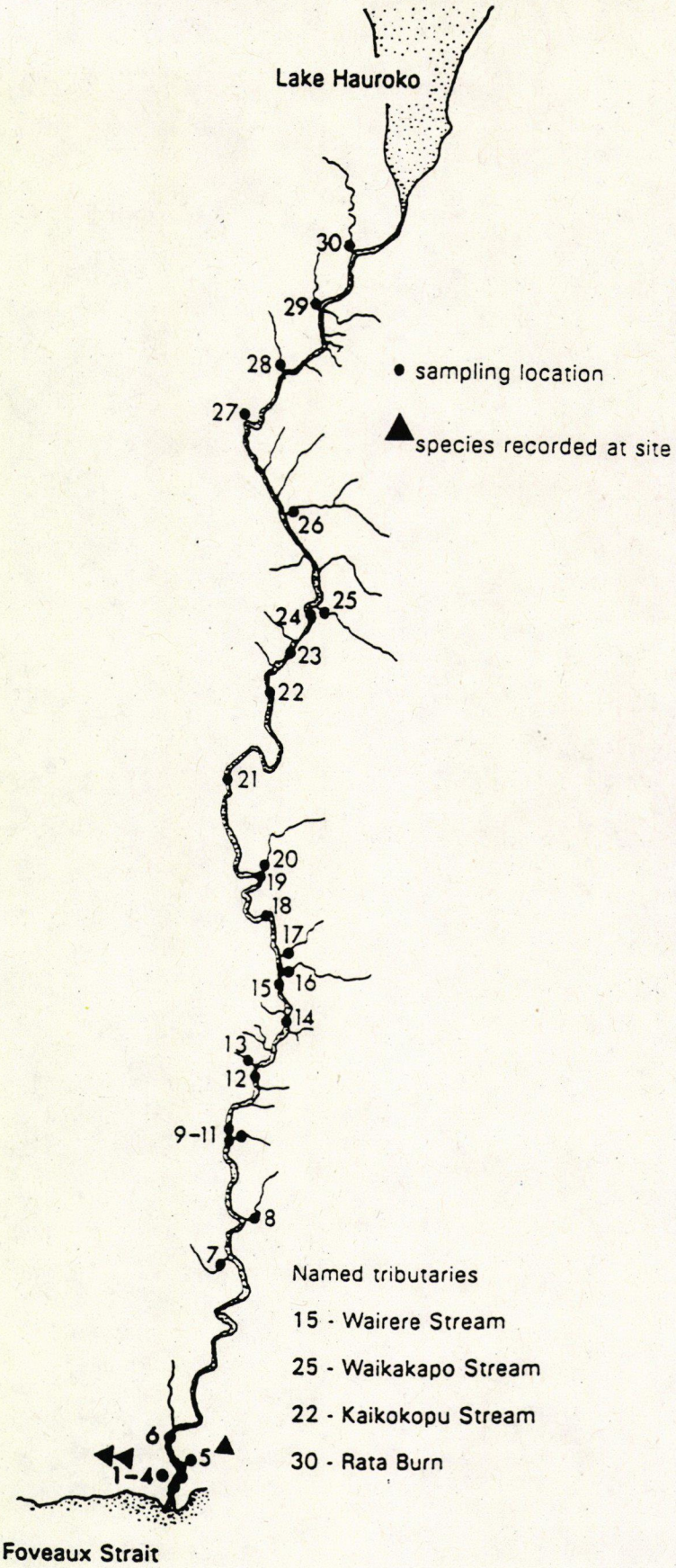


FIGURE 8 Distribution of inanga, *Galaxias maculatus*, in the Wairaurahiri River.

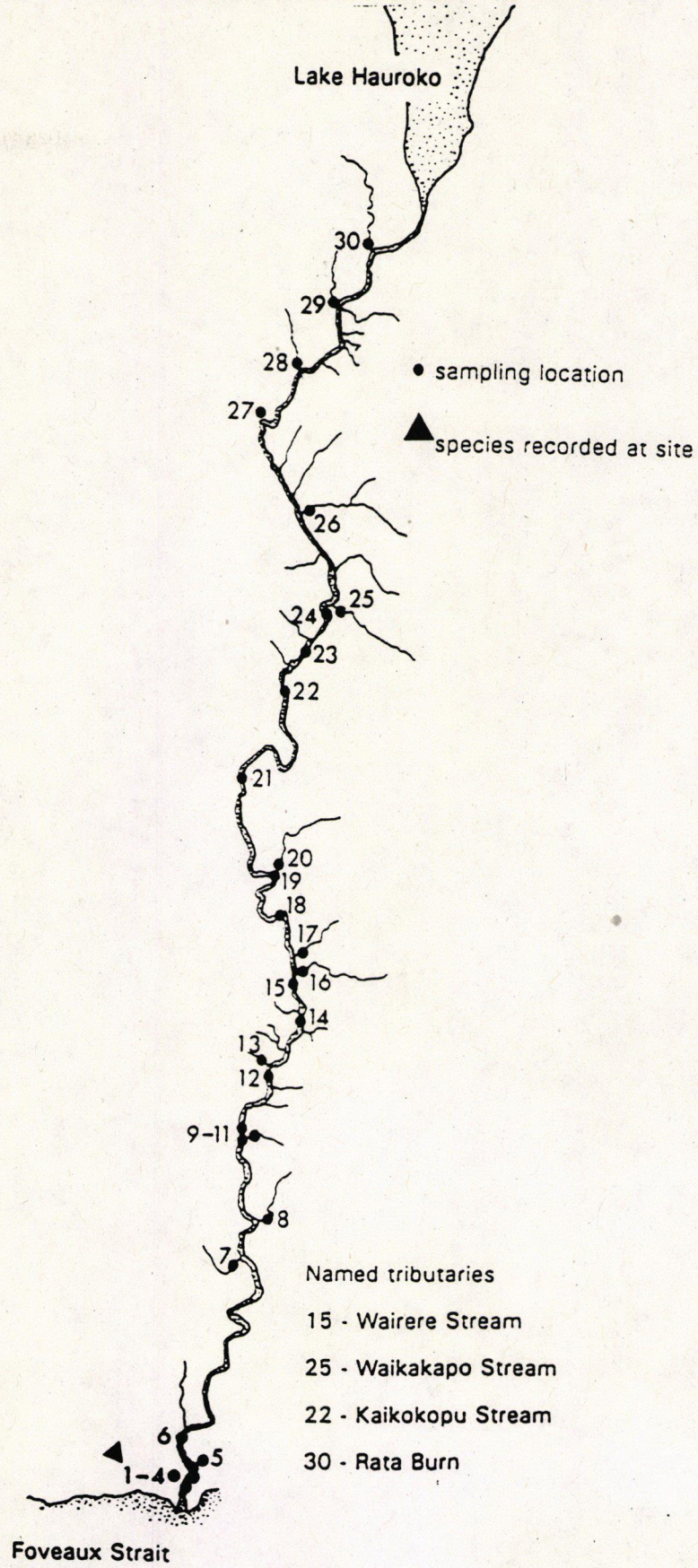


FIGURE 9 Distribution of banded kokopu, *Galaxias fasciatus*, in the Wairaurahiri River.

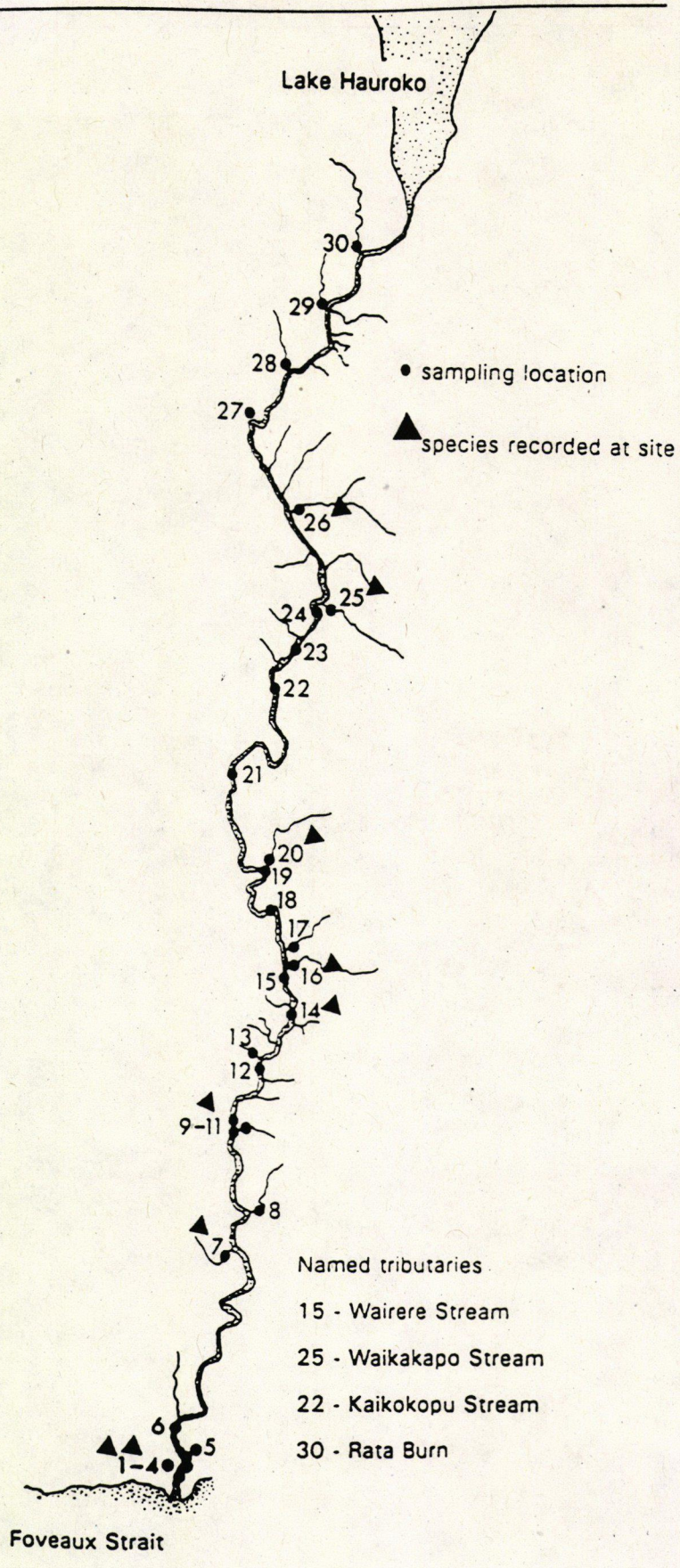


FIGURE 10 Distribution of koaro, *Galaxias brevipinnis*, in the Wairaurahiri River.

However, there is no simple way to ascertain this. Given the extensive forest cover over the river and its tributaries, and the presence of extensive reaches of bouldery riffle habitat, occurrence of koaro in the river was surprisingly sparse.

Torrentfish: Torrentfish occurred at six sites (up to 22.5 km up stream–Fig. 11, Table 2). Small juveniles (< 30 mm long) were common in a lower river riffle (< 1 km up stream and recent migrants from the sea), but in general the fish was otherwise sparsely present, even though there is very extensive riffle habitat available to torrentfish in the Wairaurahiri River.

Common bully: We took common bully at only two sites in the lower river (to 1.0 km up stream–Fig. 12; Table 2). There is an NZFFD (DIA) record 9.1 km up stream but we are somewhat dubious about the accuracy of this record. It is usually a fish of the lower rivers but was sporadic and sparse in the Wairaurahiri. It does form landlocked populations (McDowall 1990), so that common bullies could move into the river from Lake Hauroko if a landlocked population is present there. The limited, slow-flowing habitat in the Wairaurahiri River undoubtedly restricts the distribution and abundance of this species, also.

Redfinned bully: We found redfinned bully at only five sites, in addition to which there are two NZFFD (MAF and DIA) sites (up to 23.6 km up stream–Fig. 13; Table 2); it was nowhere common. It is a fish of coarse, bouldery substrates, so that there is plenty of habitat available to it in the river.

Bluegilled bully: We found bluegilled bully at seven sites, and there is an additional NZFFD (DIA) site (to 22.5 km up stream–Fig. 14; Table 2). Juvenile bluegilled bullies, recently migrated from the sea, were common (with juvenile torrentfish) in riffles in the lower river (< 1 km up stream). Bluegills otherwise occurred sparsely to commonly through much of the river. This species was confined to the mainstem, where there are huge areas of boulder/cobble riffle habitat that may be well-suited to it.

Koura: The koura (or freshwater crayfish), is the only indigenous species in the Wairaurahiri River that spends its entire life in fresh water. It occurred widely though sporadically and very sparsely, and in both the mainstem and tributaries (Fig. 15; Table 2).

Brown trout: The introduced brown trout was the most widespread and abundant fish in the river. We found it at 18 of 27 sites, and it was reported in two further NZFFD (DIA) site records (Fig. 16; Table 2). These were mostly tributary sites (13 sites), and all but three fish taken were either this year's newly emergent fry or, more often, yearlings from last year's spawnings (ca. 100 mm long). Local people who use the river report that adults of brown trout are widespread throughout the river's mainstem where they provide fruitful angling, and

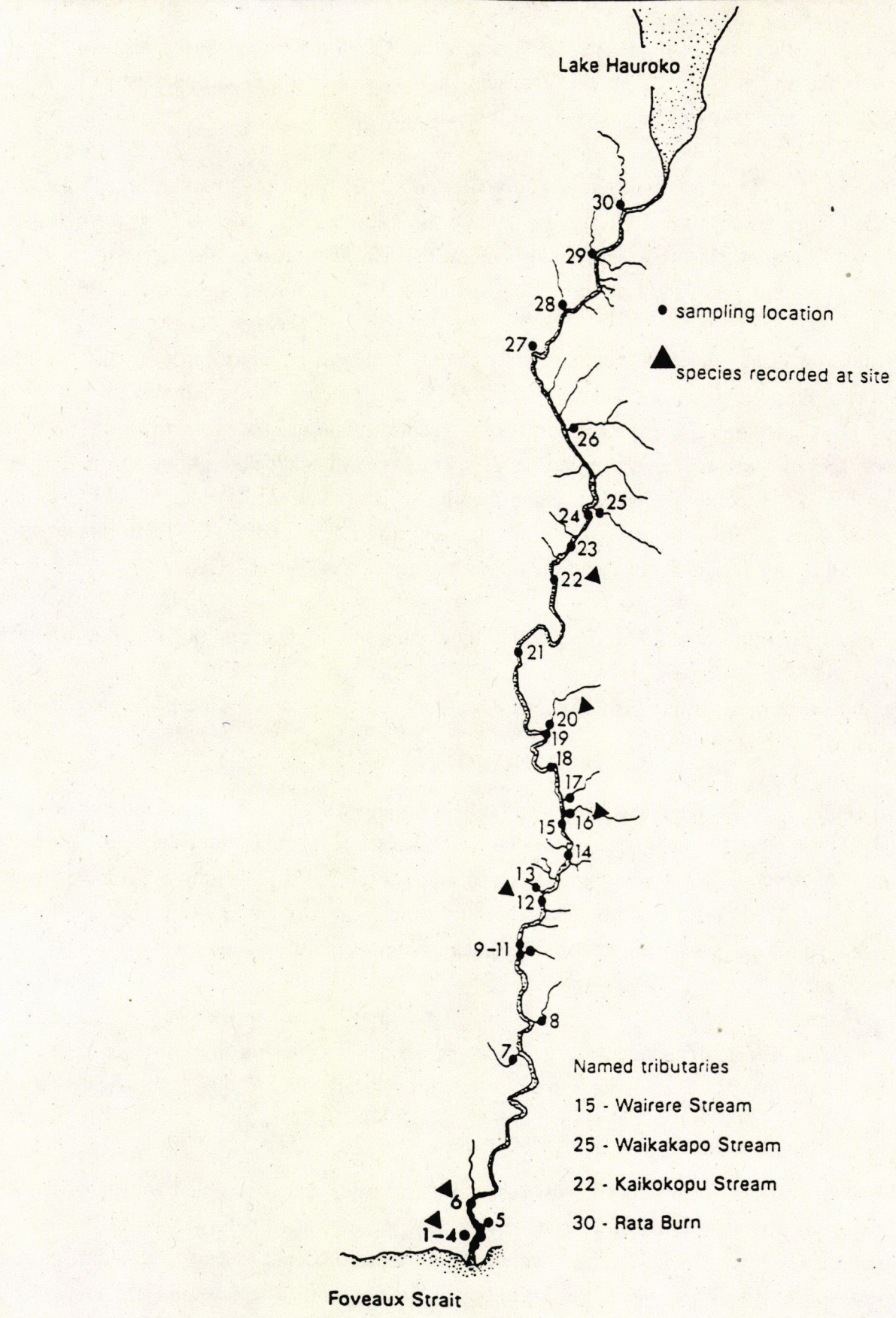


FIGURE 11 Distribution of torrentfish, *Cheimarrichthys fosteri*, in the Wairaurahiri River.

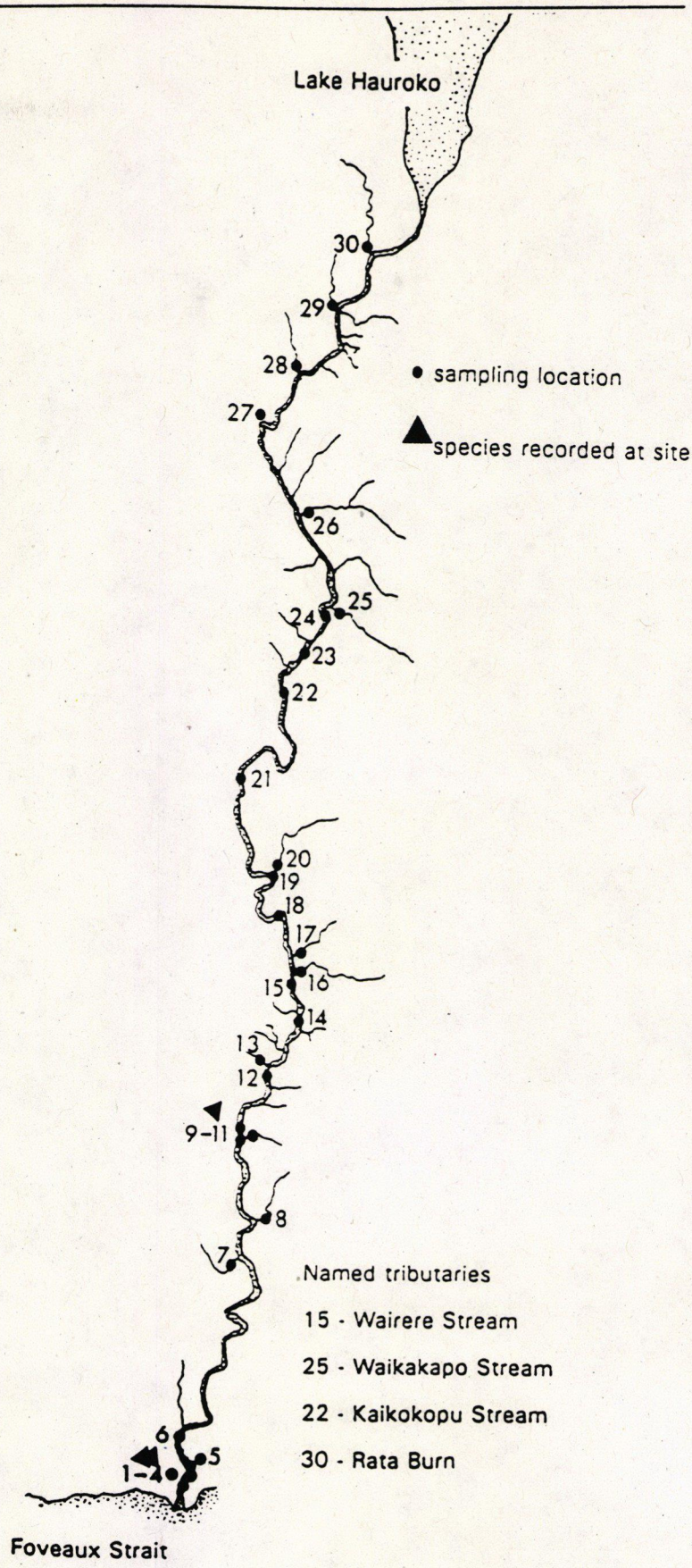


FIGURE 12 Distribution of common bully, *Gobiomorphus cotidianus*, in the Wairaurahiri River.

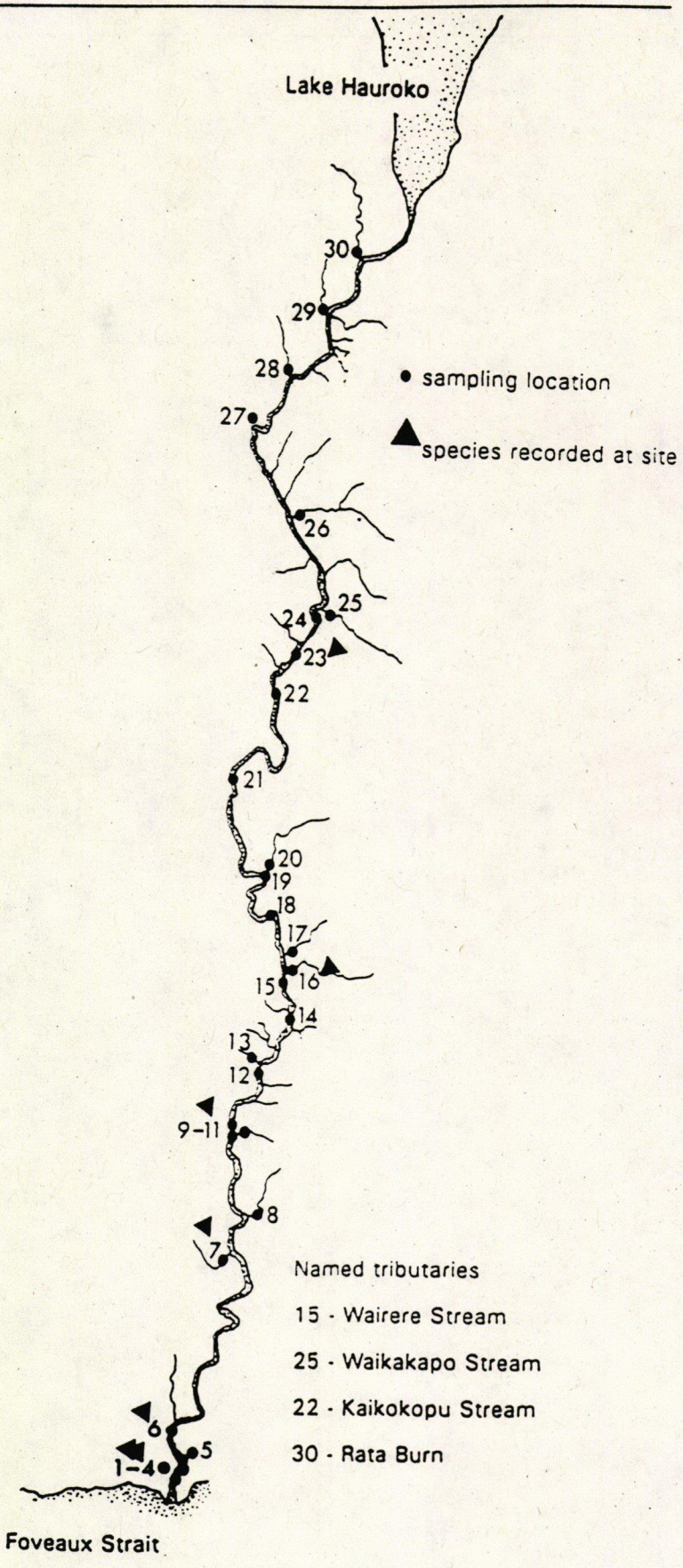


FIGURE 13 Distribution of redfinned bully, *Gobiomorphus huttoni*, in the Wairaurahiri River.

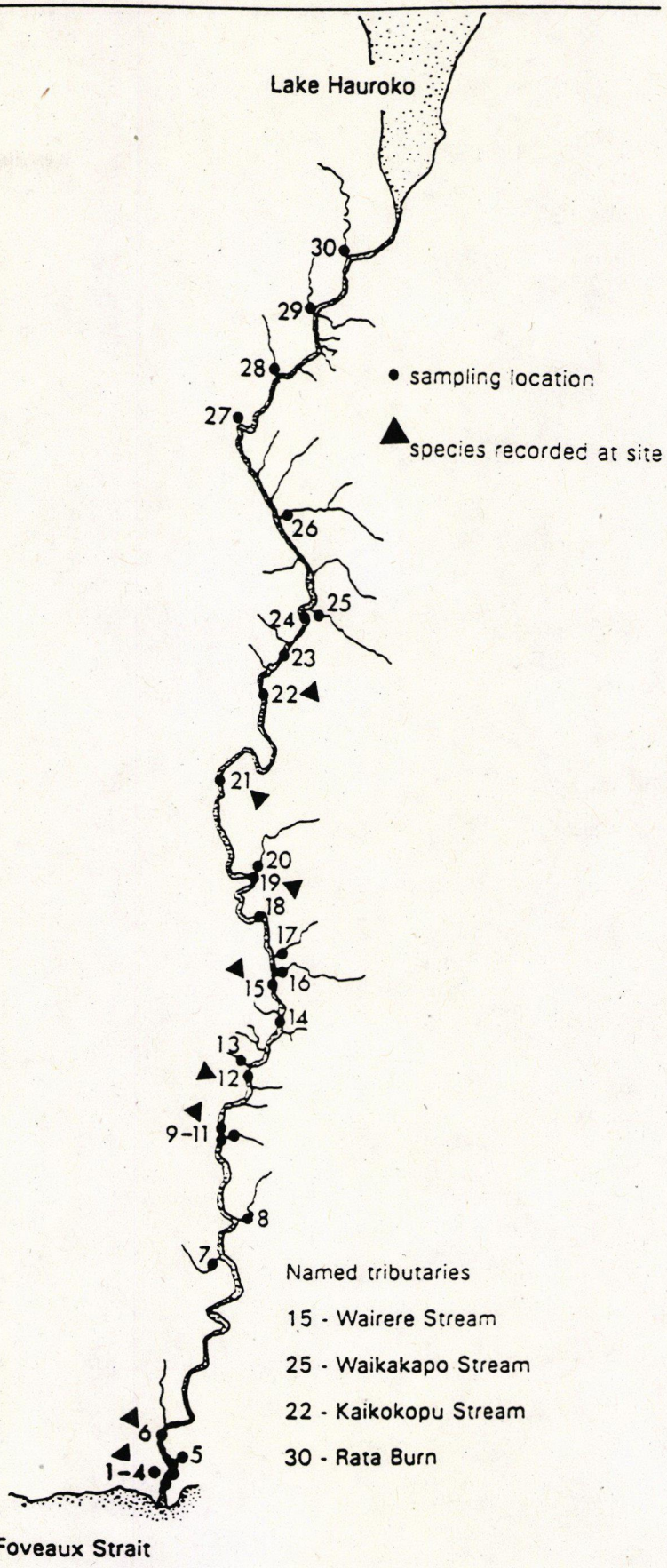


FIGURE 14 Distribution of bluegilled bully, *Gobiomorphus hubbsi*, in the Wairaurahiri River.

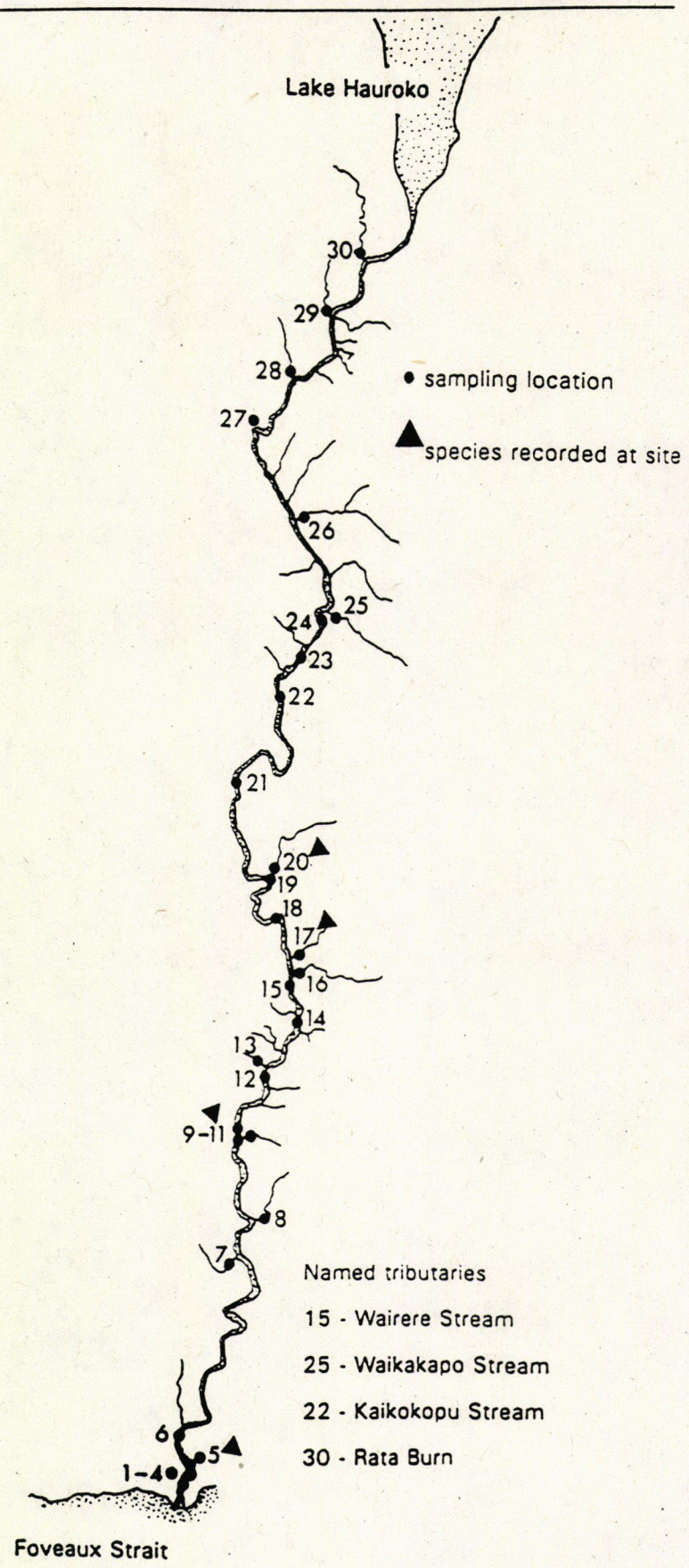


FIGURE 15 Distribuiton of koura, *Paranephrops zealandicus*, in the Wairaurahiri River.

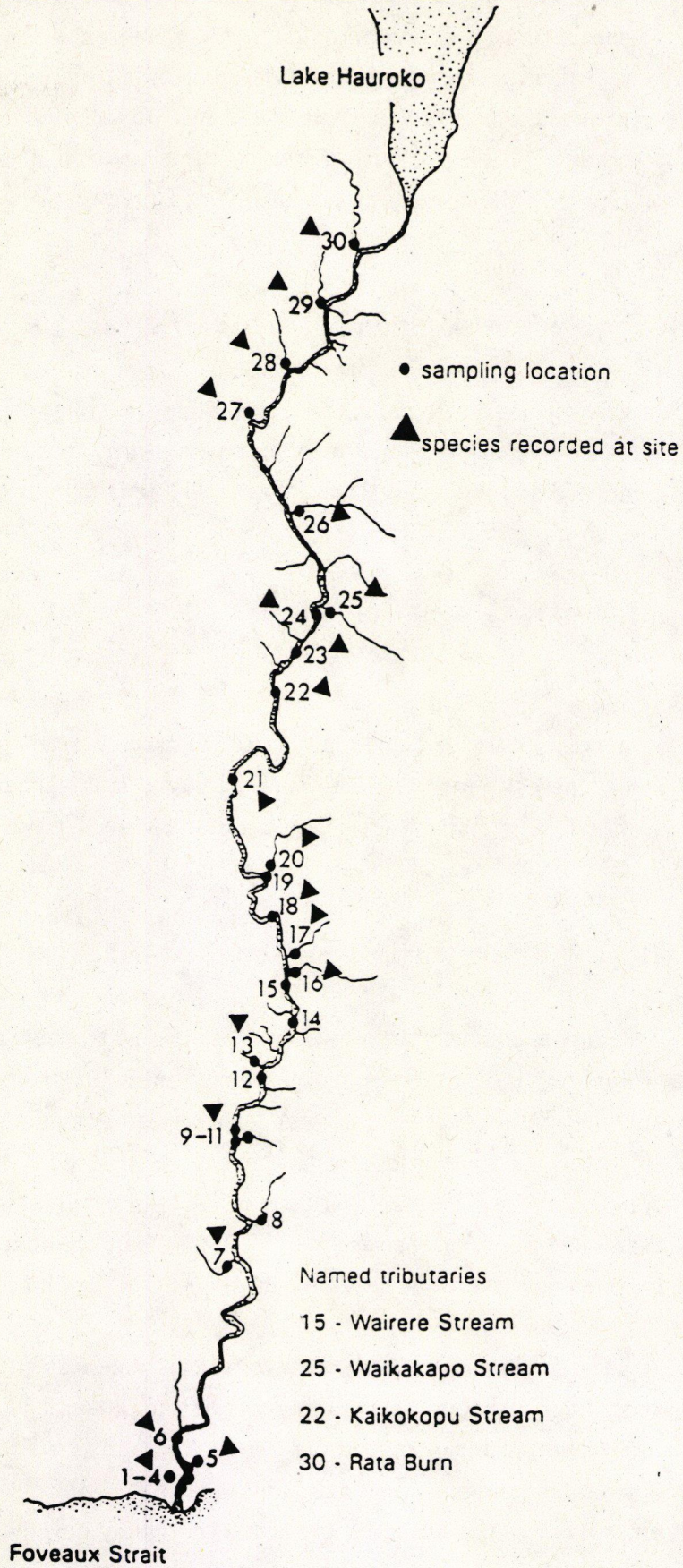


FIGURE 16 Distribution of brown trout, *Salmo trutta*, in the Wairaurahiri River.

the species is also known throughout Lake Hauroko. The migratory status of brown trout in New Zealand river systems is poorly defined, but there is clear evidence that some fish go to sea, behaving like European "sea trout" (McDowall 1990). We took one sub-adult trout in the lower river (Table 2), but otherwise found no explicit evidence for the occurrence of sea-migratory stocks in the Wairaurahiri River. However, we were not equipped to investigate this point.

4.2 Species not found in the Wairaurahiri River

Several species not found in the Wairaurahiri, that might have been expected there on the basis of occurrence in the Waiau or other rivers nearby include giant kokopu, shortjawed kokopu, roundhead and flathead galaxias, giant bully, upland bully and black flounder. Possible reasons for their absence are discussed below.

4.3 Species richness at sites

Number of species at any site varied from 0 to 8, with average 2.7 species per site. There were on average 2.4 species per site at 20 tributary sites and 3.1 species per site at 14 mainstem sites. These figures are not much different from an analysis of species richness at 276 quantitatively sampled sites throughout New Zealand in the NZFFD (3 species per site—J. Richardson, NIWA, Hamilton, pers. comm.).

4.4 Wairaurahiri River whitebait fishery

Access to the mouth of the river is possible only by foot (more than a day's tramping from the nearest road), by water (either by sea or from Lake Hauroko), or by air (there is no airstrip so only helicopter access is possible). As a result, the river is not intensively fished for whitebait. However, it can be productive at times (P.R. Roff, pers. comm.). We set a trap net about 300 m upstream from the mouth for about five hours, and took about 1.5 kg of whitebait. This was a mixture of three species (koaro—78.9%, banded kokopu—12.4% and inanga—8.8%), and included fish at various development stages. Two adult common smelt were also captured.

A sub-sample of the *Galaxias* whitebait catch was preserved for later study, and sorted according to species, as well as according to stage of pigmentation development. When they first leave the sea whitebait are highly transparent and sparsely pigmented (undoubtedly an adaptation to minimise predation by other fish in the surface plankton in the sea). Once they enter fresh water, however, pigmentation rapidly develops and the whitebait soon become no longer transparent, and eventually deeply pigmented like their respective adults. The whitebait sub-sample was sorted according to the following pigmentation criteria:

1 No fine melanophores (black spots), or only a few greyish, shadowy melanophores along back in front of dorsal fin, though there may be a few to many large, black spots, usually confined to a narrow strip along dorsal midline.

2 Fine melanophores present in a band along back, band broadest at dorsal fin origin, but narrowing towards head and may not reach head; melanophores often greyish, shadowy and ill-defined.

3 Fine melanophores in a band along back in front of dorsal fin as far forward as head, but not usually spreading down to lateral line and never present below lateral line; melanophore outlines not usually shadowy, distinctly black.

4 Back covered with fine melanophores in a broad band from head to dorsal fin origin, this pigmentation spreading down sides to lateral line, melanophores often linearly arranged along myomeres, usually with some melanophores below lateral line, particularly on caudal peduncle.

5 Whitebait obviously, visibly coloured, dusky to greenish.

These five categories represent varying amounts of time spent in fresh water since leaving the sea (time increasing from 1. to 5.). Obviously, the categories represent attempts to sub-divide a continuum, rather than identifying discrete developmental stages, so that classification of some fish is somewhat subjective and arguable. Nor is there information on the time periods spent in fresh water associated with each of the above five stages.

Classification of the sample, by species, and by the above pigmentation stages, is shown in Table 3. This indicates that koaro whitebait (78.8%) predominated in the catch, followed by banded kokopu (12.4%) and inanga (8.8%). It also shows distinct differences between the species in the proportions of the catch at each pigmentation stage. Inanga whitebait were, with one exception, all stage 1 fish, representing recent migration from the sea. Banded kokopu were also largely stage 1 fish (61.9%), with a few fish at stages 2-5. By contrast, koaro whitebait comprised a distinct minority of stage 1 fish (3.4%) with the highest proportion of the sample being stage 4 (35.4%). The more advanced pigmentation stages (3-5) comprised 77.6% of the koaro in the sample.

TABLE 3 Composition of whitebait sample, Wairaurahiri River, 26.10.95.

Pigmentation status		Species					
		inanga		banded kokopu		koaro	
1	No	29		26		9	
	%		96.7		61.9		3.4
2	No	0		4		51	
	%		0		9.5		19.0
3	No	0		3		65	
	%		0		7.1		24.3
4	No	0		5		95	
	%		0		11.9		35.5
5	No	1		4		46	
	%		3.3		9.5		78.8
Total		30		42		268	340
% of sample			8.8		12.4		78.8

5.0 DISCUSSION

5.1 The river's fauna in local and regional context

The Wairaurahiri River, overall, carries a moderately diverse freshwater fish fauna. Based on a general knowledge of the distributions of New Zealand's freshwater fishes (McDowall 1990), most of the species that might be predicted to occur there were found in our survey. Amongst the diadromous (sea-migratory) species in the fauna, shortjawed kokopu might have been expected, and certainly is present in the Percy Burn, and Edwin Burn which enter Foveaux Strait about 7 and 6 km east of the mouth of the Wairaurahiri River, and in Crombie Stream and an unnamed stream about 3 and 16 km west of the Wairaurahiri, respectively (NZFFD records). We know of no reasons relating to habitat suitability that would exclude shortjawed kokopu from the Wairaurahiri River, though the species is everywhere rare (Tisdall 1994). Giant kokopu is widely present across Southland to the east of the Wairaurahiri though it is not recorded from any of the streams named above immediately east of the river. It does occur in a tributary of Lake Poteriteri and in the Aan River 10 and 18 km west of the Wairaurahiri (NZFFD records). It is absent from the Wairaurahiri, but we encountered no habitats that appeared suitable (deep-water, slow-flowing, heavily-vegetated, swampy streams and lagoon margins with plentiful instream cover). Giant bully has been recorded occasionally from Southland streams (McDowall 1990), but not from the streams of Fiordland, including the

Wairaurahiri River, and not from the Waiau (McDowall 1994). It may be absent from all of these waters, though sampling techniques that we used, and that have been used in nearly all sampling in Fiordland (mostly electric fishing and usually with low-powered, battery-operated back-portable machines), are ill-suited to the capture of giant bullies, that most often live in tidal estuaries and lower river reaches where water conductivities tend to be high. Black flounder abounded in the estuary of the Waiau River (McDowall 1994) but was not found in the Wairaurahiri, probably because there is no suitable tidal estuary for the fish to occupy, perhaps, also, because our sampling did not extend right to the river mouth, though there are really no suitable habitats for this fish there.

5.2 The absence of non-diadromous species

Several non-diadromous fish species (that are confined to fresh water throughout their life histories) occur widely across Southland. These include two species of the "common river galaxias" species group (flathead galaxias and roundhead galaxias), as well as alpine galaxias, and upland bully (Table 1). None of these species has hitherto been recorded west of the Waiau River (McDowall 1990, 1994) and none was taken in the Wairaurahiri River, which is the next major river catchment west of the Waiau. Thus the Waiau seems to be the western limits of all of these species (except alpine galaxias which extends no further west than the upper Oreti–McDowall 1990). The apparent absence of these species from the Wairaurahiri is likely due more to historical/geological causes, such as the Pleistocene glaciations that formed Lake Hauroko, or even earlier Tertiary marine submergence (Stevens 1980), than to ecological reasons such as habitat suitability and migratory access.

5.3 Fish abundance

In some contrast with the about-predictable species diversity in the Wairaurahiri River, fish abundance there was very low. In many instances sampling sites produced just a single fish of a species, occasionally two or three, and seldom more; in 38 of 51 species/site records, abundance was ranked as "present" or "occasional" ("p" or "o" in Table 2). Moderate abundance was encountered only in the lowest riffles, which were heavily dominated by recently-immigrated juveniles of koaro, torrentfish and bluegilled bullies; these constituted six of 13 species/site records that were ranked as "common" ("c" in Table 2). This scenario, of:

- moderate abundance of juvenile life stages in the lower reaches
- moderate species diversity but low fish abundance further upstream

is familiar to us from a similar survey of the fish fauna of the Waiau River (McDowall 1994), and seems consistent with what little is recorded about the faunas of other rivers in Southland such as the Oreti and Mataura. At no site were longfinned eels present in substantial numbers,

in contrast with the Waiau River, where this species was abundant below the Mararoa Weir, and also in Excelsior Creek (McDowall 1994). Nor was common smelt abundant anywhere in the Wairaurahiri River.

The fish fauna of the Wairaurahiri River is perhaps similar to that of the Waiau, for similar reasons. The geographical location of the Wairaurahiri River, which discharges into Foveaux Strait, is essentially similar to that of the Waiau. The Wairaurahiri differs from the Waiau in having a steeper overall gradient (Fig. 2), in having lower flow variability, and in lacking a substantial tidal estuary. But both rivers discharge directly to sea at such gradient that there is apparently no reversal of flow through the river mouth at high tide. This is not unique, but is shared by some of the rivers of the Canterbury Plains, such as the Rakaia and Rangitata, and both of these latter rivers have steep gradients (Fig. 2–Rakaia River). Both also have fish faunas of comparable species richness to the Waiau and Wairaurahiri. But, in spite of having much less stable beds than the Wairaurahiri and Waiau, the Rangitata and Rakaia have prolific riffle-dwelling fish faunas dominated by juvenile longfinned eels, torrentfish, and bluegilled bullies (Davis *et al.* 1983; Bonnett 1986), species that occur, but are very sparse, in both the Waiau and Wairaurahiri Rivers. Both east coast rivers also have prolific occurrence of smelt in their estuaries and lower reaches (Eldon and Greager 1993). McDowall (1994) hypothesised that the impoverished nature of the Waiau River fauna was related to oceanographic conditions in Foveaux Strait, in essence that the small juveniles of some species, particularly torrentfish and bullies, have difficulty returning to river mouths from the sea. What we found in the Wairaurahiri is consistent with this hypothesis, and may be interpreted as corroboration of it.

5.4 Composition of Wairaurahiri River whitebait

The proportion of koaro whitebait in our sample (78.9%) was unusually high compared with most other rivers (McDowall 1965, 1994; McDowall and Eldon 1980). A single whitebait sample taken from the Waiau River, only a few kilometres east of the Wairaurahiri, contained only 7.6% koaro (McDowall 1994). However, the high proportion of koaro whitebait for our Wairaurahiri sample is not unique. At some times rivers in South Westland may have similarly high proportions of koaro, especially after floods when the river waters still remain somewhat turbid (McDowall and Eldon 1980). Specifically, McDowall and Eldon (1980) showed that proportions of koaro in the whitebait catches of South Westland rivers tended to be much higher after floods, and to decline as rivers returned to normal levels and normal clarity. High, flood-generated flow levels and turbidities are not an explanation for high proportions of koaro whitebait in our Wairaurahiri whitebait catch as the river was clear at the time of capture and probably is most of the time.

Rowe *et al.* (1992) reported that koaro whitebait comprised more than 70% of the whitebait catch in the Motu River, eastern Bay of Plenty, and noted that this was distinctly higher than in other rivers of the Bay of Plenty. The Motu and Wairaurahiri Rivers resemble each other in having catchments that are heavily dominated by indigenous forest associations. They differ, however, in that the Motu was shown to have high densities of adult koaro in its headwaters (Rowe 1981), whereas the same cannot be said for the Wairaurahiri, where we found few adult koaro. Rowe *et al.* (1992) suggested that the high proportions of koaro whitebait in the Motu River whitebait catch may have been due to "chemosensory recognition of conspecifics", i.e. odours emitted by adult koaro in the Motu River tributaries may have attracted koaro whitebait into the river. Our data on the Wairaurahiri provide no support for such a mechanism. However, it is possible that there are dense populations of koaro of lacustrine origins in Lake Hauroko, which is the source of most Wairaurahiri River water, and if so, this may provide an explanation for high numbers of koaro in the Wairaurahiri River whitebait catch. Our data are based on only one sample on one day, and could be regarded as abnormal. Studies of the responses of koaro whitebait to water with and without conspecific adults are needed to clarify/corroborate the hypothesis of attraction of its whitebait in response to the upstream presence of conspecifics.

Differences in the proportions of the various pigmentation stages of the three whitebait species clearly indicate differences in the behaviour of the fish at migration, and suggest that inanga and banded kokopu whitebait move upstream more directly and rapidly than those of koaro. This is consistent with our capture of whitebait of only koaro in the riffles in the lower Wairaurahiri (Table 2). It is also consistent with observations by McDowall and Eldon (1980) that the whitebait of koaro settle in the riffles of lower rivers after leaving the sea and during their eventual movement upstream into adult habitats.

5.5 Upstream penetration

Distances that the various species penetrate up stream vary greatly and probably relate primarily to behavioural characteristics of the fish rather than to variation in habitat suitability. When species are listed in order of the distance that they penetrate upstream in the Wairaurahiri River (Fig. 17) the sequence is comparable to what would be predicted from studies in other rivers (Hayes *et al.* 1989; McDowall 1993), i.e. longfinned eels penetrated farthest, followed in varying order by bluegilled bullies, torrentfish and koaro, and then perhaps lamprey and redfinned bully, with common bully, inanga and smelt confined to the lowest reaches of the river.

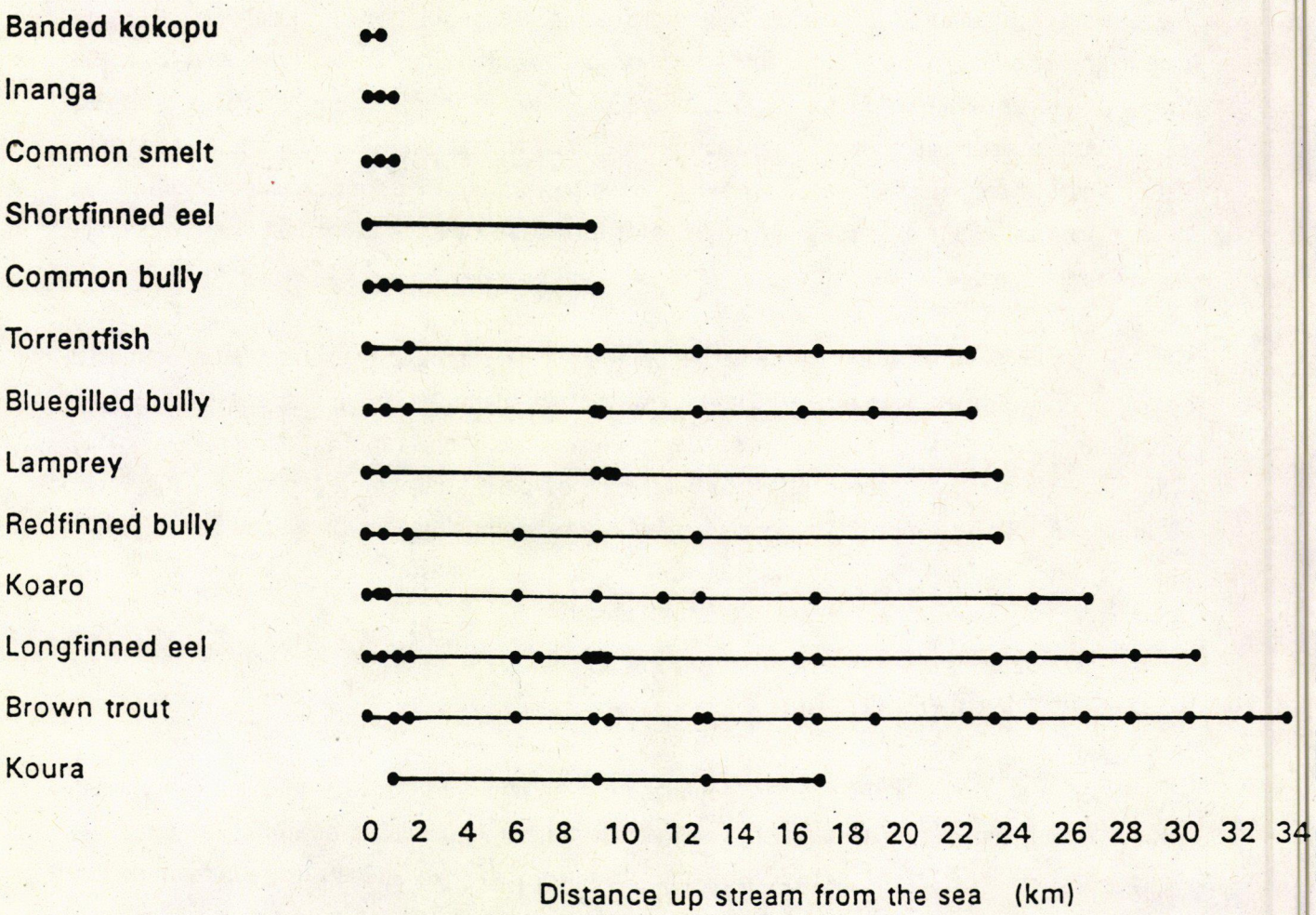


FIGURE 17 Upstream penetration by fish species in the Wairaurahiri River (dots indicate locations for capture of each species; all species but koura begin at 0 km in view of their habitual movements to and from the sea).

5.6 Problems in sampling the Wairaurahiri River fish fauna

Owing to the depth and flow velocities of the river, there are very extensive areas of habitat that are essentially unfishable without the application of specially developed means of catching fish. Most of the river is inaccessible to normal methods of capture, and the point needs to be made that these could, in theory, harbour large numbers of fish. We think this probably unlikely. We intensively fished areas of habitat from the river margins to water as deep and fast as could be safely managed by wading. There was no indication that the range of species was changing significantly with water depth, or that either the frequency of occurrence or the abundance of any fish species was increasing towards the upper depth and velocity limits of our work. Hence there is no indication that we were fishing at the lower margins of either water depths or flow velocities favoured by fish species present in the river. Adult brown trout, which we never captured from the river's mainstem flows, do occur in the deep runs in the river (P.R. Roff, pers. comm.), but we are aware of no other species that is either known or suspected of occurring in the deeper waters of the river and which we did not encounter at all.

5.7 Implications for the Waiau River and its impoundment and control

Concerns have been voiced that the impoverished nature of the Waiau River might be due to modification of that river's flows as a consequence of impoundment of the outlet of Lake Manapouri, and a resultant reduction in flows down the river and an increase in the magnitude of its flow fluctuations. Patrick and Woods (1995) even speculated, though without any supporting evidence, that Stokell's smelt may have been extirpated from the lower Waiau as a result of the hydro-electric development of the upper river. The fauna of the Wairaurahiri River is generally similar in species richness and fish abundance to that of the Waiau. Unlike the Waiau, the Wairaurahiri is totally unmodified (both catchment and flows), and retains its natural flow volumes and fluctuations. Being a lake outlet river with only minimal tributary inflow below the lake outlet, it is likely that it has much more stable flows and substrates than the Waiau has had since impoundment at the Mararoa Weir. Notwithstanding these apparent habitat benefits, the fauna of the Wairaurahiri River is comparable in species richness and abundance to that of the Waiau. These similarities could be coincidence, or they could be due to the same causal factors. In that case low species richness and fish abundance are unlikely to have anything to do with the human modifications of the flow patterns of the Waiau.

Thus, overall, this distinctive river, with its rapid fall and swift flows, its lack of human modification, and its retention of original catchment and riparian vegetation, has a fish fauna much as would be predicted from knowledge of the fish faunas of other rivers in Southland, such as the Waiau, that have been severely modified - a fauna that is moderately speciose but

characterised by low abundance of most species present. Compared with the rivers further east in Southland, the distinctive feature of its fauna is the absence of the non-migratory species such as flathead and roundhead galaxias and upland bully.

6.0 Acknowledgements

This study was funded by the Waiau River Working Party, convened by the Electricity Corporation of New Zealand. Paul Roff, Wairaurahiri Wilderness Jet, provided transport on the river, and we appreciated his knowledge of the river and skills in navigating what the former New Zealand Forest Service once described as "this dangerous river". Lindsay Chadderton, Department of Conservation, Invercargill was involved with the field sampling, and we enjoyed his company and benefited from his enthusiasm and commitment to the work. Maurice Duncan, NIWA, Christchurch, extracted historical hydrological data on the Wairaurahiri River and Evan Baddock,, NIWA, Dunedin provided an estimate of flows in the river during late October 1995.

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