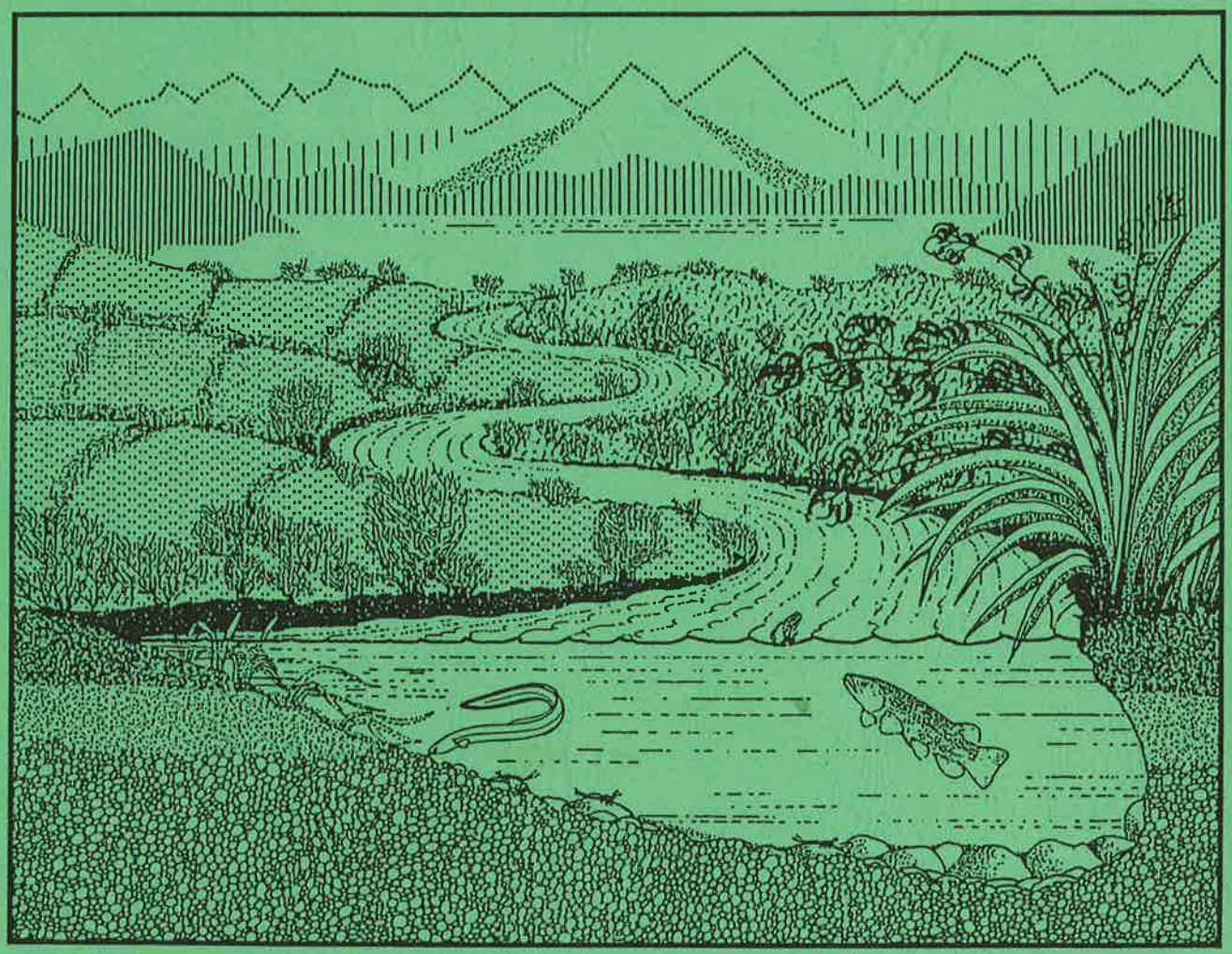
ISSN 0113-2504

New Zealand Freshwater Fisheries Report No. 114

Quinnat salmon spawning in the Waimakariri catchment



MAF Fish

New Zealand Freshwater Fisheries Report No. 114

Quinnat salmon spawning in the Waimakariri catchment

by

C.J. Hardy

Freshwater Fisheries Centre

MAFFish

Christchurch

September

1989

NEW ZEALAND FRESHWATER FISHERIES REPORTS

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ISBN 0-477-08182-7

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SUMMARY

Pioneer work on the natural reproduction of quinnat salmon in New Zealand was first done in the 1930s, in the Waimakariri catchment. One of the sites where this research was carried out was Winding Creek, an important spawning site for salmon, particularly in its upper reaches.

Between 1976 and 1984, Winding Creek was trapped regularly to supply eggs for MAF's hatchery at Silverstream. In 1979, a permanent trap was installed and thereafter, until 1984, the annual run of salmon into the stream was monitored between the beginning of April and the middle to end of June each year.

Annual numbers of migrant salmon varied between 169 and 3045. By comparison, the range recorded in Glenariffe Stream (a major spawning tributary of the Rakaia River) was 522 - 2887 over the same period. Low-run and high-run years in Glenariffe Stream coincided closely with those in Winding Creek.

The mid-point of the Winding Creek run was about 15-16 May, some two weeks later than in Glenariffe Stream, and about 10 days later than the mid-point of the run into Silverstream hatchery in the lower Waimakariri basin. The mid-point of the entry of salmon into the Waimakariri River from the sea appeared to be the middle of March, indicating a mean migration time of about eight weeks from the coast to Winding Creek.

The age structure of Waimakariri quinnat salmon was generally similar to that found in other east coast salmon rivers, with 3-year-old fish comprising the dominant age class and no fish over five years old. Salmon in Winding Creek were of similar size to those recorded at Glenariffe.

Examination of scales from angler-caught salmon from the mainstem of the Waimakariri River, and from fish trapped in Winding Creek, showed a high incidence of "stream type" nuclei. This type of scale nucleus is found in fish that spent most, or all, of their first year of life in fresh water, before migrating to sea. Almost two-thirds of all scales collected from Waimakariri salmon have this type of nucleus. Scales from Waitaki River salmon show an incidence of scale type similar to that of Waimakariri salmon. In contrast, the majority of scales taken

from salmon in the Rakaia and Rangitata Rivers have "intermediate" type nuclei, indicating that, as juveniles, these salmon spent only a few months in fresh water. These differences may reflect differences in the relative stability of the river habitat occupied by juvenile salmon before they migrate.

Salmon spawning in the Waimakariri basin is distributed over a number of tributaries, mostly small, but which collectively comprise about 42% of all known spawning areas. Winding Creek and streams on the Poulter River flats account for the remainder. However, there are tributaries of the Waimakariri where spawning has never been assessed accurately. The relative importance of these streams for salmon spawning must vary from year to year, because access to them is changeable depending on conditions in the main river.

1. HISTORICAL BACKGROUND

In the period 1875-1878, four importations of quinnat salmon (Oncorhynchus tshawytscha (Walbaum)) eggs - then popularly known as "California salmon" - were made into New Zealand from the United States Fish Commission's McCloud River salmon breeding station in northern California (Stone 1885, 1896; Thomson 1922). They were distributed to acclimatisation society hatcheries throughout New Zealand and to a government hatchery in Southland. Fry and juvenile salmon were liberated in numerous waters in both the South and North Islands (Thomson 1922).

In early 1877, 20 000 fry were released into the Waimakariri River from a shipment of eggs hatched in the Gardens Hatchery of the Canterbury Acclimatisation Society in Christchurch. A further 10 000 fry were released into the river from a second shipment of eggs received at the end of 1877. Releases also were made into the Rakaia and Rangitata Rivers (Thomson 1922, Lamb 1964).

A view has been expressed by Thomson (1922), Allen (1956), and McDowall (1978) that these first introductions were unsuccessful, because they were scattered in distribution and involved relatively small numbers of fish. However, occasional specimens of adult quinnat salmon were reputedly caught by anglers and in nets in the lower

Waimakariri River before the turn of the century. Their identity was established locally by people familiar with the species back in California. One of three fish sent from the Waimakariri to the South Kensington Museum, London in 1884 was identified by Dr A. Gunther as a quinnat salmon (Farr 1885, Lamb 1964), the other two were brown trout (Salmo trutta Linnaeus). L.F. Ayson (1899), later responsible for further introductions, mentioned the presence of quinnat salmon in the Waitaki River at that time in a report to the New Zealand government.

In 1901, the New Zealand Marine Department began a second, systematic attempt to establish the species. A hatchery was constructed on the Hakataramea River (a tributary of the Waitaki River) to which shipments of quinnat eggs came from the Sacramento River, California, from 1901 until 1907 (Ayson 1910, Thomson 1922). Although liberations of the juveniles hatched and reared from these eggs were made solely into the Waitaki River system, the fish soon began to spread up the east coast and had reached the Waimakariri before 1916 (Allen 1956).

Winding Creek, or, as it was once called, Windy Creek, is a tributary of Broken River, which is itself a tributary of the Waimakariri River, North Canterbury. A pioneer study of the natural reproduction of quinnat salmon was carried out in Winding Creek, Slovens Creek, and Broken River (all Waimakariri River tributaries) by D.F. Hobbs during 1932/33 (Hobbs 1937). From this study came the first documented report of adult quinnat salmon from the upper Waimakariri River system. Mr J.H. Kidd of Avoca wrote to Hobbs in November 1933 reporting "I first saw quinnat salmon in Broken River two years after I came to Avoca, in very small numbers". This would be in 1922, for Mr Kidd stated that he had lived at Avoca for 13 years.

Kidd's report does not necessarily mean that 1922 was the first time that sea-run quinnat salmon had entered the area. It is remote and mountainous country, lightly populated (even today), and in Kidd's day was occupied mainly by a scattering of people working a few high country pastoral runs (like him), or involved with maintenance of the crude road linking Canterbury with the West Coast via two alpine passes (Porters and Arthurs), or with operation of the Midland railway line, which was completed in 1923.

During the early 1920s, there was conjecture in acclimatisation society circles as to whether quinnat salmon could pass through the upper Waimakariri into the river's higher reaches. At Easter 1926, one councillor, G. Bryant Hobbs, had an adventurous trip with his brother down the river from Cora Lynn to Whites Bridge. He saw no sign of salmon in the upper river, despite crystal-clear water conditions. Because of the steepness and turbulence of several rapids encountered in the upper gorge, he believed it improbable that salmon would be able to pass through, although he conceded that there had been reports of their presence in the upper river (Hobbs, cited in Holden 1984). While the rapids and turbulent whirlpools of the rock-girt upper gorge impressed and bothered river travellers, no waterfall or cataract impeding or obstructing the passage of salmon existed. It is possible that salmon had passed into the upper river in earlier years, but either had not been noticed or not been remarked upon, and that by 1922 they were already utilising the same waters throughout the Waimakariri system as they do today.

No further liberations of quinnat salmon into the Waimakariri River occurred until 1963, when the North Canterbury Acclimatisation Society (NCAS) began a project to enhance the spawning run into Slovens Creek. Over four years (1963, 1964, 1965, and 1968) a total of 154 850 hatchery-reared juvenile salmon, obtained from eggs collected from the Rangitata and Rakaia Rivers, were released into Lake Hawdon. No results from this project have been reported, and it is not known if any enhancement eventuated.

2. WAIMAKARIRI CATCHMENT

The Waimakariri River system has been described extensively by Speight (1928), Dalmer (1971), and the North Canterbury Catchment Board and Regional Water Board (1986). It is an alluvial river, which flows about 150 km from its headwaters on the eastern slopes of the Southern Alps to discharge into the Pacific Ocean in Pegasus Bay (Fig. 1). Of its 3564 km^2 total catchment, 2490 km^2 are in the mountainous headwaters and are drained by the major contributary rivers Waimakariri, Bealey, Hawdon, Andrews, Poulter, Esk, and Broken. For much of its upper reaches, the mainstem Waimakariri occupies a wide, braided, gravel bed

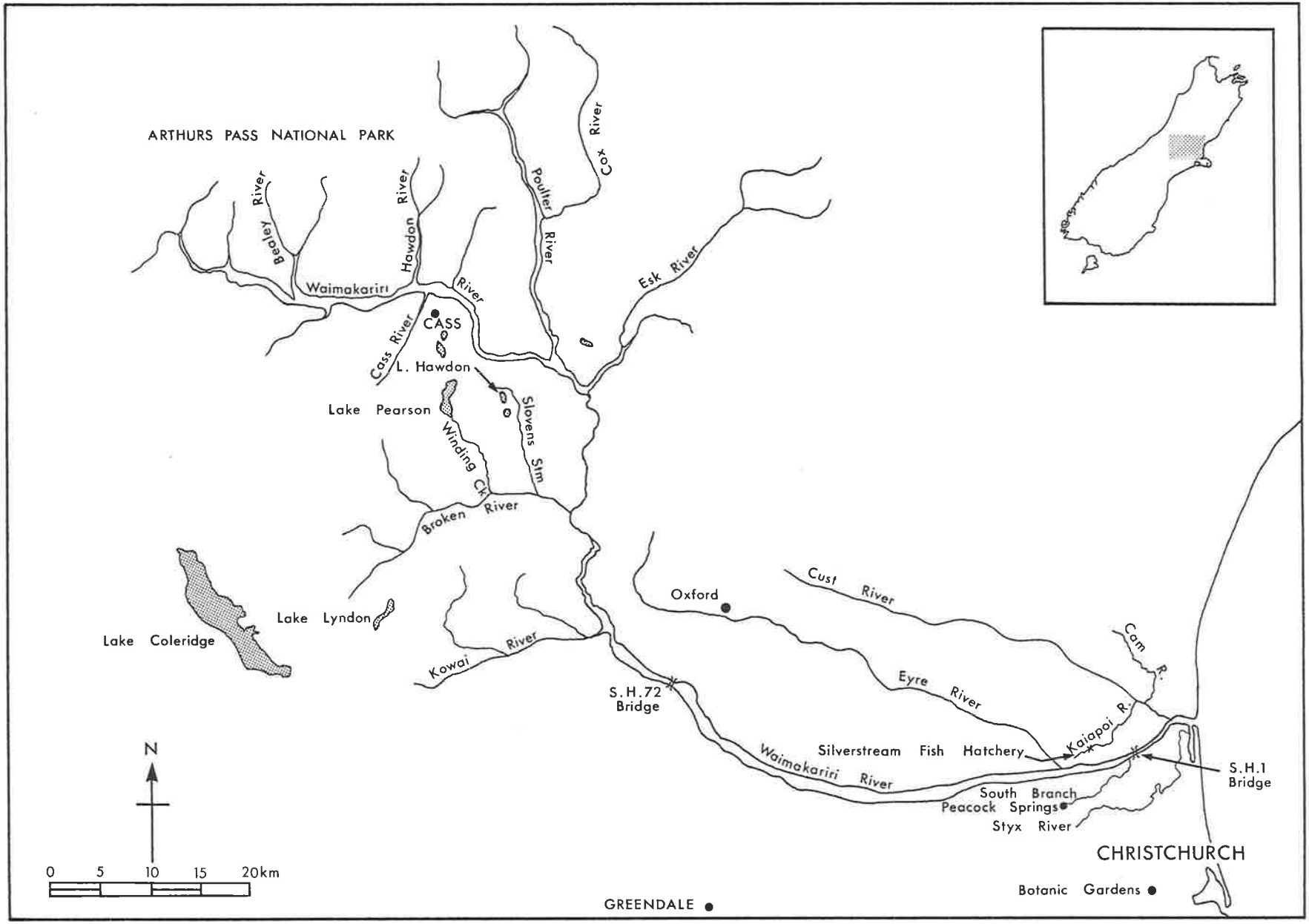

FIGURE 1. Location map, showing localities mentioned in the text.

within a region known as the Waimakariri basin, where there are several significant lakes (Pearson, Grasmere, Sarah, Hawdon, Marymere, and Letitia).

The Waimakariri leaves its upper catchment by a steep-sided, rock-walled (100 m high) gorge bisecting the Torlesse and Puketeraki mountain ranges. The lower, middle (Otarama), and upper gorges comprise some 51 km of the river's total length. Between the middle and lower gorges, the last mountain catchment tributary, the Kowai River, enters. From the lower gorge downstream, the river flows in a wide (1.5 km), multi-channelled, braided, gravel flood bed across the Canterbury Plains to the coastal lowland, where the South Branch, Kaiapoi River, and three minor tributaries join. Unusually among Canterbury alluvial rivers, the Waimakariri has a 5.5 km long estuarine reach and associated coastal lagoon (Brooklands). The river discharges through a permanent mouth to the sea.

The river gradient in the Waimakariri basin averages about 6.6 m/km. In the gorge, the gradient reaches about 4.0 m/km, whereas across the plains it is about 5.3 m/km, until, some 16 km from the sea, it reduces gradually to reach about sea level at the head of the tidal reach (Speight 1928).

The mean annual flow of the Waimakariri River at the old Highway Bridge gauging site is 119 $\pm$ 6 m^3/s (1967-1983). A daily minimum low of 22 m^3/s was recorded on eight occasions in late summer/autumn of 1971, when, for 71 consecutive days, the discharge remained below 40 m^3/s. Within the period of record, a flood with a maximum daily discharge of 1830 m^3/s occurred in 1984 (North Canterbury Catchment Board and Regional Water Board 1986). A flood with a maximum instantaneous discharge of 4250 m^3/s was recorded in 1957 (Griffiths 1979). Historically, floods of greater magnitude probably have occurred.

The Waimakariri's discharge is governed largely by the frequency and amount of precipitation on the Main Divide, which is brought principally by strong west and north-westerly winds (Speight 1928). The periods of lowest flow tend to occur more often in late summer, and through into autumn. Heavy winter snow in the mountains, and the associated freezing conditions, retard runoff and reduce flows. However, snow melt in the

spring, usually assisted by an increased frequency of north-west rain, increases mean discharge, and there tend to be more freshes and floods in this season. Nevertheless, freshes and floods may occur in any season, as shown by the long-term discharge record. While major floods do not result solely from westerly or north-west precipitation, heavy north-eastery rain is uncommon. These climatic conditions are a consequence of New Zealand's geographic location in the prevailing westerly wind system of the south 40's latitude.

2.1 Broken River

Broken River is an alluvial tributary, which enters the Waimakariri near the head of the middle gorge, about 83 km from the sea. Its mean annual discharge is 12 m^3/s (North Canterbury Catchment Board and Regional Water Board 1986). It flows from a mountainous catchment of about 400 km^2, bounded to the east by the Torlesse Range and to the south-west by the Craigieburn Range, each of these ranges being about 2000 m in height. The catchment lies to the east, within the rain shadow of the Main Divide, and so is less influenced by north-westerly rains than other headwater tributaries, tending to higher flows in the winter from south-westerly rain and from snow melt in the spring. It has been observed to have quite low flows in summer, autumn, and early winter.

For about 4 km upstream from its junction with the Waimakariri, Broken River flows through a steep, narrow gorge. Throughout its approximately 26 km length, the river alternates between narrow gorge sections (about 9 km in total), and open, alluvial, flood bed. There are no significant obstacles to salmon passage, except for one short reach near the confluence with Cave Stream, where the channel is down-cut through a limestone ridge. At low flows, this reach may be impassable, but, so far as is known, the possibility has not been investigated. However, a small number of adult sea-run salmon is known to spawn in a spring stream in the headwaters of the Porter River (North Canterbury Acclimatisation Society Annual Reports, personal observation).

2.2 Winding Creek

Winding Creek (Fig. 2) is a tributary of Broken River, and has a mean annual discharge of 2.5 m^3/s (North Canterbury Catchment Board and Regional Water Board 1986). The upper reaches occupy the floor of an open, glaciated, partly terraced, mountain-rimmed valley, towards the head of which lies Lake Pearson. The outlet from the lake flows intermittently, with the first 3.5 km of Winding Creek usually being dry. From this point downstream, Winding Creek has a permanent flow contributed by small tributaries (e.g., Rata and Bernard Streams) which bring underflow from the talus fans of Broken Hill and the St Bernard ranges.

As a salmon spawning stream, Winding Creek may be considered in two parts. The upper reach, from the point of permanent flow downstream for about 2 km, follows an extremely sinuous course occupying part of the bed of a receded glacial lake (Speight 1939). It has numerous ox-bow bends, deep slow pools and runs, and stretches of shallower, gravel riffles. Overall, the gradient is moderate. At the end of the reach, the creek encounters a ridge of moraine where the valley narrows. The principal upper Winding Creek salmon spawning grounds consist of about a 1600 m length of this reach.

Passing through a gap in the moraine ridge, the stream cuts along the toe of a steep talus watercourse plunging down from Broken Hill. Debris brought down the watercourse by heavy runoff sometimes partially dams the creek, ponding water upstream until it is cleared by the flow. From the ridge downstream to Broken River, the valley progressively narrows, confining Winding Creek in a straighter course with its gradient gradually steepening to descend about 100 m in 3.6 km. On its approach to Broken River, the valley narrows appreciably, passing through scrub and beech forest. The bed of the creek then drops quickly through short, rocky pitches, with large boulders, creating a series of low cascades and rapids. This is the second reach. Where it leaves the valley, the river often follows a course parallel to Broken River for some distance, but separated from it by a gravel berm.

Hobbs (1937) considered both reaches to be attractive to spawning salmon. In this study, it was found that, while moderate numbers of salmon spawned in the lower reach, particularly towards its upper end

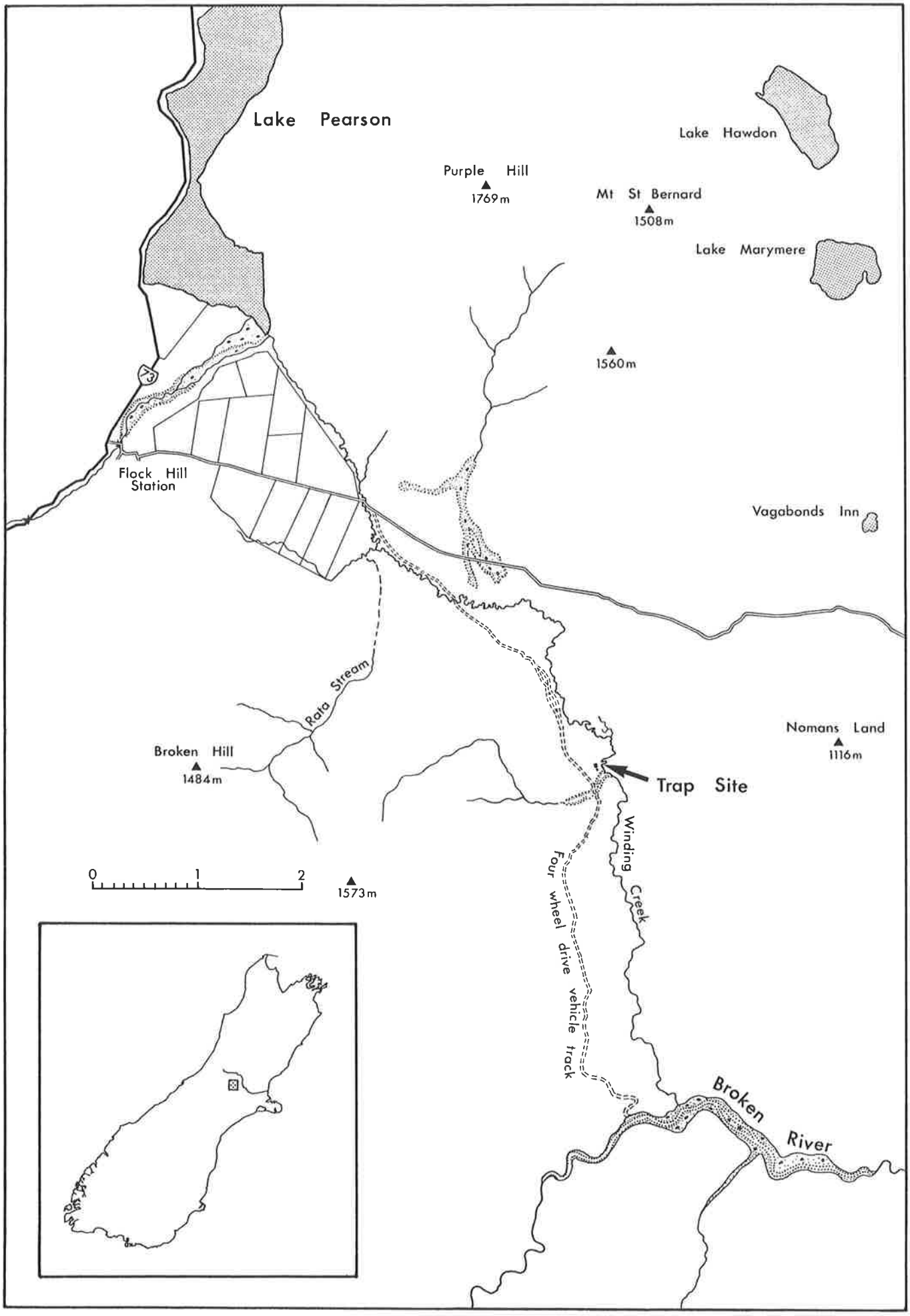

FIGURE 2. Winding Creek, showing location of the trap site.

where there were extensive gravel riffles interspersed with pools and runs, most of the salmon ascended to the upper reach.

3. QUINNAT SALMON TRAPPING IN WINDING CREEK

In 1962, the North Canterbury Acclimatisation Society (NCAS) decided "to improve the salmon potential of Lake Hawdon", which drains via Slovens Stream into Broken River (Fig. 1). An attempt was made to trap fish below a cataract in Slovens Stream (which denies salmon access to most of its length), to obtain eggs for hatchery propagation. (It was planned to modify the cataract later to ensure fish passage, but it remains unmodified.) The attempt was unsuccessful since no female salmon entered the creek. The next year, a trap was placed in Winding Creek to secure eggs. It was abandoned because of sudden spates, which caused weed accumulation, and the absence of sufficient males for fertilisation of ova. Netting carried out in Winding Creek in May 1967 secured only a small number of fish.

Trapping Winding Creek between 20 April and 10 May 1968 provided enough eggs to hatch 20 000 quinnat fry at the NCAS Greenpark hatchery. Eleven female quinnat salmon were trapped from Winding Creek in 1970 and stripped of 59 000 eggs for use in a trial of a jar system of incubation, which had been newly installed in the NCAS Silverstream fish hatchery (Hardy 1972, Henderson 1972). No further trapping was carried out in Winding Creek until 1976, when mature salmon began to be taken to provide ova for the induced-run project (Hardy 1988).

3.1 Silverstream Hatchery Induced-run Project

In 1972, the South Island Salmon Committee (Cunningham 1972) approved the establishment of a project, based on the Silverstream fish hatchery, to induce a return run of adult sea-run quinnat salmon to the hatchery for egg-taking and fishery development purposes. The project began in 1973/74 with the release of juvenile salmon into the upper Kaiapoi River.

Eggs for the project were obtained from a number of salmon spawning streams in the Rakaia, Rangitata, and Ashburton River catchments, but

none were collected from Winding Creek until 1976. By this time, the control of Silverstream and its programmes had passed to the Ministry of Agriculture and Fisheries (MAF). However, obtaining mature fish for ova production continued to be carried out co-operatively between MAF's Silverstream staff and the acclimatisation societies.

In 1976, a trap was erected by MAF and NCAS staff at the lower end of upper Winding Creek to intercept the salmon spawning run. It was operated by field officers of the NCAS. MAF staff were responsible for transporting the mature salmon back to the hatchery to be ripened for egg-taking, and for taking and fertilising eggs at the trap site for incubation at Silverstream (Table 1).

TABLE 1. Number of adult salmon from Winding Creek used to provide eggs for hatchery production at Silverstream, 1976-1981.

Year	No. of females	No. of males	Comments
1976	79	29	transported live to Silverstream
1977	166	25	transported live to Silverstream
1978	103	-	transported live to Silverstream
1979	147	+	stripped at Winding Creek trap
1980	81	+	stripped at Winding Creek trap
1981	139	+	stripped at Winding Creek trap

- = Silverstream males used for fertilisation.
+ = number of males used for fertilisation not recorded.

Because the NCAS was concerned that the quantity of fish or eggs taken from Winding Creek should not reduce future natural spawning in the creek, and because it was unnecessary to obtain all the eggs for the induced-run project from this source, the trap was only fished now and again during the spawning season. Most of the time, the fish had free access to their spawning grounds. No attempt was made to count the total number of fish, although an approximate check was made on abundance by carrying out spawning surveys during the 1976, 1977, and 1978 spawning seasons.

In total, about 3.2 million salmon eggs (715 females x an average of 4500 eggs* (Field-Dodgson and Galloway 1985)), or about 536 000 eggs each season, were obtained from Winding Creek stock.

3.2 Census Trapping

A change in the trapping was instituted in 1979. As well as collecting eggs for the hatchery, an attempt was made to obtain a total count of the sea-run salmon entering upper Winding Creek each year until 1984, and to examine each fish for the absence of an adipose fin. (This absence indicated that the fish was probably tagged with a coded-wire nose tag.) The recovery of tagged fish was important to the collection of data for a tagging programme being carried out throughout the salmon fishery by MAF (Unwin et al. 1987). Large numbers of juvenile salmon produced and released by the Silverstream hatchery were part of that programme (Hardy 1988).

3.2.1 Trap Site

Whereas the site of the traps used in previous years had been variable over a 500 m length of the creek, in 1979 the position of the trap was fixed (map reference S66:289019) about 100 m upstream from the moraine ridge which marks the start of the upper Winding Creek spawning grounds (Fig. 2). There, a deep run and pools often were used by salmon as a holding area, prior to ascending further.

The trap consisted of a barrier rack, set across the full width of the stream, with fish-holding pens and a trap attached to the downstream face. Converging wings leading from each stream bank led fish upstream through a non-return "V" entrance inserted into the trap. Downstream inclined screens were placed along the top of the lead-in

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*Hobbs (1937) listed the number of ova per fish from data provided from the Hakataramea hatchery for 20 female quinnat (size range 4.1-10.5 kg) from the Waitaki River. The average number derived from his Table 2 was about 5800. Galloway (cited in Hawke 1978) counted ova in 12 female salmon from the upper Rakaia River, which had a mean length of 73.3 cm (range 65.2-80.5 cm), a mean weight of 4.8 kg (range 3.5-5.7 kg), and a mean number of 4400 eggs. In 1982, eggs were stripped from 26 adult females returning to the Silverstream hatchery. The mean length of the females was 64.6 cm (range 43.0-80.5 cm), and the average number of eggs per female was 4360 (Hardy 1988).