ISSN 1170-2001

NEW ZEALAND FRESHWATER FISHERIES MISCELLANEOUS REPORT NO. 51

OPIHI RIVER: MINIMUM FLOW FOR SALMON PASSAGE

by

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CHRISTCHURCH

Servicing freshwater fisheries and aquaculture

JULY
1990

NEW ZEALAND FRESHWATER FISHERIES MISCELLANEOUS REPORTS

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ISBN 0-477-08376-5

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Opihi River: minimum flow for salmon passage

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30 July 1990

Introduction

Environmental studies related to the diversion of Lake Tekapo water to the Opihi catchment have raised the question of salmon passage in the Opihi River. This report estimates the minimum flow required for salmon passage.

Graham McClintock of the Canterbury Fish and Game Council has observed low flows and salmon passage in the Opihi River for a number of years and has provided much of the background material and photographs for this report, and more importantly, identified the areas of the river which were critical.

According to Graham, Opihi River salmon congregate below the Te Muka/Opihi confluence during periods of low flow. As soon as a small fresh occurs these salmon run up the Opihi River. This type of behaviour has been observed in other rivers and it is not clear whether it is the change in flow or the magnitude of the flow which stimulates the salmon run. Similar behaviour has been observed in the Rakaia River (G. Glova pers. comm.) where water depths are greater than in the Opihi River. However, it is clear from photographs that low flow conditions in the Opihi River do present a physical barrier to the passage of salmon. This report estimates the flow required to give a sufficient depth of water for salmon passage through these critical areas.

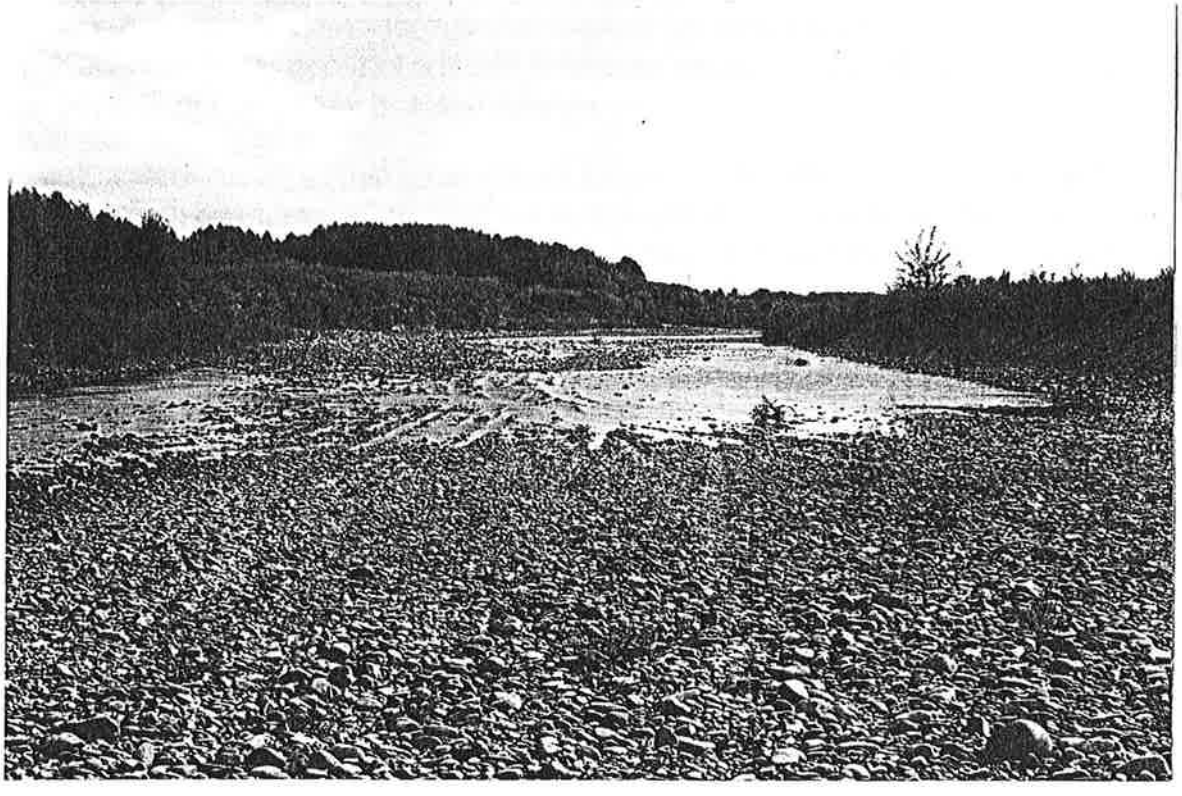
Method

It was originally intended to inspect the Opihi River under low flow winter conditions and to survey the shallow riffles which might impede salmon passage. However, northwest weather and snowmelt resulted in a flow of about 14.7 m^3/s on the day of our visit. Fortunately Graham McClintock was able to provide photographs of the river at a flow of about 0.5 m^3/s. Two of the riffle areas were between the State Highway 1 Bridge and the Te Muka River confluence and one was upstream of the bridge. We visited these locations and measured river widths and depths. The critical areas were riffles of relatively constant depth across their width and it was considered that they could be modelled hydraulically as broad-crested weirs, where the depth of water across the weir is given by the formula:

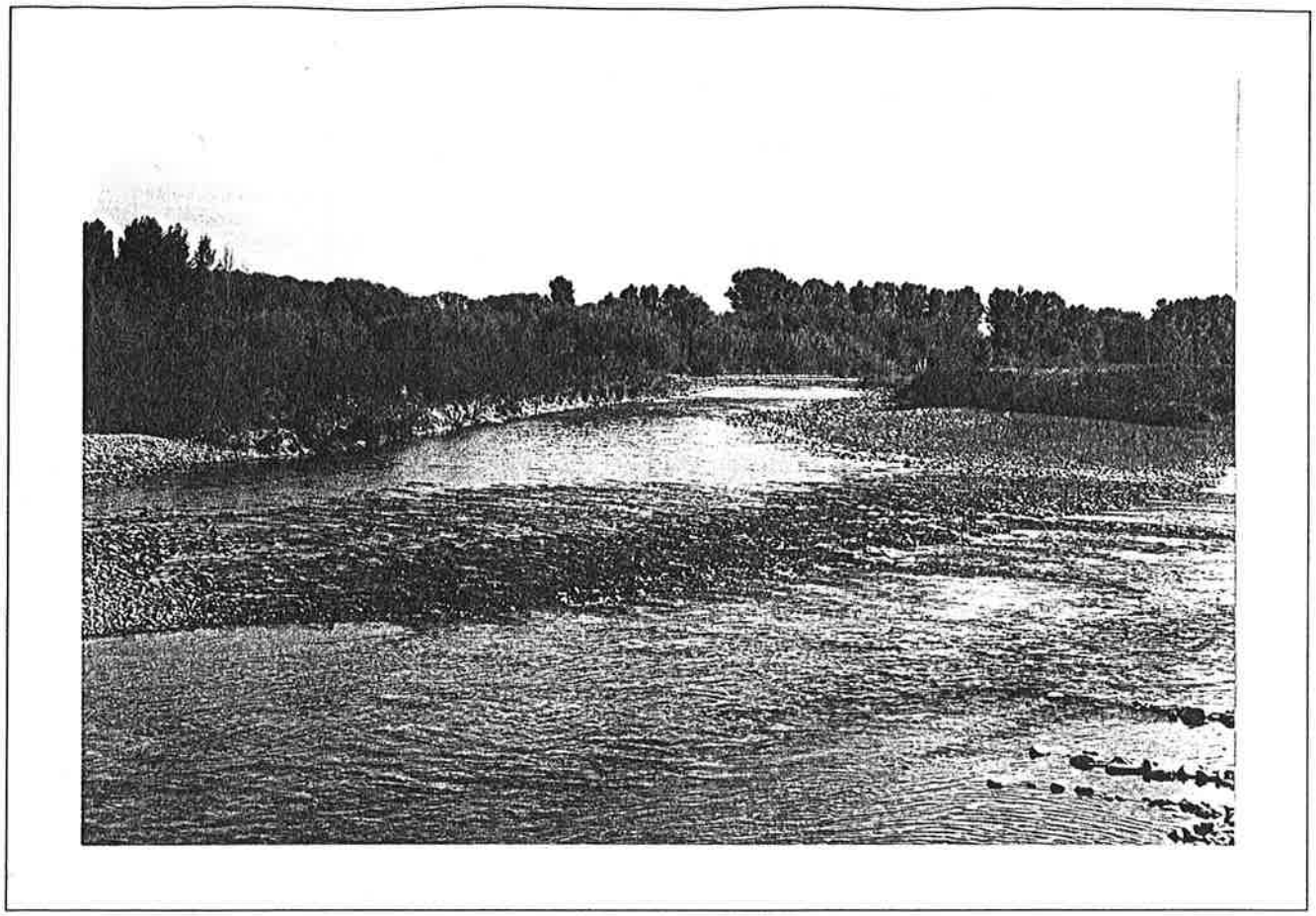
$$H = (0.59\ Q/L)^{2/3}$$

where H is the depth of water for a flow of Q over a weir of width L.

Ophi River just above the Te Muka River confluence - 4/4/90 (Photo G. McClintock)



Opihi River between main road bridge and Te Muka River confluence - 4/4/90 (Photo G. McClintock)



Opihi River about 1 km above main road bridge - 4/4/90 (Photo G. McClintock)

Results

The minimum passage depth for salmon is given by Wesche (1978) as 0.24 m. This is about the average body depth of a North American salmon and is slightly larger than the average body depth of a New Zealand salmon.

River widths were measured at three critical locations. At a flow of about 14.7 m^3/s river widths were 25 m, 38 m, and 40 m. The average depth across the 38 m and 40 m sections (which could be waded) was about 0.4 m with a maximum depth of 0.6 m. River widths and depths at lower flows could only be estimated from photographs and the field observations at a higher flow. It is estimated that river widths in critical areas will range from 15 m to 25 m at a flow of about 0.5 m^3/s. Generally the riffles were poorly confined with the result that both their width and depth increase with an increase in flow.

The mean depth across a section is less than the maximum depth, as illustrated by our measurements where the maximum depth was 0.6 m and the mean depth 0.4 m. If a river section is parabolic the ratio of mean to maximum depth is 1.5. However, this ratio is often less than 1.5 especially where river morphology is controlled by sediment load. If we assume a mean:maximum depth ration of 1.25 for the Opihi River, the mean riffle depth for salmon passage is 0.19 m. The flows required to provide this depth of water across riffles of various sizes are shown in Table 1.

Table 1. Opihi River flow (m^3/s) required for the provision of minimum salmon passage depth.	
Riffle width (m)	*Flow*
20	2.8
30	4.2
40	5.6

Conclusion

Opihi River flows of between 2.8 m^3/s and 4.2 m^3/s would provide a minimum passage depth of 0.24 m across riffles of 20 m to 30 m. Examination of photographs suggests that riffles of about 30 m width do occur and that the higher level of flow would be required to ensure adequate passage.

References

Wesche, T. A. 1978: Determining instream flows for management of aquatic and riparian ecosystems. Water resources Research Institute, Laramie. 158 p.