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NEW ZEALAND FRESHWATER FISHERIES MISCELLANEOUS REPORT NO. 122

DRIFT DIVING VALIDATION

by

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1. INTRODUCTION

Drift diving has been recognized in New Zealand as a quick and practical method of assessing trout populations in clear-water rivers. It has been used to obtain trout counts for several single river surveys (Richardson & Teirney 1982; Hicks & Watson 1985; Cudby & Strickland 1986), to assess the effects of floods on fish numbers (Jowett & Richardson 1989), and for a project that identified factors governing trout abundance in rivers nationwide (Jowett 1990; Jowett (in press)). Despite the extensive use of drift diving in New Zealand, there has been little effort to validate the method.

Drift diving validation studies conducted in the USA and Canada have reported variable results. Studies that compared drift diving counts to those made from the bank or a helicopter (Northcote & Wilkie 1963), or seining (Goldstein 1978; Whitworth & Schmidt 1980) showed the number of fish observed while snorkelling is usually greater. When population estimates of cutthroat trout obtained by mark-recapture and diving were compared, one study showed diving underestimated the trout population by 26% (Slaney & Martin 1987), whereas another study showed diving estimates were about 17% higher than other estimates (Zubik & Fraley 1988). A comparison of the mean number of rainbow trout counted by divers with those subsequently recovered after rotenone poisoning indicated over 40% of the fish had not been counted by the divers (Northcote & Wilkie 1963).

Similar results have been obtained in New Zealand. A tag and recount study of brown trout on the Mataura River concluded 70-80% of fish may escape detection by divers (Witherow 1985). A second study compared the counts obtained from diving three artificial river channels with counts from a combination of other methods such as netting and electric fishing (Palmer & Graybill 1986). The number of fish sighted in this study were only 33-41% of those later captured. Although both of these studies were conducted in poor visibility water ($\leq$ 3.0 m), it was clear the method needed to be validated. Accordingly, a study was set up to determine the accuracy of drift diving within and among some clear-water rivers.

2. METHODS

Development and application of drift diving in New Zealand has been well documented; Teirney and Jowett (1990) describe the method in detail. In brief, a team of divers space themselves evenly across a river perpendicular to the river flow. Divers float with the current and count fish which pass under or around them. The species of fish are noted, and the fish are assigned to one of three size categories; small (10-20 cm in length), medium (20-40 cm), or large ($\geq$ 40 cm).

Two methods of validation were used. The first year, the procedure was to block off a 0.5-1.0 km reach of river with stop nets, to dive the reach, to remove about one third of the fish, and finally to re-dive the reach 12-14 hours later. The

number of trout counted on the final dive was compared to the number of fish remaining to assess the accuracy of the method. Abundance and biomass were also calculated (Teirney & Jowett 1990) and compared.

Catching and removing fish from medium-sized rivers is not easy. However, removing fish was preferable to releasing tagged fish into the reach or tagging resident trout, as these activities can cause behavioral modifications. A high proportion of tags can be lost (Cudby & Strickland 1986), and unless large and brightly coloured, tags are often hard for divers to see. Hand-netting or driving the fish into a stationary trap net proved to be the most effective methods for capturing fish. Captured fish were removed from the reach.

In the second year, attempts were made to obtain an independent estimate of the trout population by repeated netting and removal for comparison with the drift dive count. The netting method chosen, seine netting, was unsuccessful and no data were collected.

The first method was successfully applied to three rivers which represented a range of river types and trout populations. The Mohaka River, in northern Hawke Bay, had high numbers of predominantly large brown trout, little bank cover, and moderate amounts of instream cover, mainly large boulders. A distinct pool-run-riffle habitat sequence was

encountered. The reach surveyed was 0.9 km in length and 16 m wide.

On previous drift dives, high numbers of medium and large brown trout were found in the Riwaka River. The Riwaka contained small pools with bank-side willow cover, runs with little cover, and riffles with a few boulders. The reach surveyed (0.5 km x 12.5 m) was mainly run habitat, with one small pool.

The Rai River, a tributary of the Pelorus River, had long stretches of slow run habitat with dense bank-side willow cover along both banks. Both species of trout were present in high numbers. The reach chosen was 1.0 km long and 22.8 m wide.

A fourth river, the Waitahanui, was also surveyed. This river is a spawning tributary of Lake Taupo and holds large numbers of adult rainbow trout during winter. Efforts to obtain data from this river were unsuccessful because it was too swift and deep for seining, and rainbow trout cannot be captured in hand nets. Attempts to find an alternative rainbow trout river for the project were not successful despite considerable effort.

3. RESULTS

Results for the Mohaka, Riwaka, and Rai Rivers are shown in Table 1. In the Mohaka River, 34 large brown trout were seen

TABLE 1. Numbers of trout recorded while drift diving the Mohaka, Riwaka, and Rai Rivers. (S=small fish; M=medium fish; L=large fish).

River	Brown Trout			Rainbow Trout			Total	
	S	M	L	S	M	L	All	M+L
Mohaka								
counted	1	4	34	-	-	-	39	38
removed	-	-	12	-	-	-	12	12
remaining	1	4	22	-	-	-	27	26
recounted	14	4	20	-	-	-	38	24
Riwaka								
counted	4	3	7	-	-	-	14	10
removed	-	1	3	-	-	-	4	4
remaining	4	2	4	-	-	-	10	6
recounted	-	2	5	-	-	-	7	7
Rai								
counted	18	46	10	219	26	6	325	88
removed	-	10	5	68	28	-	111	43
remaining	18	36	5	151	-2	6	214	45
recounted	8	26	19	93	22	12	180	79

on the first dive. Twelve were caught with hand nets and 20 were seen on the final dive. Thus, only two more trout were seen on the first drift dive than could be accounted for by subsequent netting and drift diving. Results were even better for medium-sized brown trout; four were counted initially and four were also seen after removal of some of the large trout. For medium and large brown trout, the degree of accuracy in the Mohaka was about 92%.

In the Rai River, the results for large brown trout were much less concise. On the initial dive, 10 large trout were seen and five were removed by hand netting, yet 19 were counted drift diving the following day. The Riwaka followed a similar pattern with seven large brown trout counted in the initial dive, three removed, and five seen on the re-count. Nevertheless, accuracy of counts for medium and large brown trout combined were quite high in both the Rai (91%) and Riwaka (86%).

One reason so many large brown trout were missed during the first dives in the Rai could be that they were scared into deep cover when the upstream stop net was being placed. Setting the net caused much periphyton to be disturbed, with subsequent downstream effects. Disturbed brown trout can find deep cover and remain undetected during drift diving, especially when cover is abundant and dense as in the Rai.

All three rivers showed that counts of small brown trout were

not repeatable. In the Rai, 18 were seen in the initial dive, but only eight were counted in the final dive and none were captured while netting. In the Riwaka, four were seen in the initial dive, but were not found again in either the netting or diving. In contrast, a school of 14 small brown trout was seen on the final re-count dive in the Mohaka.

The Rai River was the only river containing rainbow trout. There was considerable discrepancy among the rainbow size classes; for example, more medium fish were captured than were actually counted on the first dive. However, the final count of 127 rainbow trout versus an expected count of 155 (82%) was only slightly less accurate than results for medium and large brown trout.

Measurements of captured fish from the Rai showed many trout between 15-25 cm in length and large trout which were only marginally longer than 40 cm. This probably caused the divers some difficulty in assigning fish to the correct size class, and may explain why the total number of fish agreed so closely even though the size class distribution was not repeatable.

When the data were converted to abundance and biomass (Table 2), the anomalies in the Rai River were accentuated because of the large trout missed in early dives. In contrast, the discovery of 14 small brown trout in the final Mohaka dive made little impression on abundance or biomass measures.

TABLE 2. Abundance and biomass measures for the Mohaka, Riwaka, and Rai Rivers.

River	Abundance (kg/km)	Biomass (g/m_2)
Mohaka		
counted	45.3	2.8
removed	15.5	1.0
remaining	29.8	1.8
recounted	27.8	1.7
Riwaka		
counted	18.4	1.5
removed	7.6	0.6
remaining	10.8	0.9
recounted	12.8	1.0
Rai		
counted	51.9	2.3
removed	21.4	0.9
remaining	30.5	1.4
recounted	55.9	2.5

4. DISCUSSION

Trout numbers in the Rai and Riwaka Rivers were not as expected. In the Rai, numbers were much higher than in previous years. High numbers of schooling fish make accurate counting difficult, especially when trying to differentiate species as well as assign fish to the correct size class. In contrast, trout numbers in the Riwaka were about half their previous level.

The inability to obtain an independent estimate of the trout population means we are not able to tell whether a consistent fraction of fish are being seen in different river types. With hindsight, a more effective but destructive method, such as poisoning or gill netting, should have been used as seining was not very successful in shallow or swift water.

CONCLUSIONS

The best results in this study were obtained for medium and large brown trout; trout counts after removal were about 90% of what was expected in all three rivers. The New Zealand studies which showed up to 80% of brown trout may escape detection by divers (Witherow 1985; Palmer & Graybill 1986) were conducted in poor underwater visibility and in the former study, without adequate diver coverage. Rather than demonstrate drift diving is not a good technique for counting brown trout, these studies underline the importance of

adhering to established diving protocols such as those outlined by Teirney and Jowett (1990).

There appeared to be a relationship between the amount of cover and accuracy of the counts for medium and large fish; the Mohaka had the least cover and the highest accuracy (92%), whereas the Rai had the most cover and the lowest accuracy (57%). However, this was complicated by the fact that the Rai contained both species of trout and high numbers in all three size classes. More work would need to be done to confirm this relationship.

Counts of small trout were not repeatable in any of the three rivers. Jowett (in press) concluded drift diving was best for large trout; Slaney and Martin (1987) also found drift diving was most consistent for fish over 30 cm in length. This could be because small trout inhabit shallow runs and riffles where it is difficult to maintain diver formation, or because divers have difficulty discriminating between small and medium size classes when fish are borderline in length. The latter case was an important factor in the Rai River.

Drift dive counts can be used to compare fish stocks between rivers, providing the differences are fairly large. Despite the problems associated with diving the Rai, trout numbers were obviously much higher in this river than either the Mohaka or Riwaka. Because the Rai had large numbers of small trout and the Mohaka almost all large, it is not surprising

trout biomass in these rivers was similar.

Despite finding diving overestimated trout numbers by 17%, Zubik and Fraley (1988) concluded drift diving gave a reliable population estimate. In fact, all the drift diving studies conducted in the USA and Canada (Northcote & Wilkie 1963; Goldstein 1978; Whitworth & Schmidt 1980; Slaney & Martin 1987) concluded drift diving was a good census method for trout and other fish. The ease and speed of the method were mentioned repeatedly. This was also true in this study; drift diving was more effective and much quicker than the seining, hand-netting, and trapping methods used for removal.

RECOMMENDATIONS

Although the accuracy of drift diving counts has not been determined quantitatively by this study, qualitatively it remains the most practical method of assessing trout in clear-water rivers. Some recommendations for ensuring accuracy are:

1. Stick to established protocols, particularly in regard to underwater visibility and diver coverage. Teirney and Jowett (1990) describe the method and its limitations.
2. The trout size classes developed for drift diving are arbitrary. Size classes such as legal-sized/undersized or adult/juvenile are just as valid and may be more appropriate to a particular study. But, ensure the team is trained in recognizing the chosen trout size classes as well as being familiar with the species present.

3. Where drift diving is going to be used to monitor fish stocks within a river, establish a coefficient of variation with at least two dives 24 h apart. This will give a statistical base to monitor changes against. Slaney and Martin (1987) also recommend replicate dives to obtain mean counts.

6. REFERENCES

Cudby, E.J. and Strickland, R.R. 1986. The Manganuioteao River fishery. *Fisheries Environmental Report 14*. 226 p.

Goldstein, R.M. 1978. Quantitative comparison of seining and underwater observation for stream fishery surveys. *Progressive Fish Culturist 40*: 108-111.

Hicks, B.J. and Watson, N.R.N. 1985. Seasonal changes in abundance of brown trout (*Salmo trutta*) and rainbow trout (*S. gairdnerii*) assessed by drift diving in the Rangitikei River, New Zealand. *New Zealand Journal of Marine and Freshwater Research 19*: 1-10.

Jowett, I.G. 1990. Factors related to the distribution and abundance of brown trout and rainbow trout in New Zealand clear-water rivers. *New Zealand Journal of Marine and Freshwater Research 24*: 429-440.

Jowett, I.G. (in press). Models of the abundance of large brown trout in New Zealand rivers. *North American Journal of Fisheries Management*.

Jowett, I.G. and Richardson, J. 1989. Effects of a severe flood on instream habitat and trout populations in seven New Zealand rivers. *New Zealand Journal of Marine and Freshwater Research 23*: 11-17.

Northcote, T.G. and Wilkie, D.W. 1963. Underwater census of stream fish populations. *Transactions of the American Fisheries Society 92*: 146-151.

Palmer, K. and Graybill, J. 1986. More observations on drift diving. *Freshwater Catch 30*: 22-23.

Richardson, J. and Teirney, L.D. 1982. The Whakapapa River: a study of a trout fishery under a modified flow regime. *Fisheries Environmental Report 22*. 71 p.

Slaney, P.A. and Martin, A.D. 1987. Accuracy of underwater census of trout populations in a large stream in British Columbia. *North American Journal of Fisheries Management 7*: 117-122.

Teirney, L.D. and Jowett, I.G. 1990. Trout abundance in New Zealand rivers: an assessment by drift diving. *New Zealand Freshwater Fisheries Report 118*. 31 p.

Whitworth, W.R. and Schmidt, R.E. 1980. Snorkelling as a means of evaluating fish populations in streams. *New York Fish and Game 27*: 91-92.

Witherow, D. 1985. Some observations on drift diving. *Freshwater Catch 28*: 10-11.

Zubik, R.J. and Fraley, J.J. 1988. Comparison of snorkel and mark-recapture estimates for trout populations in large streams. *North American Journal of Fisheries Management 8*: 58-62.