INCUBATION ENVIRONMENT: TESTING OF REDD CAPPING

NECHAKO FISHERIES CONSERVATION PROGRAM
Technical Report No. RM88-9

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ABSTRACT

The Strangway Working Group recognized that the change in flows from the short term to the long term regime requires the conservation of the Nechako River chinook (*Oncorhynchus tshawytscha*) population. One of the Nechako Fisheries Conservation Program projects to monitor the state of the chinook stock is the indexing of the numbers and quality of emergent fry. Should the fry emergence index indicate a negative trend in stock health, it may be necessary to intensify the monitoring project to gain further insight on processes within the incubation environment. Redd Capping was identified as one technique which could be used. This technique was investigated at two sites along the Nechako River. Traditionally, this technique has been used in smaller systems and modifications were developed to improve the viability in the larger Nechako River system. Although the modifications proved successful, it was concluded that due to the prohibitive costs associated with an extensive monitoring program of Redd Capping, it is unacceptable as a part of the Nechako Fisheries Early Warning Monitoring Program.

INTRODUCTION

The mandate of the Nechako Fisheries Conservation Program (NFCP) is to conserve the Nechako River chinook (*Oncorhynchus tshawytscha*) population. To achieve this goal, it is necessary to design monitoring programs that allow for ongoing analysis of stock status.

Enumeration of returning adults is the primary monitoring tool for measuring achievement of the conservation goal. To provide an early warning of stock health, monitoring of the juvenile life history phases will be conducted. An outmigration indexing project will enable the NFCP to determine both numbers and condition of juvenile chinook leaving the system. Similarly a project which indexes the number and quality of fry emerging from spawning areas will monitor the quality of the incubation environment.

Should the fry emergence index indicate a negative trend in stock health, it may be necessary to intensify the monitoring program to gain further insight on processes within the incubation environment. If monitoring productivity from individual redds becomes necessary, a technique will be required to perform this task. A literature review conducted in 1989 indicated that the technique of Redd Capping has been used successfully on other salmonid species in other systems (Phillips and Koski 1969, J.C. Scrivener 1988; Plate 1). This technique was attempted in the Nechako River in 1982, but had met with some structural problems due to high water velocities associated with the redds of Nechako River chinook (Ross Murray, pers. comm.).

The objective of the 1989 program was to address the physical problems associated with this technique and to make the appropriate modifications necessary to improve the viability of this method for use in the Nechako River.

METHODS

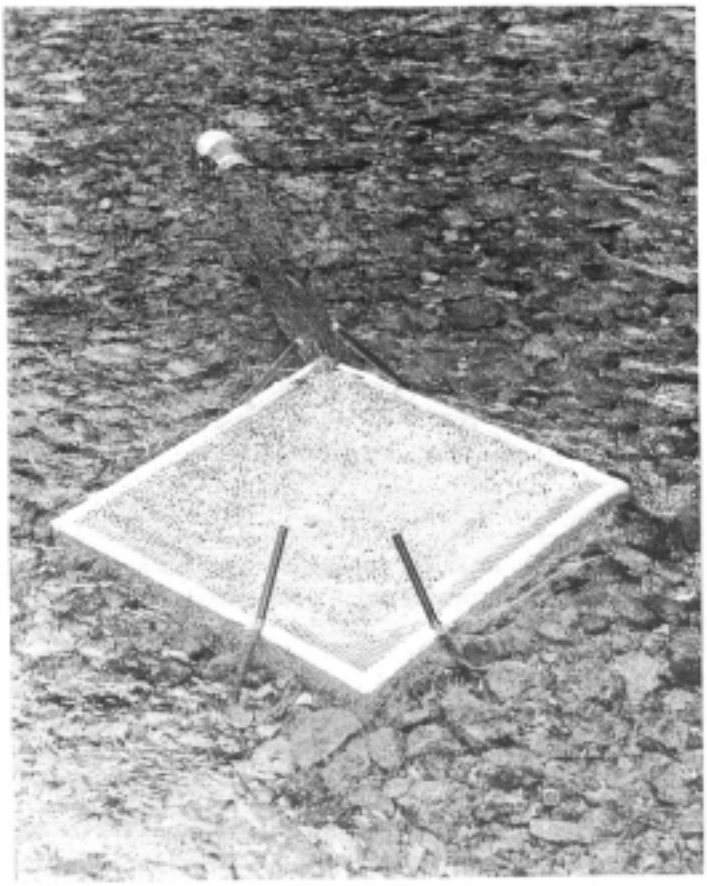
Study Duration and Logistics

Field studies for redd capping were conducted from April 16, 1989 to May 22, 1989. The crew consisted of 2 to 4 people operating out of Fort Fraser. Access to the site was by truck to the Merz farm on the Nechako River, and then by 3.5 m inflatable boat with a 35 hp jet to each of the redd cap sites. The sites were approximately 1.4 km apart. All work on redd caps, including installation, cleaning and testing, was conducted by personnel in dry suits.

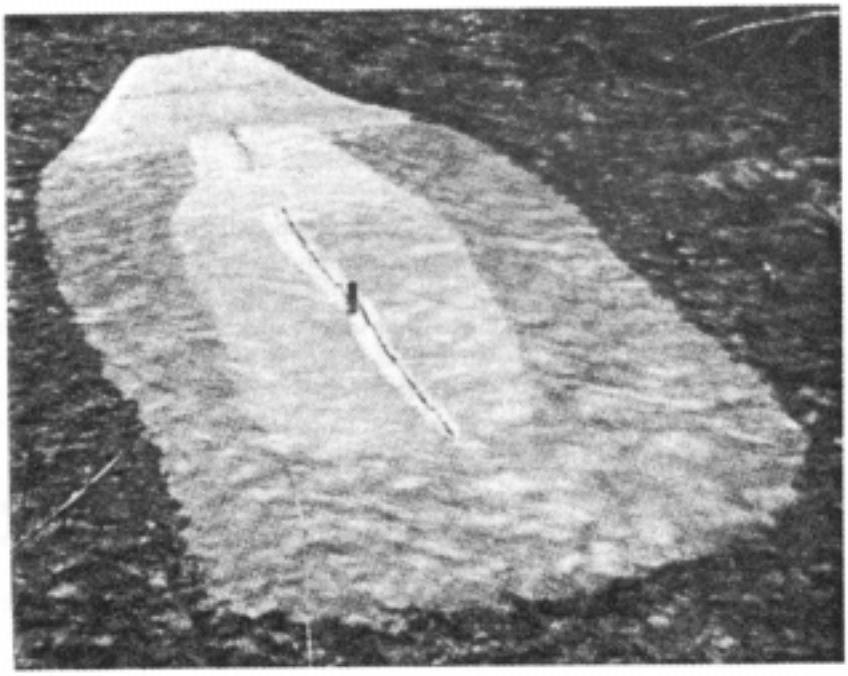
The Vanderhoof area was originally chosen to test the Redd Cap design. It was hoped that it would be possible to cap an active redd and test the design on the fry emerging. The emergence time of fry in this area is approximately one month later than spawning sites in the upper Nechako River due to differences in spawner timing and river temperatures during incubation. It was estimated that emergence would occur approximately mid-April.

In 1989, snowmelt and runoff from agricultural areas caused large amounts of sediments to enter into the Nechako River below the Nautley River confluence. The turbidity of the water made it difficult to locate redds. It was also recognized that the poor underwa-

Plate 1: Redd Capp Designs from Other Studies



Chum Incubation Trap - Carnation Creek



Redd Capp for Coho, Drift Creek, Alsea River, Oregon

ter visibility would hamper construction, assessment and modification of design on an ongoing basis. As a result, the redd cap design was tested in the Nechako River above the Nautley River where river turbidity was much less than at the Vanderhoof area. The Nechako River was travelled by boat from Fort Fraser to Diamond Island on April 22. Two sites were chosen for redd cap installation. These sites were approximately 3 km downstream of Diamond Island (Figure 1). At these sites, fry had already emerged from the gravels, hence the test was primarily to determine if redd caps could be constructed and maintained in the Nechako River.

Redd Cap Materials

The 1989 field program for redd capping consisted of several test designs, and therefore, various materials were used until installation and operation of the final design was accomplished.

The redd cap itself consisted of a 2.5 m x 3 m piece of marquisette. Along the bottom of the marquisette was lead line covered by a rubber coating. A vinyl skirt approximately 15 cm deep extended below the lead line. The front and back of the lining each had four grommet holes for anchoring pins. Each of the sides had five grommet holes (including corners). The back of the redd cap had a 30 cm canvas opening which tapered to 10 cm over a length of 60 cm. This

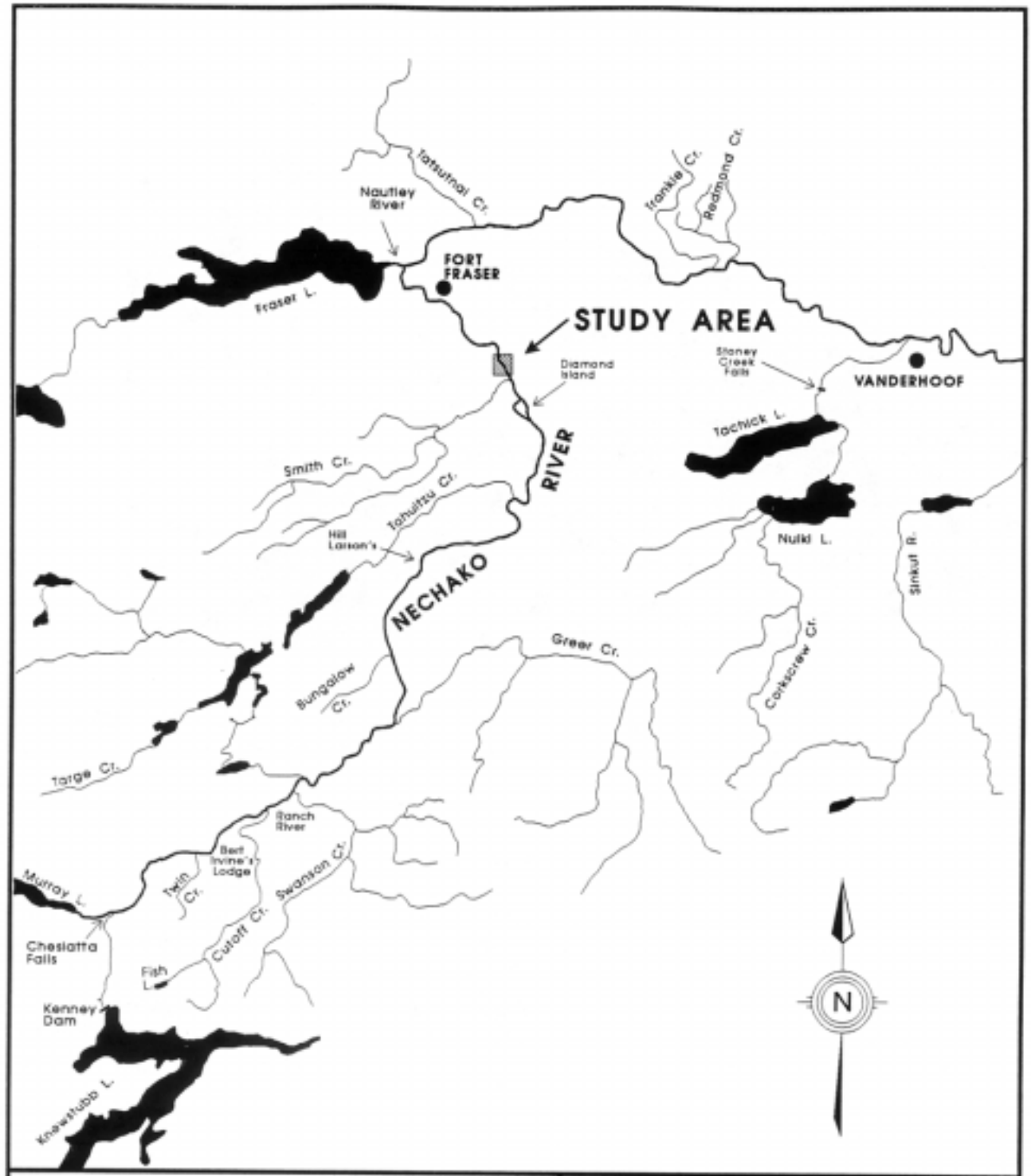


FIGURE 1. STUDY AREA FOR REDD CAP TESTING

Plate 2: 1989 Nechako Redd Cap Design

was designed to funnel fish into a piece of flexible hose leading to a live box (Plate 2).

Partially inflated vehicle tire tubes were attached to the two front center pieces of re-bar. When the redd cap was installed, the tires provided enough positive buoyancy to counteract a plastering effect of the redd cap material to the substrate due to localized downwelling water flows through the tailspill of the redd.

Once the redd cap was inserted over the four front (upstream) pieces of the re-bar, other pieces could be hammered in according to positions designated by redd cap size.

The redd cap was then sealed to the substrate using 60 cm x 10 cm x 5 cm pieces of steel acquired from the local CN scrap yard. A layer of gravel was then pushed up over the skirt to fully seal the redd cap.

Once the redd cap was installed and sealed, the hose leading to the live box was installed. At first, flexible dryer hose was used between the redd cap and the live box. However, when the hose became torn on several occasions, a more rigid PVC hose of the same dimension (10 cm ID x ~200 cm) was used. The rigid PVC hose was fastened to 10 cm O.D. x 10 cm PVC couplers using No. 10 sheet metal screws. The coupler was in turn fastened to the redd cap canvas with hose clamps.

The final piece in the design was a floating live box, constructed of 6 mm plywood with styrofoam attached to each side for floatation (Plates 3 and 4). Two baffles were inserted inside the live box and a 15 cm x 20 cm piece of marquisette was installed on the back to allow flow through the box.

Locations

The first redd cap was installed at river km 86.1; the second at river km 84.7 (Figure 2). The substrate at the first site was loosely compacted gravel of small to moderate size (5-10 cm). Water velocities were 0.75 m/s.

The substrate at the second site was mostly medium to large gravel (10-15 cm), and more compacted than the first site. Velocities at the second redd cap site were 1.0 m/s.

Modifications

During the field testing, the redd cap design used in 1989 field studies on the Nechako River was modified in several ways in an effort to alleviate the problems encountered during the initial 1982 application of this technique to the Nechako River.

The first modification was the use of inner tubes to prevent the webbing material from being plastered to the stream bed.

Plate 3: Floating Live Box Installation

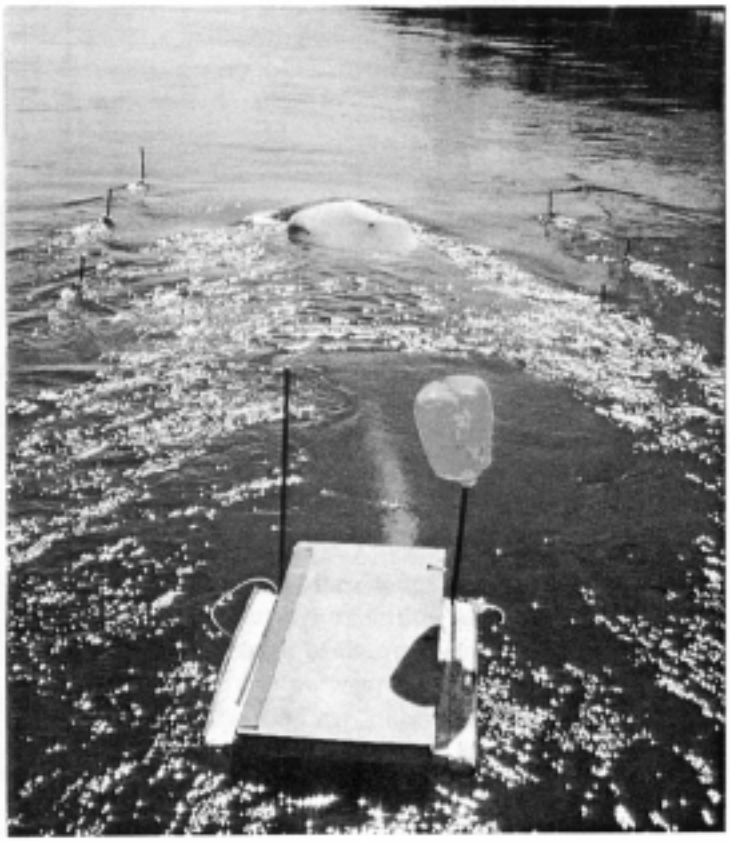


Plate 4
1989 Redd Cap Testing Design: Redd Cap, Flexible Dryer Hose and Floating Live Box

The second modification was a redesign developed after several weeks of testing. Initially, chinook introduced into the redd cap were found to be impinged on the back of the redd cap by the water flow. To reduce impingement, the steel used for sealing the skirt was re-arranged to form a triangular shape at the downstream end of the redd cap so that fish would be funnelled towards the hose leading to the live box (Plate 2).

The third modification was the use of flexible P.V.C. hose rather than dryer hose which was too weak to endure prolonged use.

A fourth modification was made to the anchoring mechanism. Anchoring was first attempted with 10 mm re-bar. However, this was found to be structurally inadequate and eventually stronger 20 mm re-bar was used. The length of re-bar varied with the composition of substrate. Long lengths were used for fine soft substrate and shorter lengths used for coarser, more stable substrate.

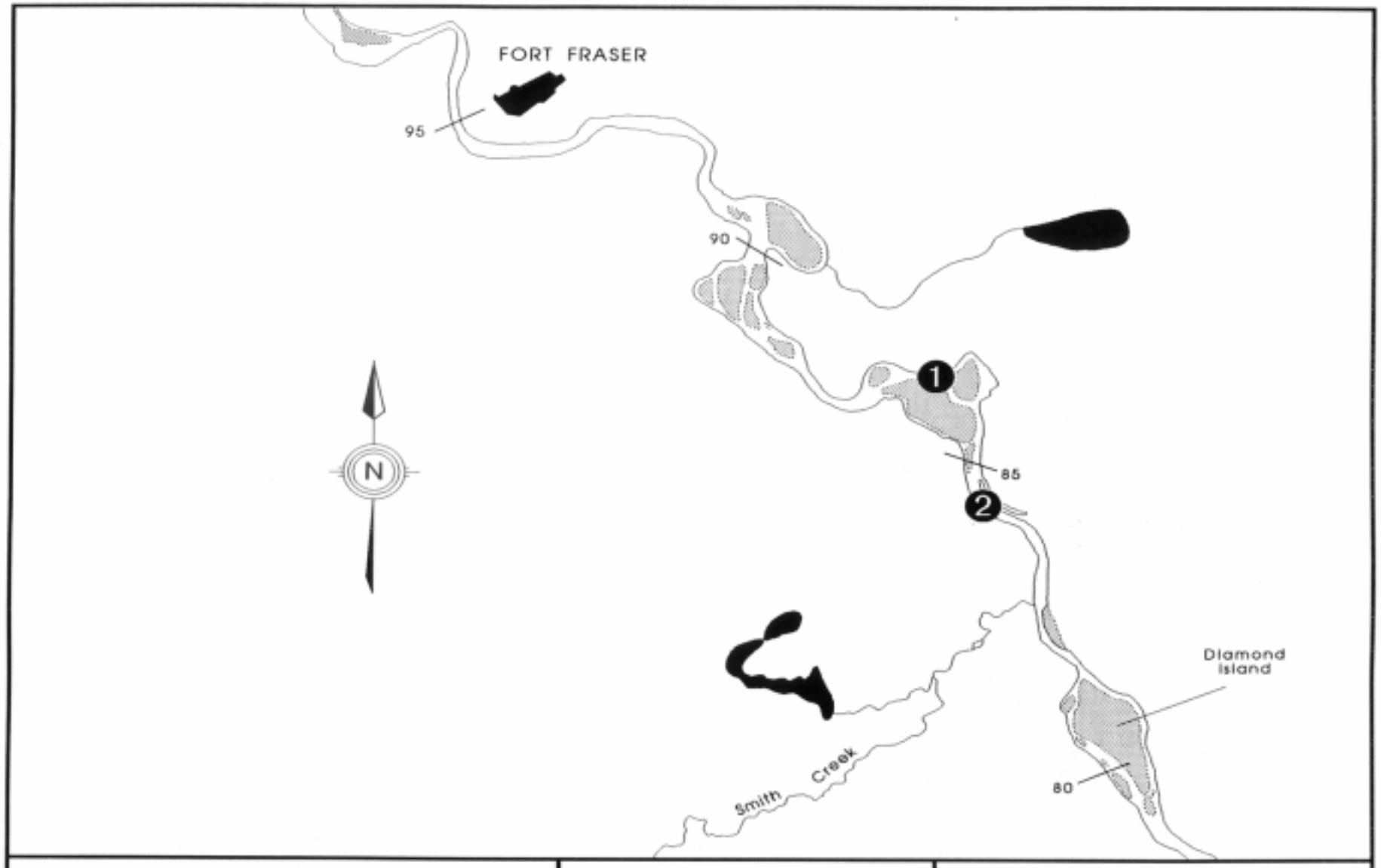


FIGURE 2. RED CAP INSTALLATION SITES

Biological Testing

Testing of the redd cap design was conducted over several weeks. The tests consisted of inserting chinook fry, caught the previous night in the 4 x 4 inclined plane trap (located at Ft. Fraser), into the redd cap and checking for their presence in the live box.

The chinook fry were inserted into the redd cap through a funnel attached to a 1.5 m length of flexible PVC pipe, which had been previously inserted under the skirt of the redd cap and sealed (Plate 2). Water was then poured into the funnel to insure that the chinook fry were all flushed into the redd cap.

The live box was then checked for the presence of released fish and if none were seen, snorkeling was conducted around the redd cap in an effort to see where the fry were located.

RESULTS

Physical Testing and Modifications

The first redd cap took one day to install. Experience gained from this excercise enabled the second redd cap to be made operational in half a day. Redd caps were maintained over a five week period. This is likely the amount of time necessary to ensure that trapping effort will be of sufficient duration to capture all chinook emerging from a single redd.

River flows at this time averaged 58 m^3/s. Several modifications were made over the testing period. Immediately apparent was the lack of anchoring stability afforded by the 10 mm diameter re-bar. The size of this anchoring rod was upgraded to a 20 mm diameter rod.

The attachment of the inner tubes was attempted in two ways. The method of tying the inner tubes to the anchoring pieces of re-bar proved to be superior to attaching the tubes directly to the mesh of the redd caps. Pressure from water velocities caused the mesh to tear when the latter method of attachment was used.

The shape of the redd cap and the configuration of the outlet pipe made it difficult to maintain flow into the live box. In fact, when the front of the redd cap became clogged, the direction of the flow was reversed and went from the live box to the redd cap. Reshaping of the downstream end of the redd cap appeared to alleviate this problem. Cleaning of the redd cap was required only once daily under the controlled flow conditions of the upper Nechako River.

Biological Testing for Trap Efficiency

Several trials were held to test the efficiency of the trap for holding fish and for directing them back into the live box. Initial tests indicated that although fish remained trapped within the redd cap, they were not being forced back into the live box (Table 1).

One reason that the fish were not being forced back into the live box may be that the chinook used for these tests came from the incline plane trap at Fort Fraser. These fish likely had emerged two to three weeks previously, as indicated by their size. Thus, they would be stronger than emergent fry and would also be expected to exhibit different behavioural patterns than fish emerging directly from the gravel.

The redd cap was modified to form a funnel-type downstream end. This modification was tested with newly emergent sockeye fry. It was believed that the size and life stage of these fry would give a better indication of how emergent chinook would respond. Within one minute there was a 90% recovery rate.

During the trials a number of fish could not be accounted for (Table 1). These fish may have escaped either through holes in the marquisette (Redd Cap Site # 2; Table 1), through the broken hose to the live box , while the seal was lifted to look for fish holding behind tires (Redd Cap Site # 1; Table 1), or during repositioning / sealing of the lip. When Redd Cap # 1 was removed, several chinook juveniles were still inside the trap, however, they were not enumerated.

TABLE 1
Biological Testing for Trap Efficiency

Date	Redd Cap Site #	# Fish Released	# Fish in Live Box	# Fish Seen
Chinook Fry				
April 27	1	19	1	4+
April 30	1	9	0	0**
April 30	2*	22	1	2+
May 2	1	47	2	10+
May 14	1	10	0	10++ / 15-20+++
Sockeye Fry				
May 19	1	10	9	0

* Large holes found in marquisette, live box missing May 5
** Torn hose to live box
\+ Impinged on back of redd cap
++ Holding behind tires
+++ Holding at back of redd cap

DISCUSSION

Redd Cap Design

Field studies conducted in April / May 1989 indicated that capping individual redds for fry emerging from an individual redd in the Nechako River is possible by adapting redd cap designs that have been used in smaller stream systems.

The main adaptive changes in design were required because flows were 0.5 to 1 m / s, and depths were 0.3 to 1.0 m at the chinook redd sites in the Nechako River. Typically, redd caps are used in streams where flows are lower and water depths are less. The floatation provided by the inner tubes to keep the redd caps buoyant alleviated the effect of downwelling of water through the tailspill of redds which caused the plastering of redd cap materials onto the substrate.

The downstream end of the redd cap can be modified so that it tapers gradually until it reaches the exit end to the live box (Figure 3). This tapering allows for sufficient flow to be directed into the live box and appears to eliminate impingement of fry onto the downstream end of the redd cap.

One design suggestion from the 1989 study is to submerge the live box to eliminate the vertical difference that currently exists between the redd cap and the live box. This design change will help to concentrate all the fry from the redd into the live box.

To ensure that all fry from an individual redd are accurately counted, the redd cap area can be electroshocked just prior to removal of the structure. The shocked fish are swept downstream and into the live box.

The 1989 study has demonstrated that redd caps can be modified to function in the water velocities and depths found in the Nechako River.

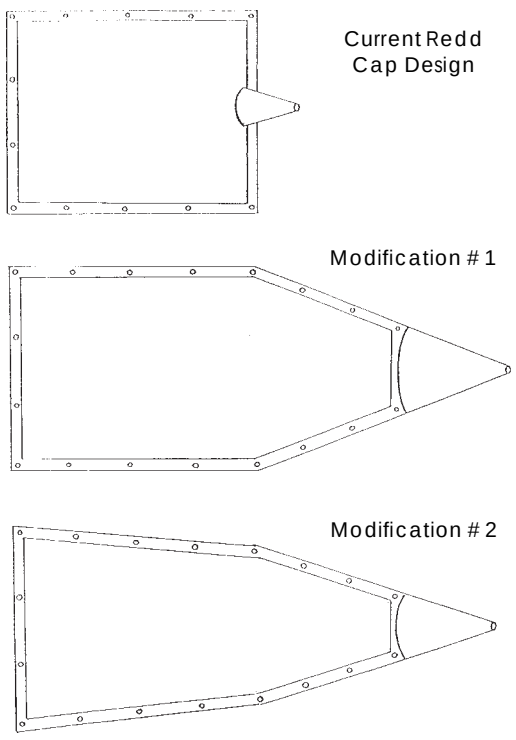
While the appropriate design modifications that demonstrated the ability to install and maintain single redd caps in the Nechako River were accomplished during the 1989 / 90 testing project, the applicability of this technique to achieve the desired system wide monitoring objective must be assessed.

A large scale program of fry emergence assessment would require knowledge of active redds and temperature data to enable the prediction of emergence timing. The number of redd caps used should be sufficiently large to give significant results. Likely, a minimum of 20 redd caps per redd type (i.e. near shore, mid-channel, high velocity, moderate velocity) in several different river locations would be necessary to give statistical power to the results.

In the lower portion of the river, ice cover usually persists beyond the initiation of emergence. The presence of this ice cover precludes any sampling of these river reaches because of the problems associated with installation of redd caps under ice and the difficulty of maintaining the redd caps through the ice breakup period.

In conclusion, the inability to sample all river reaches, combined with the time taken to install redd caps (½ day / redd cap) and the current high cost per unit would make this an unacceptable methodology for conducting the type of emergence monitoring required for the Nechako Fisheries Early Warning Monitoring Program.

FIGURE 3
Recommended Redd Cap Design Modifications



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