MFR PAPER 1069

Coded wire tagging is excellent for automatic identification.

Marking Fishes and Invertebrates. III. Coded Wire Tags Useful in Automatic Recovery of Chinook Salmon and Steelhead Trout

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ABSTRACT

The successful use of the coded wire tag (1 × 0.25 mm, placed in snout) for marking of juvenile Pacific salmon (Oncorhynchus *spp.) and steelhead trout* (Salmo gairdneri) *migrating downstream in the Snake River is described. Problems associated with tagging and with detection of tags in adult fish previously marked as smolts are discussed. General descriptions of the automatic tag detector and adult fish separator are given.*

INTRODUCTION

The problem of marking or tagging juvenile salmon and trout for later identification as adults has perplexed fishery biologists for years. The most common method has been to excise one or more fins. This procedure often results in problems of excessive stress and disease—or sometimes in changed behavior and growth (Bergman et al., 1968). Moreover, fin-clipping of experimental groups of fish does not allow more than two comparably marked groups. Experiments that require comparison among several experimental groups cannot be conducted without bias as one or more of the experimental groups will have additional or different fins removed.

The use of thermal marks (hot and cold) on juvenile Pacific salmon, *Oncorhynchus* spp., and steelhead trout, *Salmo gairdneri,* for later identification as adults has been described by Groves and Jones (1969) and by Ebel, Park, and Johnsen (1973). Their data indicated that cold branding has considerable potential as a versatile form of marking certain species and size ranges. However, the optimum technique for use on a given species and size range is still in the process of evaluation.

A promising method for long-term marks appears to be the coded wire identification system developed by Jefferts, Bergman, and Fiscus (1963). It was further evaluated by Bergman et al. (1968) and by Hager and Jewell (1968). Many of the disadvantages associated with fin-clipping are eliminated, and an almost unlimited number (10^6) of experimental groups can be identified. This system, of course, is not without fault. Problems with tag loss, malfunction of the tagging gear, and later detection of the tags on adult fish are some of them, but recent refinements of the injectors, detectors, and mark and recovery methods in the field have eliminated most of the problems. Initial cost of equipment is relatively high, however, which can be a disadvantage.

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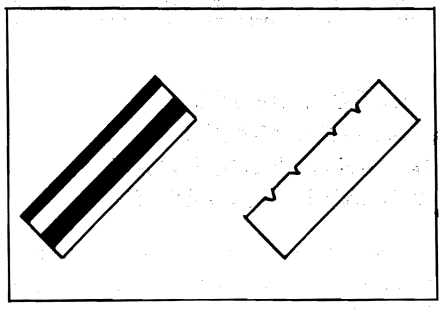


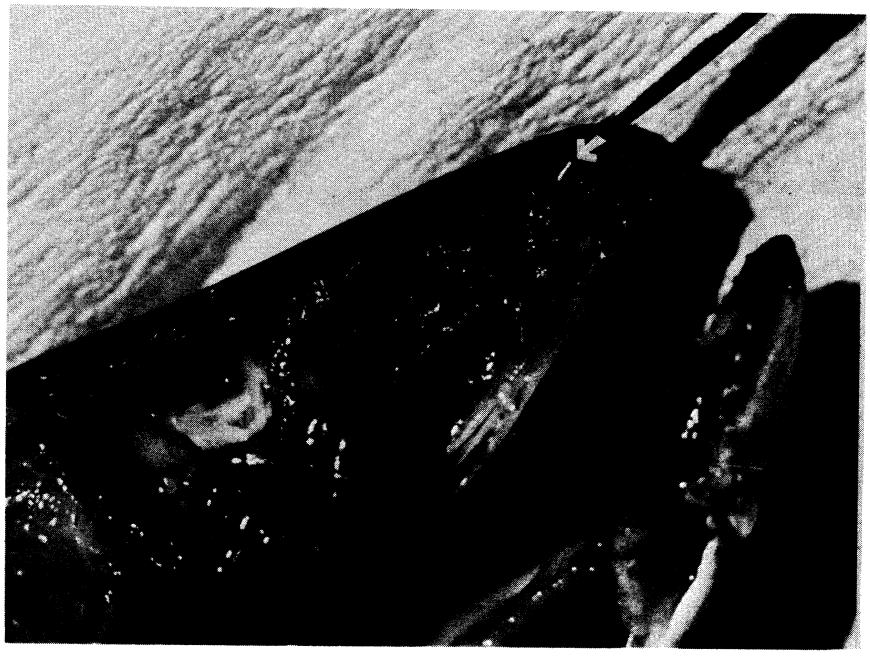
Figure 1.—Magnified binary and color coded wire tags (actual size 1 × 0.25 mm).

At present two types of commercially available tag injectors and two types of wire (binary and color coded, Fig. 1) are available. Detection systems for recovery also are available from two commercial firms.

We recognized the potential of the magnetized wire tag for automatic detection and separation of tagged adult salmon. A system, or device, that would detect and separate tagged from untagged fish was needed in evaluating our experiments on transportation of juvenile fish past hazardous areas. We developed an automatic system with the assistance of Dr. Keith Jefferts and other personnel of the Technical Research Company, Seattle, Washington.[1] This sytem was successfully operated in fish ladders on the Snake River at Ice Harbor and Little Goose Dams from 1970 to the present. Ice Harbor is in Washington State near the confluence of the Snake and Columbia Rivers; Little Goose is approximately 65 miles upstream.

[1]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

Figure 2.—Cross section of juvenile chinook salmon showing placement of coded wire tag.



CODED WIRE TAG USED IN MARKING NATURALLY MIGRATING JUVENILE SALMONIDS

Use of the wire tag for marking salmonids was formerly limited to hatchery stocks. To evaluate our experiments on the Snake River, it was necessary to mark naturally migrating hatchery or wild juvenile spring and summer chinook salmon, *O. tshawytscha,* and steelhead trout. We soon found that marking of these stocks of primarily wild fish with wire tags presented unusual problems. Juvenile salmon and steelhead migrating in the lower Snake River consist of many races. Consequently there is wide diversity in size range of the migrants, depending on the time that one wishes to sample the population. Our project was ambitious. We wished to mark samples from all stocks or races. For a successful tagging operation, correct placement of the tag was highly critical. Bergman et al. (1968) found that the best area for inserting the tag was the cartilaginous wedge of the chondrocranium located in the snout anterior to the eyes (Fig. 2).

Since we were attempting to mark two species of fish with a wide range of sizes, it was necessary to construct a facility where fish could be conveniently sorted by size and species and routed to an injector with a head mold of appropriate size for accurate placement of the tag (Fig. 3).

Both mobile and stationary facilities (Fig. 4) were constructed where large samples of juvenile fish could be held, anesthetized, and sorted. These facilities have worked well. Tagging techniques have been refined to the point where initial tag loss (determined by checking several days after tagging) is less than 1 percent. In 3 successive years of tagging from 1968 to 1970, initial tag loss was 9.2, 5.0, and 1 percent. Tag loss from fish now being marked at Little Goose Dam has been less than 1 percent.

Overall tag loss (from time of tagging to return of adults) was obtainable from those marked in 1968 when 9.2 percent initial tag loss was recorded. Overall tag loss was 27 percent from that year's marking. We attributed this high tag loss primarily to poor placement of the tag because of inexperienced taggers. Lack of refinement of the earlier tag injectors and head molds also contributed to this tag loss. Overall tag loss was not obtainable in 1969-70 because of lack of sufficient returns. At Little Goose, recent overall tag loss was 3 percent.

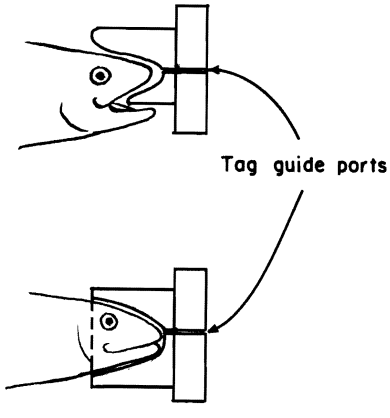


Figure 3.—Open (top) and closed-type (bottom) head molds used in positioning head of fish for wire tagging.

Figure 4.—Inside of marking building showing sorting area and tagging locations.

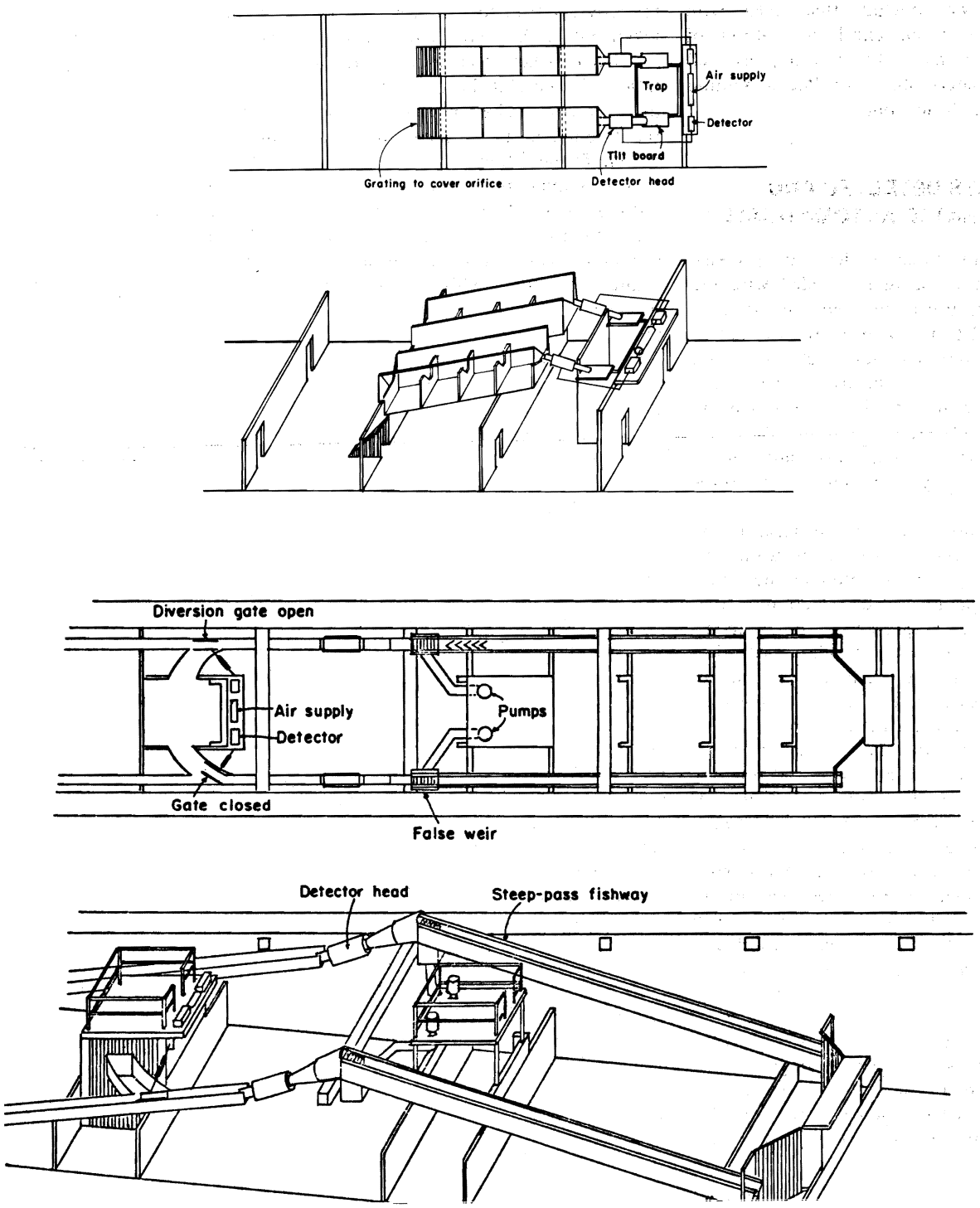


Figure 5.—Plan views and isometric diagrams of wire tag detector and fish separator systems used at Ice Harbor Dam (upper) and Little Goose Dam (lower).

Thus, we conclude that coded wire tagging is an excellent method of marking naturally migrating as well as hatchery stocks of Pacific salmon and steelhead trout.

ADULTS DETECTED AND SEPARATED AUTOMATICALLY

As indicated earlier, our primary interest in using the coded wire tag was because of its potential for automatic detection and recovery of naturally migrating adult chinook and steelhead ascending fish ladders. Such a system was needed to evaluate the results of experiments in which we transported juvenile fish past barrier dams during their migration downstream.

In 1966, when we first began investigating the possibility of using the wire tag for rapid automatic detection and separation, no detection system had been designed that could accomplish the objective. Available detection equipment was designed for use on dead fish recovered either in the fishery or at the hatcheries.

Preliminary studies (Durkin, Ebel, and Smith, 1969) at the Fisheries-Engineering Research Laboratory of the U.S. Army Corps of Engineers, Bonneville Dam, and at the Minter Creek Hatchery of the Washington Department of Fisheries near Purdy indicated that a system utilizing a hollow cylindrical detection coil located where fish would pass through at a speed of 0.6 mps or greater could be used.

Attempts to devise a system where the fish would swim through the detector coil were unsuccessful as the fish moved too slowly to induce sufficient current for detection. The detector proved satisfactory, however, when taken out of the water and used in a fish ladder where fish jumped over a false weir and slid down a chute past the detector. This movement was rapid enough to induce sufficient current for detection.

A prototype system was built and installed at Ice Harbor Dam in 1970 (Fig. 5) for use in detecting and examining adult fish, tagged as juveniles in 1968. This system was successful in automatic detection and separation of about 300 tagged adult spring and summer chinook from a run of about 30,000 fish that passed through the unit.

The need for several improvements was indicated, however. The tilt board did not always direct the fish accurately into the trap. The overfall-type ladder placed within the existing ladder at Ice Harbor caused some delay in passage of the migration, which forced us to take the system out of operation during the peak of the run.

An improved design of the Ice Harbor type system (Fig. 5) was installed at Little Goose Dam in 1971. This system used a Denil-type ladder instead of the overfall weir-type and eliminated all problems in delay of passage. A gate-type diversion chute replaced the tilt board which eliminated the escape of fish encountered with the Ice Harbor trap.

The electronic circuitry was modified slightly to include a counter for enumeration of tagged fish. A power supply was also built to replace the detector batteries normally used in the detectors, and additional circuits were added to the detectors to eliminate excess sensitivity to outside signals. This unit operated very well in 1972-73 and permitted detection and separation of over 1,500 tagged fish from the migrations passing up the ladder at Little Goose Dam. Although data on exact efficiency of the unit are incomplete at this time, a preliminary estimate indicates that at least 70 percent of all tagged fish passing up the ladder were successfully detected and separated.

The unit was also used to assist other organizations in their investigations. For example, data from over 1,000 adult salmon carrying magnetized spaghetti tags were recovered and relayed to the Fish Commission of Oregon.

CONCLUSION

We concluded that use of the wire tag for marking both hatchery and naturally migrating juvenile salmon and trout is superior to other methods such as fin-clipping or branding if automatic separation and positive identification are required.

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☆ GPO 799-421

MFR Paper 1069. From Marine Fisheries Review, *Vol. 36, No. 7, July 1974. Copies of this paper, in limited numbers, are available from D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235.*