A THERMAL MARKING TECHNIQUE FOR JUVENILE SALMONIDS

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September 1964

FISH-PASSAGE RESEARCH PROGRAM
U.S. Bureau of Commercial Fisheries
Seattle, Washington

INTRODUCTION

Work with juvenile salmonids often calls for short term marking techniques by which individual fish or groups of fish may be identified for varying periods. Such recognition can be provided by various familiar means such as fin removal, attachment of markers or tags, tattooing, or perhaps whole body staining.

Although the above methods may each serve in specific applications, a simple, quickly learned technique is needed which will permit the rapid use of a variety of visible surface marks such as letters, numbers, or symbols, by which individual fingerlings may be recognized easily over intervals of weeks or months. The purpose of this report is to describe a marking system which appears to meet such needs. The method, developed in the Seattle laboratory of the Fish-Passage Research Program, U.S. Bureau of Commercial Fisheries, consists of marking juvenile salmonids by topical application of mild heat to dorsal skin surfaces.

Use of heat to mark or brand small fish has been attempted previously. In such instances the levels of applied heat have been relatively high. Buss (1953) marked young brook trout with a wood burning pencil. He reported that some brands remained visible after 21 months and one after 4 years. Johnson and Fields (1959) tried to mark fingerling steelhead by applying to the skin surface a nichrome wire electrically heated to white heat. According to the authors, this caused injuries which penetrated the skin. Though these were readily visible, they were slow in healing. After 5 months, no distinguishable marks or scars were left. Similarly, white-hot wire was used by Watson (1961) to mark young sea herring. He reported that scars were discernible after 7 months, but differences between marks were evident only during the first several days.

To mark fingerling salmon, we explored the use of a small electrical soldering iron with the heat tips shaped into various patterns. The trials were not satisfactory. Marks could not be produced consistently at heat levels other than those which caused lesions penetrating through the skin into the underlying musculature. Though the resultant injuries appeared as prominent dark gray marks, they bore no resemblance to the patterns of the heat tips and left no visible traces after a 3-month healing period.

These results indicated that substantially lower applied heat levels would be necessary to avert excessive damage to the

contact areas. Such attempts were made, but no marks were produced. This lack of success may have been due to the limited thermal capacities of the marking tools.

Thereupon, new applicators were designed to enhance such characteristics as heat storage and conductance. To employ a level of heat considerably lower than that applied previously, boiling water was used to heat the applicators. This heat source and the specially designed tools have made practicable the effective marking technique described herein.

MATERIALS AND METHODS

The marking tools are made from metals having superior thermal conductance properties. A pencil-sized piece of copper tubing forms the handle. The marking tip is silver, smoothly polished to facilitate heat transfer. Individual flat-surfaced figures are cut from quarter-inch thick silver plate and soldered in reverse (fig. 1) onto a matching piece of one-eighth-inch thick silver. The plate with attached figure is then soldered to the end of the copper tube. This physical continuity maintains a relatively uniform heat flow from the handle to the marking surface when applied to a fish. The copper handle is insulated with polyvinyl tubing which covers all but the first 2 inches from the marking tip. Only the tip and about 1 inch of the uninsulated portion was immersed in the heating water. Currently, the tools are produced by a manufacturing jeweler at a unit cost of about eight dollars ($8.00).

Fish used in the tests were juvenile sockeye salmon (*Oncorhynchus nerka*) and rainbow trout (*Salmo gairdneri*) from the National Hatchery at Leavenworth, Washington; fingerling spring chinook salmon (*O. tshawytscha*) from the National Hatchery at Carson, Washington; and silver salmon (*O. kisutch*) from the National Hatchery at Quilcene, Washington.

Fish for marking were anesthetized and held in aerated solutions of M.S. 222. The actual marking procedure was simple. After the fish was taken from the anesthetic, the marking tool was removed from the heating water, shaken to remove any drops, and applied to the skin surface between the lateral line and dorsal fin. A light, positive, even contact was maintained for about one and one-half seconds (fig. 2). The fish was returned to water and the marker placed back into the heating container. No more than one application with the same tool was made without reheating. If a mark required the use of several figures, the fish was usually

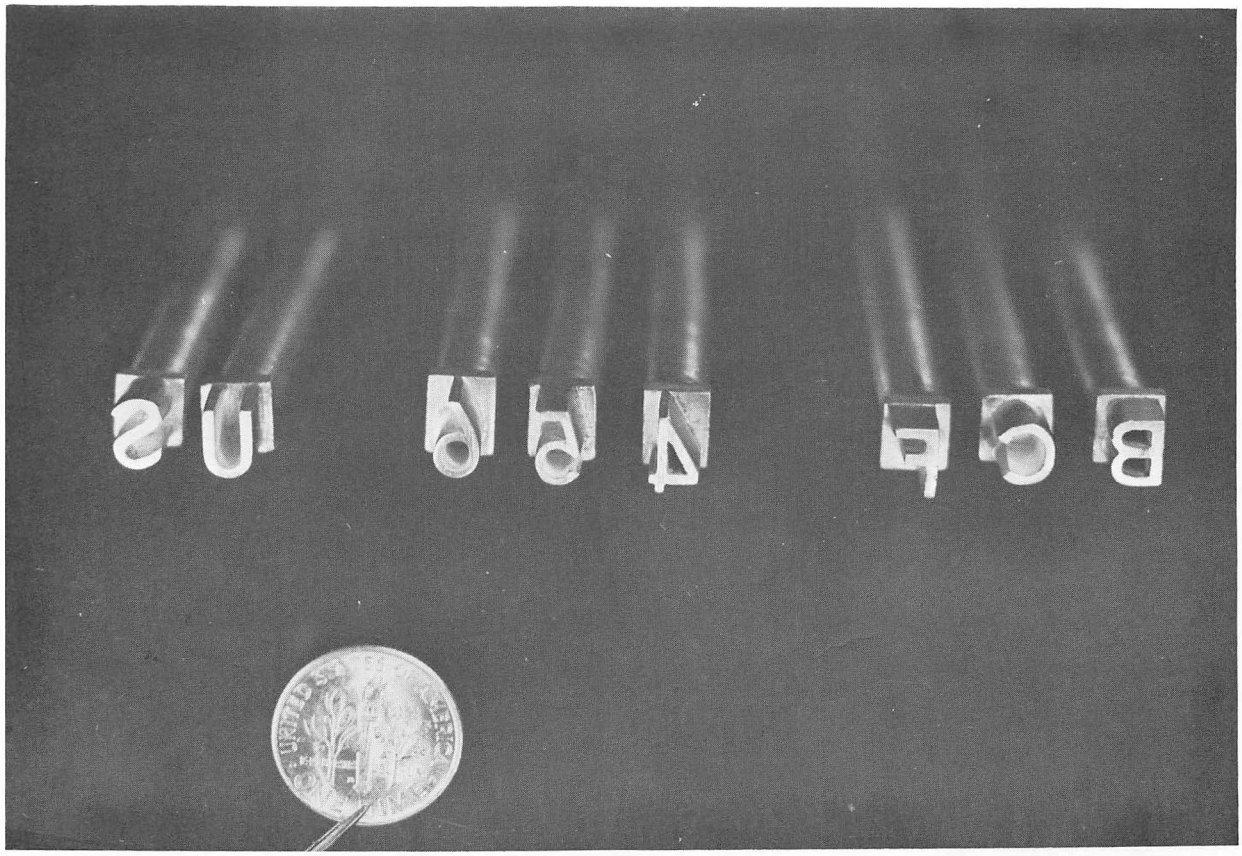

Figure 1.--Closeup of the solid silver tips of the marking tools. Ten cent piece in foreground shows size relationship.

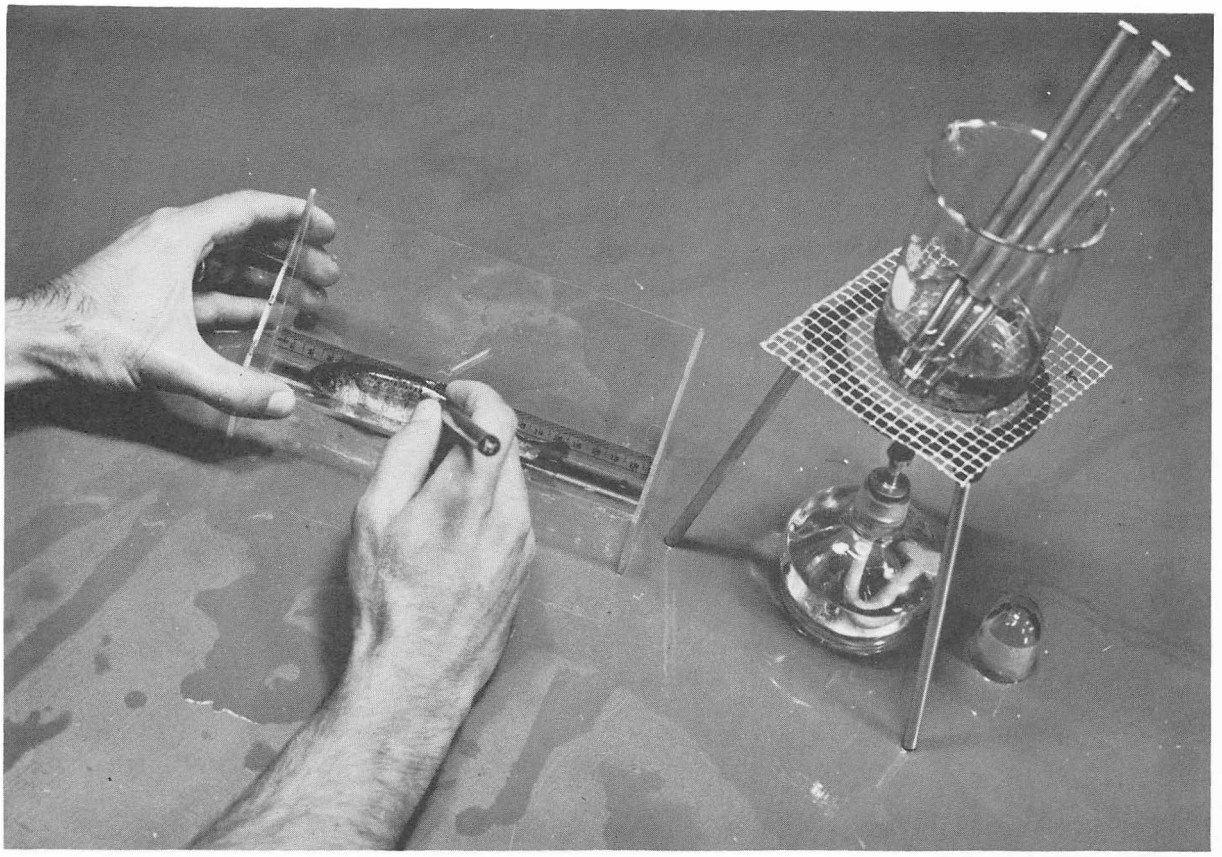

Figure 2.--Applying a thermal mark (dorsolateral) to a chinook salmon fingerling. Engraved plastic disc at top of copper handle identifies marking tool and insures proper alignment during marking. Photograph depicts the minimal equipment needed for thermal marking--marking tools, water, and a heat source.

held out of water for the full marking interval. In such instances the temperatures of the anesthetic solutions were held down to around 45° F. to help offset any possible increased handling stress.

Clear marks depended mostly on steadiness of the applicator during contact. Occasional blurring resulted from uneven contact, probably due to small amounts of mucus adhering to the marker. In most instances, however, the boiling water kept the figures clean. Immediately following application, little indication of marking was evident--other than a faint whitish outline of the mark. Minutes after the fish revived from the anesthetic, the mark usually appeared prominently dark against the normal pigmentation.

RESULTS AND DISCUSSION

In the laboratory the method has been used to place a variety of persistent marks (fig. 3) on fingerling salmonids ranging from 85 to 160 millimeters in length. Six months after marking, juvenile sockeye displayed the original figures with little loss of clarity. Similar results were obtained with spring chinook fingerlings.

Two-hundred forty-four juvenile rainbow trout were marked with individual serially consecutive arabic numerals. One month later any fish could be identified by its number. After 2 months, the numbers were still evident on all fish, but apparent local differentials in skin growth had distorted some numerals. Ten months later the fish had grown from about 100 millimeters to over 200 millimeters in length. All fish still had visible marks. These resembled the numbers two to three times their original size but many numerals were not distinctive and could not be identified. Numbers on some trout were outlined by a patterned alignment of dark pigment spots. A similar heat marking effect on rainbow was noted by Buss (1961).

Marking caused no mortalities in these tests. Overall comparisons between marked fish and control groups indicated no differences in general behavior responses or activity.

In the field, the technique has been used successfully to mark over 23,000 juvenile chinook salmon and steelhead trout migrating downstream in the Snake River. These ranged in length from 90 to 240 millimeters. Marked fish were identified easily upon recovery after varying intervals of up to 45 days.

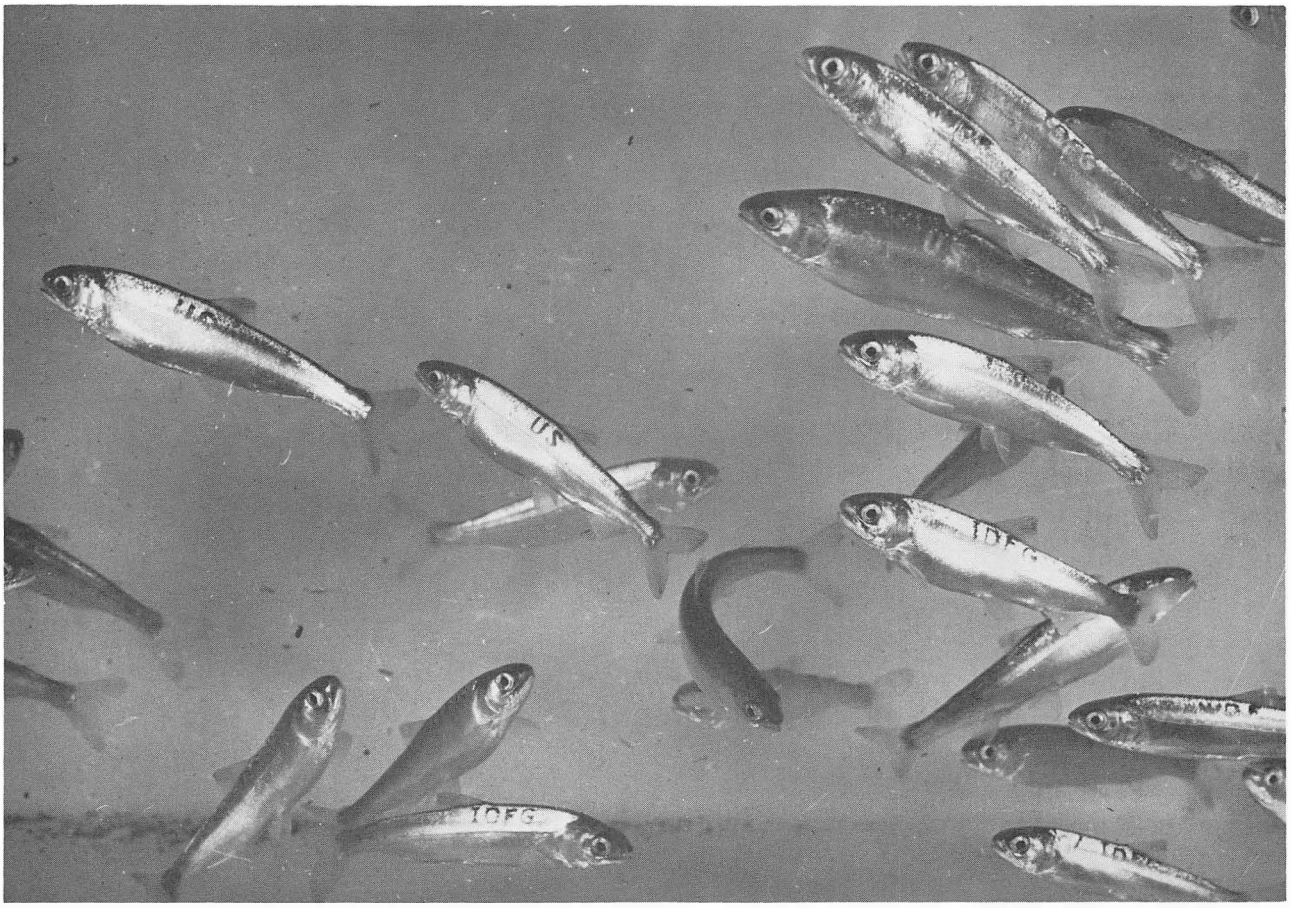

Figure 3.--Year-old sockeye salmon fingerlings about 3½ months after marking. Differences in the apparent visibility of the marks are due to the variations in position of the fish with respect to the incident light.

The applied heat evidently alters normal pigmentation at the contact site. Initial mark visibility appears due to localized disruption of chromatophores and dispersion of dark pigments. This aspect usually lasts for a number of days. Later, the silvery pigment guanine seemingly disappears from the contact area, and the resultant reflective contrast gives a high accent to the mark. In laboratory tests, this quality has persisted for several months. With chinook and sockeye salmon, as the guanine reappears in the site, the distribution of darker pigment usually is less, so that the mark appears lighter than the surrounding area (fig. 4). Except with rainbow trout, as noted, pigment differences in the mark area fade gradually within a year. Upon close examination, however, local differences in reflection of incident light can be seen which still may be distinguished as the original mark. One sockeye and one silver salmon in the laboratory displayed such marks 15 months after application.

Results so far indicate that marking success is related to the condition of the fish. Sound, actively feeding, growing fingerlings usually can be marked as described, but if the fish are less than healthy, the probability of consistent mark production appears diminished. Fish size limits for which the technique is effective have not yet been determined. Though the observed pigment changes may be related to age factors, they may well be the results of heat alone. Therefore, duration of application or applicator size should be considered in relation to size of the fish. Also to be determined are possibilities that more permanent features of the skin, such as scales, may be influenced by the heat application.

Based on the testing to date, the method shows considerable promise as a simple system for placing an impressive variety of short term marks on fingerling salmonids. It may be of help in a number of laboratory or field applications.

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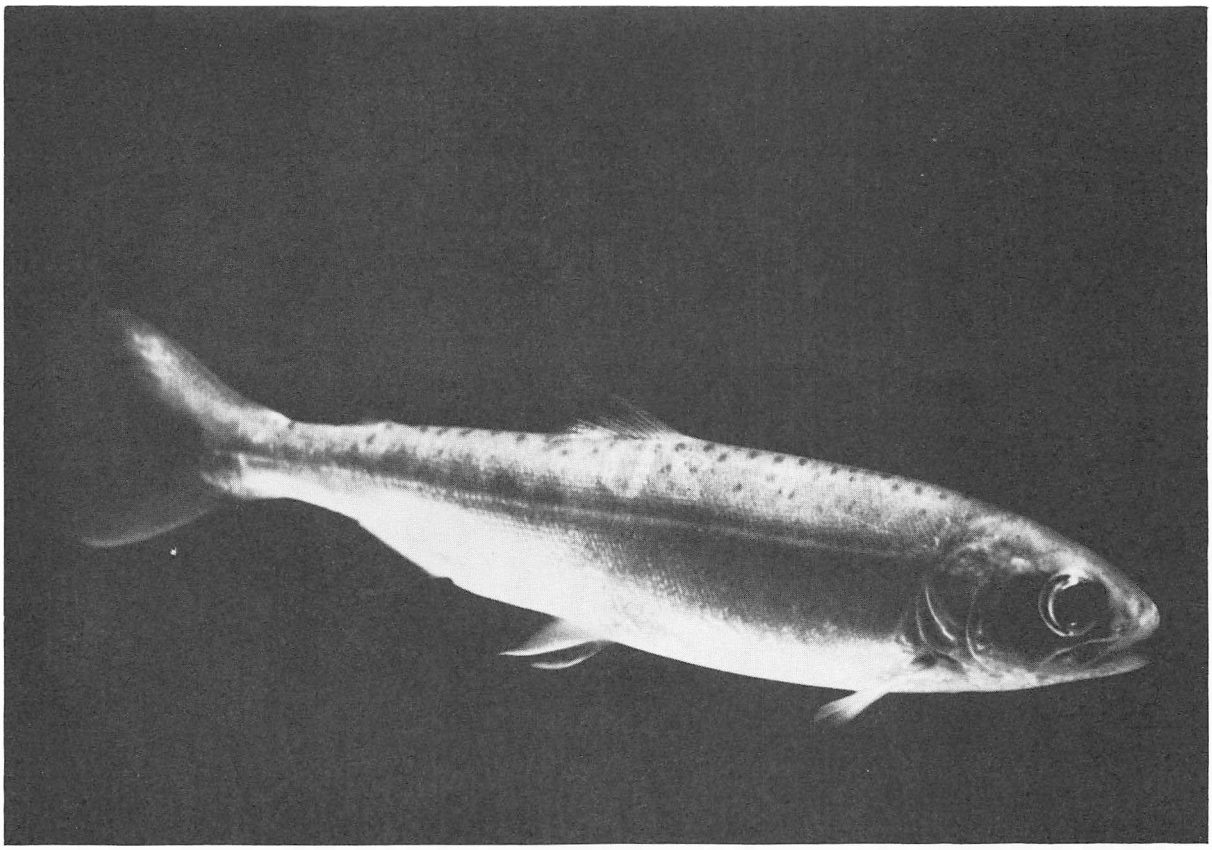

Figure 4.--Six-month old mark on one of the fish shown in figure 3. Although faded, the mark is still visible.

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