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Large and simple letters result in long-term brand retention.

Marking Fishes and Invertebrates. II. Brand Size and Configuration in Relation to Long-Term Retention on Steelhead Trout and Chinook Salmon

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INTRODUCTION

Cold-branding techniques have been used successfully by fishery researchers to place marks on many species of fish. Mighell (1969) reported using liquid nitrogen as a coolant to place a visible short-term brand on chinook salmon, *Oncorhynchus tshawytscha*, and steelhead trout, *Salmo gairdneri*, as an identifying mark during freshwater life. Until recently, however, little information has been available on the successful use of cold branding for producing long-term marks, i.e., marks recognizable on adult salmonids returning from the ocean one or more years after having been branded as smolts.

Early evidence that brands placed on juvenile salmonids would be retained to the adult stage was recorded by the Fish Commission of Oregon (Groves and Jones, 1969). They found a number of recognizable brands on returning adult coho salmon, *O. kisutch*. In the early fall of 1970, Washington Department of Game personnel observed adult steelhead trout with large brands as the fish passed a viewing window in the fish ladder of Little Goose Dam on the Snake River.[1] These fish were returnees from a study group that had been branded and released in the spring of 1969 as smolts in the Grande Ronde River, a tributary of the Snake River. Size of brand symbols used in this instance was larger than on any previous occasion. The obvious legibility of the brand used by Washington State indicated that brand size might be a significant factor in determining long-term legibility.

Ebel, Park, and Johnsen (1973) subsequently reported on brand legibility of adult chinook salmon and steelhead trout returning to the Snake River from transportation experiments at Ice Harbor Dam in 1968. Some of these data obtained during 1970-71 are presented to provide a baseline comparison of the large brands we tested in 1971-72.

Realizing that long-term brands could be placed on juvenile salmonids and that brand size might be the key to long-term retention, we began experimenting with various sizes and configurations of brands. The results of these tests are presented in this paper.

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[1] Pers. comm. Anthony Eldred, Washington Department of Game, Moses Lake, Washington.

METHODS

Juvenile spring and summer chinook salmon and steelhead smolts migrating downstream in the Snake River were obtained for branding at Ice Harbor Dam during 1968-70 and at Little Goose Dam during 1971-72. Size range of the chinook was 80-150 mm and that of steelhead 160-250 mm. The cold-branding technique described by Mighell (1969), where liquid nitrogen was used as the coolant, was utilized throughout the experiment. He specified an application time of 1-1.5 seconds for brands about $^3/_{16} \times {}^3/_{16}$ inch. We adhered to this application time during 1968-70 but, in 1971-72 when we increased the size of the brand, we reduced the application time to 0.5-1.0 seconds. The pressure applied to the brand was not measured. Application pressure, however, was kept below the level where descaling or injury might occur.

From 1968 through 1970, chinook and steelhead were branded with the same brand symbols that were $^3/_{16}$ inch high and approximately $^3/_{16}$ inch wide, depending on the symbol used. The line width was $^3/_{64}$ inch. In 1971-72, a symbol ¼ inch high and about ¼ inch wide was used on chinook. The thickness of the lines remained the same in 1968-71 but was increased to $^1/_{16}$ inch in 1972. The symbol used for steelhead in 1971-72 was ⅜ × ⅜ inch. The line thickness was increased slightly in 1972 to $^3/_{32}$ inch from $^1/_{16}$ inch in 1971. A complete range of branding symbols with details on size is presented in Figure 1 for comparison.

The ⅜- × ⅜-inch-high brand was considered maximum for steelhead. A larger brand could not be effectively placed on the smaller fish within the population size range. Similarly, ¼-inch-high brands were near maximum height for chinook. We avoided placement of the brand on the lateral line.

Many brand configurations (symbols) were used. A partial list included group 1: IK, IF, IL, and IH; group 2: F, H, K, W, and T; and group 3: IL, IH, IK, IN, and IT. Group 1

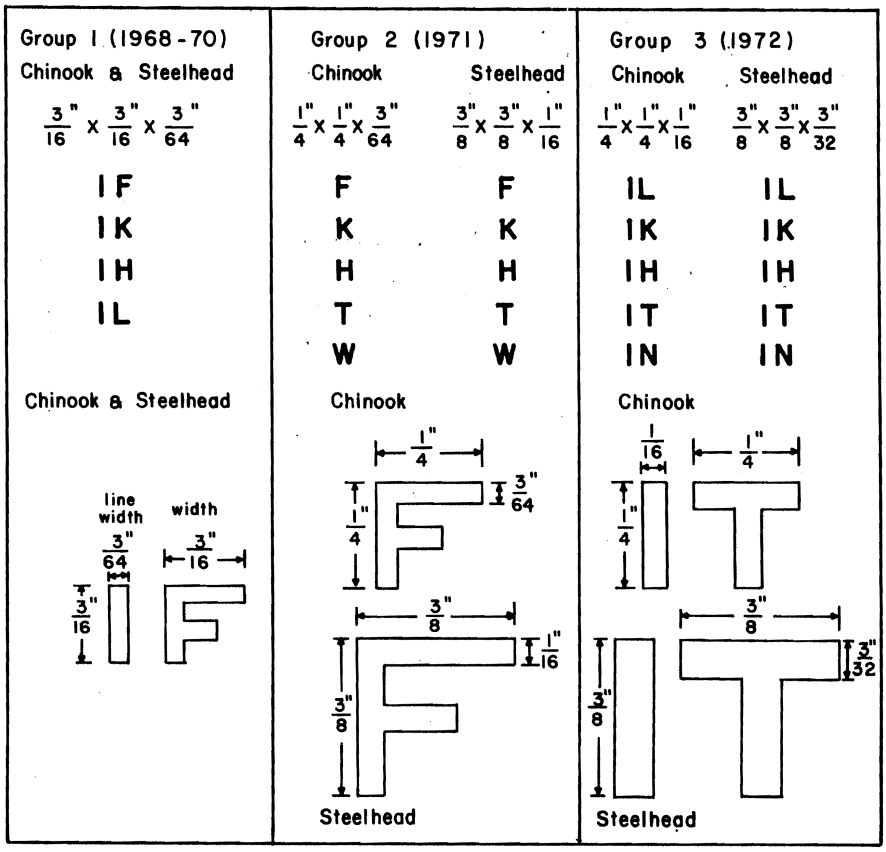

Figure 1.—Examples of brand configurations used in branding studies 1968-72 (upper section). Brands identifying dimensions and comparative sizes (lower section).

brands were used during the 1968-70 experiments, group 2 in 1971, and group 3 in 1972. After branding, the fish were released into the river at various locations where they completed their seaward migration. In addition to being branded, the adipose was excised and a minute magnetic wire tag (Jefferts, Bergman, and Fiscus, 1963) was injected into the snout. The magnetic wire provided the means for collection (Ebel et al., 1973); the adipose clip provided visual identification of test fish regardless of brand legibility. Upon their return from the ocean, adult migrants were intercepted as they ascended the fish ladder at Ice Harbor Dam (prior to 1972) or at Little Goose Dam (1972-73). Upon interception, adults were anesthetized and examined critically for brand retention.

Retention of brands was categorized as: (a) legible, (b) partly legible, or (c) illegible. A legible brand was complete even though faint; a partly legible brand could not be positively identified as to symbol or the symbol was partly missing. Complete loss of the brand was termed illegible.

RESULTS

Among returns of fish marked in 1968-72, legibility was determined for 1,706 adult steelhead and 582 spring and summer run chinook salmon (Table 1). Group 2 and group 3 type symbols clearly produced the most legible long-term brands. Group 3 brands were retained on steelhead slightly better than were the group 2 brands. The reverse was indicated for chinook. The authors and others recording legibility of brands unanimously favored the group 2 symbols for both species. The double-symbol brand used in group 3, because of the large size and numerous lines, caused some lines to be more faintly imprinted. This was especially true on the smaller chinook, and errors in reading were increased.

In general, symbols with the simplest lines and fewest angles produced the sharpest brands (Fig. 2). Among the 1-ocean steelhead, the F and T (Fig. 3) appeared most effective and the W least effective among group 2 brands in producing desired long-term retention. Conversely, four of the brand symbols (including the W) were more legible on steelhead returning after 2 years at sea than they were after 1 year at sea. This phenomenon is unexplained at this time. When the data on legibility of 1- and 2-ocean steelhead are combined and averaged, the differences among legibility of group 2 brands is reduced. Legibility ranges from a low of 87 percent for the W symbol to 95 percent for the

Table 1.—Brand legibility (percentage of group 1-, 2-, and 3-type brands) as retained on adult steelhead trout and chinook salmon. (All fish were marked at time of downstream migration.)

Species	Year marked	Brand group	Ocean age at year of return	Number of returns	Legibility (%) Legible	Partly legible	Illegible
Steelhead	1969	1	1	115	64	12	24
Steelhead	1970	1	2	283	47	30	23
Steelhead	1971	2	1	425	80	11	9
Steelhead	1971	2	2	496	80	14	6
Steelhead	1972	3	1	387	91	7	2
Chinook	1968	1	2	212	38	22	40
Chinook	1968	1	3	109	15	18	67
Chinook	1971	2	1	48	96	0	4
Chinook	1971	2	2	194	82	14	4
Chinook	1972	3	1	19	63	31	6

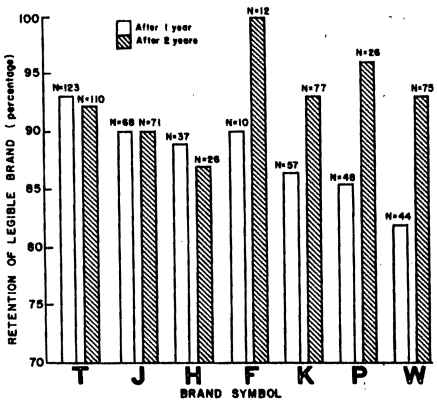

Figure 2.—Percentage of brands (group 2) retained in legible condition on steelhead trout marked during smolting migration, returning after 1 and 2 yr at sea.

F symbol. Returns of 2-ocean steelhead and chinook branded in 1972 are expected in 1974, so comparisons between legibility of brands on these fish and the 1-ocean group await that return. We want to stress that the data contained in Figure 2 do not include illegible brands. The origin of illegible brands could not be determined without sacrificing the fish.

Finally, application techniques must be considered in any branding effort. A steady hand that does not smear the brand is required, and application time must be controlled as well as possible. Brands applied too long destroy tissue and cause a wound that later heals and obliterates the configuration. A brand applied too quickly also becomes illegible.

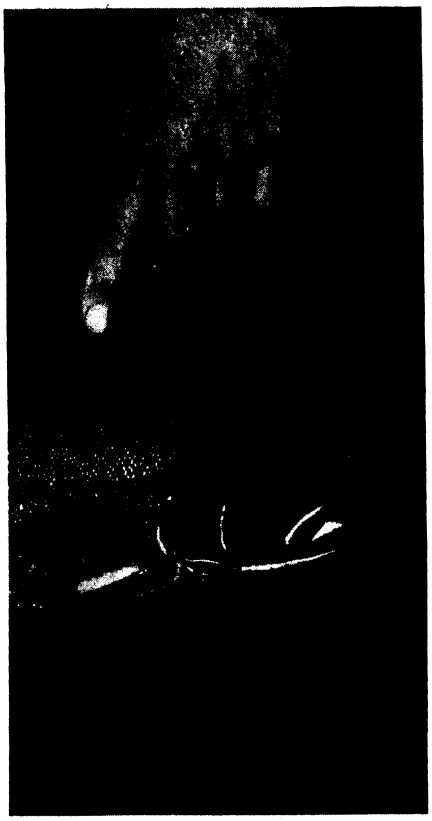

Figure 3.—One-ocean steelhead trout with group 2 type brand that was placed on the fish during its downstream migration as a juvenile.

Although we did not measure the pressure applied to our brands, it may be important to the ultimate legibility of the brand. Data obtained by the authors and others in similar experiments indicated that variations in pressure as well as variations in application time could affect brand legibility. Further testing is needed to remove these variables from the branding operation. The correct combination of brand symbol, size of symbol, application time, and pressure could probably result in 100 percent legibility and retention on juvenile spring and summer chinook salmon and steelhead trout of smolt size.

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