1990

Head Mold Design for Coded Wire Tagging of Selected Spiny-Rayed Fingerling Fishes

S Bradford Cook

William T. Davin Jr

Roy C. Heidinger
Southern Illinois University Carbondale

American Fisheries Society Symposium 7:281-285, 1990

Head Mold Design for Coded Wire Tagging of Selected Spiny-Rayed Fingerling Fishes

S. BRADFORD COOK,[1] WILLIAM T. DAVIN, JR., AND ROY C. HEIDINGER

Fisheries Research Laboratory and Department of Zoology, Southern Illinois University Carbondale, Illinois 62901-6511, USA

Abstract.—Binary-coded magnetic wire tags inserted into the nasal capsule have been used extensively to mark salmonids. Recently, attempts have been made to use coded wire tags to mark various spiny-rayed fishes. Due to morphological and behavioral differences, high tag-retention rates are not obtained for spiny-rayed fished when the standard salmonid head mold is used. We designed head molds for the purpose of tagging channel catfish *Ictalurus punctatus,* bluegills *Lepomis macrochirus,* walleyes *Stizostedion vitreum,* and largemouth bass *Micropterus salmoides.* Two full-head mold designs were tested in this study. Construction of a closed head mold, which completely surrounded a fish's head, required little finishing work, but tag retention by walleyes and largemouth bass used with that mold was only 50–85%. An open head mold, in which deep lateral notches were ground, was used on all four species of fish, and tag retention ranged from 91 to 100%. The higher tag-retention rate realized with the open head mold was due in part to its capacity to accept fish of a wider range of sizes. Proper fit of the mold is essential for correct implantation of the tag; correct implantation, in turn, assures higher retention rates.

The coded-wire-tag system described by Jefferts et al. (1963) for the marking of macroorganisms has been successfully applied on a large scale to salmonids (Ebel 1974; Argue et al. 1979). Binary-coded, full-length magnetic wire tags are internal tags consisting of a small wire (1 mm × 0.25 mm) that is implanted into the fish's nasal cartilage or bone (Bergman et al. 1968). Notches cut into the tag carry a binary code; this system allows for 262,000 different codes. Recently, the microtagging technique has been used on some nonsalmonid species, with varying results. Gibbard and Colura (1980) tagged red drums *Sciaenops ocellata* of 50-mm total length (TL) in the nasal cartilage, but only 27% of tags were retained at the end of 1 year. In another study, largemouth bass *Micropterus salmoides,* averaging 92 mm TL, were tagged in the nasal cartilage; at the end of 16 months, 59% of the tags were retained, and the tags had no effects on growth or survival (Williamson 1983). A smaller amount of nasal cartilage compared to salmon (Gibbard and Colura 1980) and poor head-mold sizing (Williamson 1983) have been suggested as reasons for wire-tag loss from nonsalmonids.

Coded wire tags are implanted with a tagging machine equipped with a head mold, which holds and aligns the fish during tagging. Head molds used for tagging salmonids are based on a half-head mold (Jenkinson and Bilton 1981). This design is effective because salmonids open their mouths when anesthetized, and thus the oral cavity can be used for alignment. Unlike salmonids, many fish do not open their mouths when anesthetized. This characteristic makes the half-head mold unsuitable for tagging spiny-rayed fishes, because proper alignment of the fish in the mold becomes difficult and as a result tag placement varies.

This study was undertaken to design and evaluate suitable full-head molds for coded wire tagging of channel catfish *Ictalurus punctatus,* bluegills *Lepomis macrochirus,* walleyes *Stizostedion vitreum,* and largemouth bass. Two types of full-head molds were tested in this study to determine the appropriateness of the molds for selected spiny-rayed fishes.

Methods and Results

Fishes used in this investigation were obtained locally. Before tagging, the fish were acclimated in 210-L aquaria with recirculated water, and received a prophylactic treatment of formalin (25 mg/L). They were fed daily a commercially prepared feed containing tetracycline. Northwest Marine Technology, Inc. (Shaw Island, Washington) furnished the Mark II microtagging unit used for this study. The system consisted of a tag injector, a quality control device, and a battery-operated magnetic field detector. Each mold con-

[1]Present address: Florida Game and Fresh Water Fish Commission, 3900 Drane Field Road, Lakeland, Florida 33811, USA.

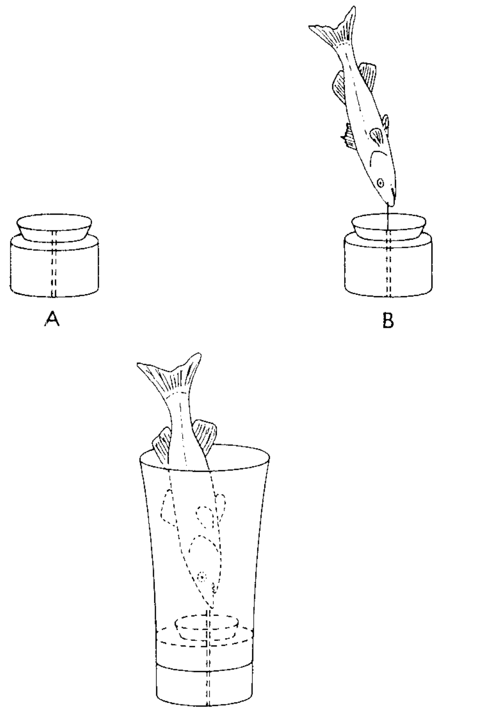

FIGURE 1.—Construction of full-head molds. (A) Reusable metal base. (B) Placement of the fish on the needle. (C) The tape cup into which resin is poured around the fish.

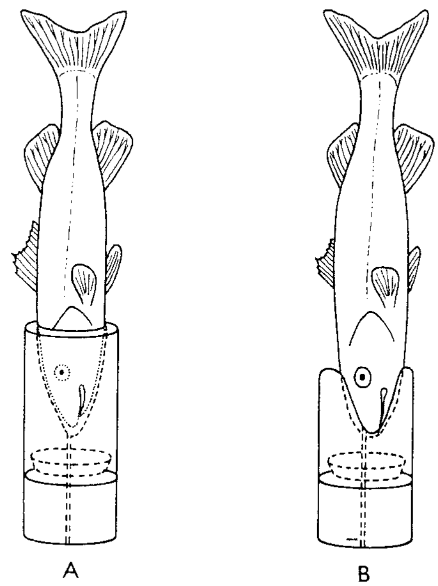

FIGURE 2.—Comparison of the two types of molds used. (A) Side view of closed-form mold. (B) Side view of open-form mold.

sisted of two parts, a reusable metal casting base (Figure 1A), and a fiberglass form.

Before the mold was constructed, the head of a representative fish of the species for which the mold was to be made was dissected and an appropriate area (cartilage or bone) was located for tag implantation. A freshly killed fish was impaled on the needle so that the previously located target area was penetrated and the most anterior part of the fish was approximately 5 mm from the casting base. To prevent the needle from glancing off the nasal bone during tagging, the needle was inserted slightly from the side and downward (Figure 1B). Masking tape (5 cm wide) was wrapped around the base so it encircled the fish (Figure 1C) and served as a temporary form. Resin was poured into the form until it reached the posterior end of the operculum, and was allowed to harden thoroughly (3–5 h), after which the fish and tape were removed.

Two types of mold designs were used in this study. The principal difference between them was the amount of material ground away with a Dremel Moto-Tool.® The first type (closed form; Figure 2A) was made with polyester resin and ground out slightly so that the eyes of the fish did not contact the mold. The second type (open form; Figure 2B) had an open, blunt, V-shaped notch cut into both sides in the area of the fish's eyes (Heidinger and Cook 1988).

All fish were anesthetized with tricaine (MS-222, 50 mg/L) or quinaldine (1.5 mg/L) before they were tagged. The tagging unit then triggered a protrusible needle, which inserted the tag into the targeted nasal tissue. Tagged fish were passed through a quality control device, which magnetized the tag, separated out untagged fish, and counted the tagged fish.

Tagging with the Closed-Form Mold

Two species, walleyes and largemouth bass, were tagged with the closed-form mold. The walleyes were used to obtain preliminary estimates of the size range of fish that could be tagged effectively with a selected mold, to compare the effects of tagging on growth and survival, and to evaluate tag retention. Only tag retention and mold compatibility were measured for the largemouth bass.

Preliminary estimates of mold compatibility were obtained by tagging 25 juvenile walleyes, 5 each measuring 70, 76, 82, 86, and 94 mm TL, with a mold constructed from an 81-mm walleye.

Immediately following tagging, the fish were X-rayed to assess the tag position. Radiographs indicated consistent tag placement within the target area of all the 82-mm fish. The 76- and 86-mm walleyes were satisfactorily tagged; however, some of the tags, 60 and 80%, respectively, were slightly outside the target area. None of the tags completely penetrated the skin of the 94-mm fish, whereas the tags in the 70-mm fish had all passed through the nasal cartilage and lodged in the roof of the mouth. Tag placement was unacceptable when the tagged more than 5 mm shorter or longer than the 81-mm fish for which the mold was made. To verify this finding and to test larger molds, a second group of 25 walleyes (mean TL, 94 mm) was tagged. The fish were anesthetized, sorted into three groups (I, 76–82 mm; II, 83–93 mm; III, 94–114 mm), and tagged with a mold constructed from an 81-mm, an 87-mm, and a 100-mm walleye, respectively. The tagged walleyes were held in a 210-L aquarium for 2 weeks, and then X-rayed to determine retention and position of the tags.

No tag loss or mortality occurred among the 25 walleyes held for 2 weeks. Radiographs indicated that the tag placement varied as much as 3 mm around the target area, although all tags were in the nasal capsule. No statistically significant relationship was found between tag placement and the size of the fish for any mold size (one-way analyses of variance, $P > 0.05$).

To determine the effects of tagging on growth and survival, and to check short-term tag-retention rates, fingerling walleyes were separated into two size-groups: A, 81 walleyes with a mean TL of 85 mm; and B, 70 walleyes with a mean TL of 106 mm. One-half of each group was tagged (41 and 35 fish, respectively) and the other half received only a fin clip. Churchill (1963) has shown that fin clipping had no significant effect on the survival or growth rate of fingerling walleyes. On the basis of previous findings, group-A fish were tagged with molds made from walleyes within ±5 mm of their TL; group-B fish were tagged with molds from fish within ±10 mm of their TL. All the fish were held for 48 h in two 210-L aquaria, checked for tag retention at 24 and 48 h, and then stocked in two 0.3-hectare ponds, one group per pond. The ponds had no other fish and had been fertilized to augment plankton growth. The walleyes were left in the ponds for 44 d, and then the ponds were drained and the fish were harvested. The fish were measured and checked with the magnetic field detector, although Williamson (1987) did not consider this method of detection to be as reliable as X-ray analysis.

No significant difference in growth or survival was found when the fin-clipped walleyes and the tagged walleyes were compared within groups A or B after 44 d in the ponds (one-way analysis of variance, $P > 0.05$). There was, however, some variation in tag retention between groups A and B (Table 1). The tag-retention rate in group A was 85% after 44 d; however, 66% of those losses occurred within the first 24 h. After 44 d, in tag retention group B was 71%; no loss was recorded during the initial 48-h holding period.

Three groups of largemouth bass were tagged to assess tag-retention rates and mold compatibility (Table 1). Group A consisted of 50 fish that had a mean TL of 75 mm; they were all tagged with the aid of a mold constructed from a 77-mm largemouth bass. The 23 fish in group B had a mean TL of 85 mm and were tagged with an 81-mm mold. The 56 fish in group C had a mean TL of 108 mm and were tagged with the aid of a 110-mm mold. All fish were held for 9 months in 210-L aquaria with recirculated water, and were checked weekly for tag loss. Tag-retention rates varied by group: they were 50%, 83, and 77% for groups A, B, and C, respectively. In all three groups, 90% of the tag loss occurred within the first 14 d. Growth and survival were not evaluated because no untagged control groups were used.

Tagging with the Open-Form Mold

Based upon the results of the tagging with the closed form, we selected a limited size range of 10 mm for all size-classes of fish to be tagged with a given mold (Heidinger and Cook 1988). Either 100 or 101 fish from each size-class were tagged. For each species and size-class tagged, a control group of untagged fish (not fin-clipped) was handled in a similar manner.

Fish were maintained in 210-L aquaria for 2 weeks, checked for the presence of tags, and transferred into drainable 0.3-hectare ponds that contained forage of aquatic macroinvertebrates and fathead minnows *Pimephales promelas*. The fish were checked for the presence of tags with a magnetic field detector, measured, and counted at 3-month intervals. At the conclusion of the study, all ponds were drained, and the fish were again checked. Growth comparisons between tagged fish and control fish were analyzed by Student's *t*-test.

TABLE 1.—Survival of, and retention of nasally inserted coded wire tags by, fingerling fish used with open and closed head molds. Values for control fish are in parentheses.

Species and mold type	Group	Study duration (months)	Length of fish for head mold (mm)	Sample size	Mean total length		Survival (%)	Tag retention (%)
					Initial (mm)	Final (mm)		
Channel catfish								
Open[a]	A	6	96	100(100)	89(89)	141(144)	62(67)	96
	B	9	156	101(100)	147(146)	178(181)	67(73)	91
	C	6	174	100(100)	171(170)	206(204)	58(61)	99
Bluegill								
Open[a]	A	6	56	100(100)	51(49)	58(63)[b]	100(100)	95
	B	9	89	101(100)	85(85)	126(124)	100(100)	93
	C	6	126	100(100)	119(120)	142(140)	100(100)	98
Walleye								
Open[a]	A	6	58	100(100)	51(51)	99(97)	71(78)	96
	B	6	78	100(100)	73(73)	123(133)[b]	94(91)	100
Closed	A	1.5[c]	81	41(40)	85(84)	102(101)	100(97)	85
	B	1.5[c]	100	35(35)	106(106)	119(121)	99(97)	71
Largemouth bass								
Open[a]	A	6	78	100(100)	72(72)	100(116)[b]	100(98)	100
	B	6	100	100(100)	95(96)	122(129)[b]	99(100)	95
Closed	A	9	77	50	75	167		50
	B	9	81	23	85	169		83
	C	9[d]	110	56	108	159		77

[a]These data are found in Heidinger and Cook (1988).
[b]Mean length of tagged fish was significantly smaller than that of controls ($P < 0.05$).
[c]This trial lasted for 44 d.
[d]Twenty-three percent of the fish had scoliosis at the start of the experiment.

Three size-classes of channel catfish (group A, mean TL = 89 mm; group B, mean TL = 147 mm; and group C, mean TL = 171 mm) were tagged with open-form molds constructed from fish of 96, 156, and 174 mm TL, respectively (Table 1). Tag-retention was 99% for group C, 96% for group A, and 91% for group B. These fish were held for 6 months, 6 months, and 9 months, respectively. There were no significant effects on survival and growth of fish in any of the three size-classes (Heidinger and Cook 1988).

Bluegills (group A, mean TL = 51 mm; group B, mean TL = 85 mm; group C, mean TL = 119 mm) were tagged with molds made from 56-, 89-, and 126-mm bluegills (Table 1). Tag-retentions after 6, 9, and 6 months were 95, 93, and 98% for groups A, B, and C, respectively. Control fish grew significantly more than tagged fish in group A ($P \leq 0.05$), but not in the other two groups. No fish died in the three groups (Heidinger and Cook 1988).

Two groups of walleye fingerlings (group A, mean TL = 51 mm; group B, mean TL = 73 mm) were tagged with the aid of head molds constructed from walleyes of 58 and 78 mm (Table 1). After 6 months, tag retention was 96% in group A and 100% in group B. Control fish grew significantly better than tagged fish in group B, but not in group A. Neither group of walleyes exhibited significant differences in survival between control and tagged fish (Heidinger and Cook 1988).

Two size-groups of largemouth bass (group A, mean TL = 72 mm; group B, mean TL = 95 mm) were tagged with the aid of head molds constructed from 78- and 100-mm largemouth bass (Table 1). Six months after tagging, fish in group A exhibited 100% tag retention, and fish in group B had 95% tag retention. In both groups, control fish gained significantly greater lengths than tagged fish; however, survival was 98% or better in all cases (Heidinger and Cook 1988).

Discussion

Because a magnetic field detector is not considered to be as reliable as X-ray analysis (Williamson 1987), fish that tested negative with the detector were again run through the quality control device in the laboratory. In the field (pond studies) only the field detector was used, and because this device does not tend to give false positives but does occasionally give false negatives, the tag-retention rates may be slightly underestimated.

A properly fitted head mold is the most important factor that affects tag placement and loss rate. Although less grinding and preparation was required to construct the closed-form mold, it did not consistently yield satisfactory results. The restricted mold orifice reduced the size range of fish that could be tagged effectively; consequently, tag-retention rates decreased when fish of a size outside the optimal range for a mold were tagged. It appears that the optimal range of fish that could be effectively accommodated by the closed form was ±3 mm of the "model" fish for walleyes less than 80 mm TL, ±5 mm for 81–110-mm walleyes, and ±5 mm for largemouth bass less than 110 mm TL. In addition allowing less than 90% tag retention, the closed form would be unsuitable for large-scale tagging operations because of the time factor involved in precise grading of fishes and the number of mold changes required.

Fishes tagged when the open form was used retained tags at rates greater than 90%, which would be acceptable for most research needs. This type of mold tolerated a wider range of fish sizes (10 mm) than the closed form (±3 mm), which reduced the amount of grading as well as the number of mold changes. A less restricted throat on this mold also facilitated rapid placement of the fish into the mold.

Tagging of these spiny-rayed fishes (channel catfish, bluegills, walleyes, and largemouth bass) with either form of full-head mold did not significantly alter the survival of the fingerlings. Significant reductions in growth were found in bluegills, walleye, and largemouth bass tagged with the open mold; however, absolute differences from control fish were small. Crumpton (1985) found that largemouth bass tagged in the nasal cartilage attained total lengths that were not significantly different ($P > 0.05$) from those of control fish. Although care must be taken in grinding the molds to ensure that no mechanical damage occurs to the fish during tagging, we do not believe that tagging with the full-head molds would result in any long-term detrimental effects on growth or survival of these fishes.

References

Argue, A. W., L. M. Patterson, and R. W. Armstrong. 1979. Trapping and coded-wire tagging of wild coho, chinook and steelhead juveniles from the Cowichon–Koksilah river system, 1976. Canada Fisheries and Marine Service Technical Report 850.

Bergman, P. K., K. B. Jefferts, H. F. Fiscus, and R. C. Hager. 1968. A preliminary evaluation of an implanted coded wire fish tag. Washington Department of Fisheries, Fisheries Research Papers 3:63–84.

Churchill, W. S. 1963. The effect of fin removal on survival, growth, and vulnerability to capture of stocked walleye fingerlings. Transactions of the American Fisheries Society 92:298–300.

Crumpton, J. E. 1985. Effects of micromagnetic wire tags on the growth and survival of fingerling largemouth bass. Proceedings of the Annual Conference Southeastern Association of Fish and Wildlife Agencies 37:391–394.

Ebel, W. J. 1974. Marking fishes and invertebrates. III. Coded wire tags useful in automatic recovery of chinook salmon and steelhead trout. U.S. National Marine Fisheries Service. Marine Fisheries Review 36(7):10–13.

Gibbard, G. L., and R. L. Colura. 1980. Retention and movement of magnetic nose tags in juvenile red drum. Annual Proceedings of the Texas Chapter, American Fisheries Society 3:22–29. (Texas Parks and Wildlife Department, Austin.)

Heidinger, R. C., and S. B. Cook. 1988. Use of coded wire tags for marking fingerling fishes. North American Journal of Fisheries Management 8:268–272.

Jefferts, K. B., P. K. Bergman, and H. F. Fiscus. 1963. A coded wire identification system for macro-organisms. Nature (London) 198:460–462.

Jenkinson, D. W., and H. T. Bilton. 1981. Additional guidelines to marking and coded wire tagging of juvenile salmon. Canadian Technical Report of Fisheries and Aquatic Sciences 1051.

Williamson, J. H. 1983. Retention of wire nasal tags by largemouth bass. Annual Proceedings of the Texas Chapter, American Fisheries Society 6:21. (Texas Parks and Wildlife Department, Austin.)

Williamson, J. H. 1987. Evaluation of wire nose tags for marking largemouth bass. Progressive Fish-Culturist 49:156–158.