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Retention of Passive Integrated Transponder (PIT) Tags for Individual Identification of Warmwater Stream Fishes

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INTRODUCTION

The inability to recognize individual fish has hampered many ecological studies of small fish, especially studies that concern growth or movement. Tagging fishes with radio or external tags, which allow individual identification, is limited to relatively large fishes because the size of the tags are large relative to the body size of most fishes (Bergman et al., 1992). Although unique marks using subcutaneous injection of paints or dyes are relatively harmless to small fishes and can be made by varying body position and color combination (Kelly, 1967; Lotrich and Meredith, 1974; Thresher and Gronell, 1978; Thompson and Knight, 1986; Hill and Grossman, 1987), they are generally time consuming and the number of unique marks is limited. Mark retention can also be short lived, especially in fast growing fishes (Kelly, 1967). Visible implant (VI) tags are another type of externally visible mark, but require implantation in clear tissue for detection and can also be time consuming to apply (Bergman et al., 1992). Passive integrated transponder (PIT) tags are reported to have high retention rates (up to ten years), provide unique numerical codes and can be injected quickly (Prentice et al., 1990a). Unlike coded wire tags, which also have unique numerical codes, PIT tags do not require recovery from dead fishes; the tag signal can be read from live individuals through the body wall (Prentice et al., 1990b). Numeric codes from PIT tags are read with a scanner that activates the tag with a low frequency radio signal. Although PIT tags have been tested with salmonids (Braennaes et al., 1989; Prentice et al., 1990a), largemouth bass (Harvey and Campbell, 1989) and other large fishes such as sturgeons (Clugston, 1996), their use for non-game fishes has not been reported, except for a large western cyprinid, *Gila cypha* (Douglas and Marsh, 1996). The objective of this study was to evaluate the effectiveness of PIT tags for marking relatively small stream fishes. Specifically, we evaluated tag retention in several warmwater stream species in the laboratory and the field.

MATERIALS AND METHODS

Laboratory Study

Four species of fish were chosen for evaluation of PIT tags: bluntface shiner (*Cyprinella camura*; n=31 experimental and 8 controls; standard length (SL)=62-95 mm, $\bar{x}$=73.1, SD=7.9); creek chub (*Semotilus atromaculatus*; n=34 experimental and 8 controls; SL=73-140 mm, $\bar{x}$=97.8, SD=19.0); brown madtom (*Noturus phaeus*; n=31 experimental and 7 controls; SL=62-140 mm, $\bar{x}$=90.8, SD=19.7); and longear sunfish (*Lepomis megalotis*; n=57 experimental and 17 controls; SL=56-131, $\bar{x}$=85.8, SD=16.9). Fishes were collected in the spring and summer of 1995 from Goodwin Creek in Lafayette County, Mississippi (Yazoo River drainage). Study species were collected by electrofishing with a backpack shocker and dip nets. Fishes were held in 84-liter aquaria in a laboratory for one week prior to tagging.

Fishes were anesthetized in a 200 mg/l solution of tricane methanesulfonate (MS -222) and 400 mg/l sodium bicarbonate. Experimental fishes were measured (SL; mm) and PIT tags were injected with a 10-cc syringe and 5/8-cm needle into the peritoneal cavity anterior to the anus. Control fishes were anesthetized, measured, and injected, but no tag was inserted. Due to the length of the tags (approximately 14 mm) and the diameter of the needle, we found that creek chubs smaller than 70 mm, bluntface shiners smaller than 62 mm, brown madtoms smaller than 68 mm and longear sunfishes smaller than 60 mm could not be tagged effectively. Bluntface shiners, creek chubs and brown madtoms were held in 84-liter tanks located in a laboratory at the Center for Bottomland Research. They were checked for mortality and fed fish food pellets daily. Control fishes, which were indistinguishable from treated fishes that lost tags, were held in separate tanks and treated identically. Longear sunfish were held in 20 1250-liter tanks housed at the University of Mississippi Biological Field Station, and were also cared for daily. A limited number of tanks required that multiple fish were held per tank. All fish were checked daily for tag retention the first week following tag insertion and were

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checked every two weeks thereafter until the conclusion of the study. Presence of the tag was determined by passing a hand-held scanner over the live fish. Brown madtoms were held 60 days, creek chubs for 147 days, bluntface shiners for 80 days and longear sunfish for 180 days.

Field Study

As part of a study on movement patterns, individual longear sunfish, green sunfish (*Lepomis cyanellus*) and creek chub in two streams in the Ouachita Highlands, South Alum Creek (Saline River drainage), Saline Co., Arkansas and Little Glazypeau Creek (Ouachita River drainage), Garland Co., Arkansas were marked with PIT tags. Fishes were collected using the same protocol as the laboratory study. The mean SL (range and SD in parentheses) of fishes used in the field study are as follows: creek chub, 96.8 mm (70-132, 16.3); longear sunfish, 81.8 mm (64-110, 14.0); green sunfish, 90.6 mm (62-146, 21.0). Mean SL (and standard deviation) for recaptured fishes were as follows: creek chub, 98.8 mm (17.6); longear sunfish, 82.1 mm (12.7); green sunfish, 88.2 mm (18.7).

Fishes were anesthetized and PIT tags were injected using the same methods as the laboratory study. External paint marks were applied to all fishes that were injected with PIT tags to detect recapture information in event a PIT tag was lost. Using the methods of Hill and Grossman (1987), these fishes were given an external mark by injecting non-toxic paint under the skin. The color and location of the marks corresponded to the location of the pools where the fishes were collected. Upon recovery from anesthesia, tagged fishes were returned to the collection area. On subsequent field trips, all collected fishes were scanned for the presence of a PIT tag. The date of collection, tag number and collection location of tagged fishes were recorded. Untagged fishes in the samples were tagged after weight and length measurements were taken. Sampling intervals ranged from two weeks to four months, with more frequent sampling during the spring and summer months.

RESULTS

Laboratory study

The four fish species had different tag retentions. Mortality due to handling and tagging was low (Table 1). Upon termination of the experiment, all fishes were autopsied to determine whether the tags were present or absent. Due to limited tank facilities, the experiments with brown madtoms, which almost uniformly retained tags, and bluntface shiners, which almost all lost tags, were terminated sooner than the other two species. Brown madtoms had the highest tag retention (100%) and survivorship (97%) after the 60 days they were held. A group of ten tagged madtoms was held over 180 days and all still retained their tags. Bluntface shiners had very low tag retention (6%), but had a 87% survival rate. The low tag retention for this species was attributable to tag loss through the injection wound, which did not close immediately. Both creek chub and longear sunfish had high tag retention, but fairly low survivorship (74% and 61% respectively) due to aggression with other fish. Fishes that died from jumping out of tanks or from wounds suffered from aggressive encounters with other fish all retained tags. In particular, the longear sunfish in our study appeared to have relatively low survival due to the holding conditions (47% survival of controls). This is an aggressive species in captivity, and animals were aggressive even in large holding tanks. All mortality of longear sunfish was due to fighting, and not to the tagging procedure.

Field Study

The 37 month duration of the field study provided an opportunity to monitor long-term tag retention, as well as performance, in the field (Table 2). By referring to the numeric codes of the tags in recaptured fishes, duration of tag retention was calculated. The external paint marks also enabled us to assess tag loss. Less than 1.24% (2 out of 161) of tagged fishes were recaptured with an external mark and no PIT tag. All fishes with PIT tags had external marks. Approximately 20% of the fishes recaptured in this study (all species combined) retained the PIT tags over one year post-tagging.

DISCUSSION

PIT tags are a feasible method for individually marking some species of stream fishes. Field and laboratory data indicated creek chub and sunfish retain tags for relatively long periods of time and appeared to be minimally affected by the tagging procedure. Brown madtom also had high tag retention and showed no mortality due to the tagging procedure. Bluntface shiner, however, was less successfully marked with PIT tags. Variability in retention rates require this procedure to be assessed on a species-specific basis as indicated by the results of this study and the findings of other PIT tag studies such as Prentice et. al 1990a which reported the retention rate for juvenile chinook salmon (fork length 66-100 mm) was 98% after 507 days and Harvey and Campbell 1989 which reported a 100% retention rate of largemouth bass brood fish for a duration of 24 months. In this study, the long retention times for creek chub and longear sunfish indicated that PIT tags would be useful for estimating home ranges and population sizes of these species, but would not be appropriate for these purposes in species that lost tags quickly. The size of the fish must also be considered because fishes below a certain size (e.g. longear sunfish < 60 mm) physically could not be injected with PIT tags.

The speed and effectiveness of the PIT tagging procedure gives investigators an opportunity to individually mark large numbers of fishes in a timely manner. Because the codes can be read through the body wall of fishes, tagged fishes can be released and can be monitored over their lifetime. Implantation was invasive, but left only a small injection wound that healed quickly in most of the species we studied. The internal location of the tag prevents the potential infections frequently associated with external tags large enough to carry information on

Table 1. Survival and tag retention of PIT tagged fishes held in the laboratory. Species were tested from 60 to 180 days. Percent survival is the number of fish alive at the end of the test period/the total number of fish. The numbers in parentheses are the total numbers of fish alive at that time. Percent tag retention included the number of fish that died with tags plus the number of fish with tags at the end of the test period/number of fish.

Species	Test	Control	Number of Days Post Tagging 1	4	21	35	60	80	100	147	180	% Survival Test	% Survival Control	% Tag Retention
Cyprinella camura	31	8	24(31)	24(31)	24(27)	24(27)	5(27)	2(27)	-	-	-	87	100	6
Semotilus atromaculatus	34	8	32(34)	30(34)	26(33)	24(33)	16(27)	15(26)	12(26)	11(25)	-	74	100	59
Noturus phaeus	31	7	31(31)	31(31)	31(31)	31(31)	31(30)	-	-	-	-	97	86	100
Lepomis megalotis	57	17	41(52)	41(52)	27(40)	23(38)	22(38)	18(35)	18(35)	18(35)	18(35)	61	47	70

Table 2. Pit tag recovery and retention of fishes in Ouachita Highlands streams. Values show number of recaptures. Total number of recaptured fish was: *S. atromaculatus*, n=11, plus four multiple recaptures; *L. cyanellus*, n=61 plus 16 multiple recaptures; *L. megalotis*, n=52, plus 17 multiple recaptures.

Species	Days Between Tagging and Recapture 1	34	36	49	56	60	84	90	96	144	213	269	273	303	309	323	329	357	363	365	399	413	447
Semotilus atromaculatus	1	1	1	1	1	2	1	-	4	-	-	-	-	-	-	-	-	-	1	-	1	-	1
Lepomis cyanellus	-	12	2	6	4	5	3	3	5	4	3	1	1	-	1	1	4	5	2	4	3	5	3
Lepomis megalotis	-	3	5	11	2	2	4	-	4	5	4	2	2	2	5	-	2	2	1	3	4	5	1

individual identification. Unlike external paint marks, PIT tags provide large numbers of unique codes that are unambiguous. One drawback of PIT tags, however, is that they are more expensive than external paint marks (approximately $500 per hundred fishes).

This technology is valuable for studies of non-game as well as game fishes. Tagging methods for small, non-game fishes that allow individual identification has hindered research into many aspects of the ecology. Ecologists may be able to use tagging techniques, such as PIT tags, to increase our understanding of these poorly known fishes. We conclude that PIT tags are an appropriate method of marking individual sunfish, catfish and some species of minnow when research questions require individual recognition without sacrifice of recaptured fish.

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