

Long-Term Passive Integrated Transponders (PIT) Tag Retention in Juvenile Rainbow Trout and Brown Trout

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How to cite this paper: Hanson, B.J., Davis, J.L., Voorhees, J.M., Huysman, N. and Barnes, M.E. (2020) Long-Term Passive Integrated Transponders (PIT) Tag Retention in Juvenile Rainbow Trout and Brown Trout. *Open Journal of Marine Science*, 10, 110-115.

<https://doi.org/10.4236/ojms.2020.103008>

Received: April 28, 2020

Accepted: May 22, 2020

Published: May 25, 2020

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Abstract

Two hundred and forty-three juvenile rainbow trout *Oncorhynchus mykiss* ranging from 73 to 119 mm were implanted with 8, 9, or 10 mm Passive Integrated Transponder (PIT) tags, with tag retention and fish survival observed for 343 days. Similarly, 173 brown trout *Salmo trutta* ranging from 71 to 86 mm were implanted with 8 or 10 mm PIT tags and observed for 293 days. Over the entire duration of the study, rainbow trout ejected only six tags, while no tags were ejected from the brown trout. All of the rainbow trout tag ejections occurred before 50 days post-tagging. There was no significant difference in the length or weight of fish that ejected tags compared to those that retained tags. No fish died during the trials. These results indicate that rainbow trout and brown trout at the sizes used in this study can be safely implanted with, and subsequently retain, up to 10 mm PIT tags for durations of nearly one year.

Keywords

Tagging, Salmonids, Passive Integrated Transponders, PIT Tag, Fingerling

1. Introduction

Passive Integrated Transponders (PIT) are relatively small, injectable, long-lasting tags emitting unique alphanumeric codes [1] [2]. The codes can be read remotely without having to look at the tag, thereby allowing the tag data to be obtained without having to physically handle the tagged fish [3] [4]. PIT tags are routinely used in fisheries management, particularly when assessing individual fish behavior, growth, and mortality [5] [6] [7] [8] [9].

The relationship between fish size and tag size has a direct effect on the survival of the tagged fish and retention of the tag [3] [10] [11]. This relationship is based almost exclusively on studies evaluating larger fish tagged with larger PIT tags; only Borchert *et al.* [12] examined the use of small pit tags in smaller, juvenile salmonids. However, Borchert *et al.* [12] only examined tag loss and fish survival for approximately five months after tagging.

Juvenile fish survival and growth is of interest to fisheries managers but is frequently lacking [13] [14]. Thus, additional information on long-term PIT tag retention and the survival of juvenile PIT tagged fish is needed. The objective of this study was to evaluate the implantation of small PIT tags in two species of juvenile salmonids for a very extended time frame.

2. Methods

This study was a continuation of the Borchert *et al.* [12] trial but extended the data collection period to 343 days for juvenile rainbow trout *Oncorhynchus mykiss* and 293 days for brown trout *Salmo trutta*.

Trout were anesthetized to stage 4 anesthesia [15] with tricaine methanesulfate (MS-222; Syndel, Ferndale, Washington, USA). A PIT tag (MiniHPT8, HPT9, or MiniHPT10; Biomark, Boise, Idaho, USA) was then implanted using a handheld injector into the peritoneal cavity. Each fish was then measured to the nearest mm and weighed to the nearest 0.1 g. The unique 12-digit alphanumeric identification number was then obtained using a HPR Lite reader (Biomark, Boise, Idaho, USA). All of the tagged fish were placed into one, 1.8-m diameter circular tank receiving well water (11°C; total hardness as CaCO₃, 360 mg/L; alkalinity as CaCO₃, 210 mg/L; pH, 7.6; total dissolved solids, 390 mg/L). They were fed to satiation or slightly above satiation once daily (1.5 mm floating PROTEC FW, Skretting North America, Tooele, Utah, USA). Tagging, rearing, and data collection occurred at McNenny State Fish Hatchery, Spearfish, South Dakota, USA. Tag retention was checked weekly for the first three weeks after tagging and monthly there-after. Total lengths and weights were recorded from any fish that ejected tags.

Rainbow trout were tagged on February 11, 2019 with either 8, 9, or 10 mm PIT tags. Brown trout were tagged on April 1, 2019 with either 8 or 10 mm tags. Final tag checks occurred on January 20, 2020. Initial fish lengths, weights, and the PIT tag sizes used are listed in **Table 1**.

Data were analyzed using the SPSS (24.0) statistical analysis program (IBM, Armonk, New York, USA). Percentage data were log transformed prior to analysis of variance to stabilize the variances [16]. Retention data was analyzed using Pearson's chi-square tests. Length and weight comparisons between trout that either lost or retained tags were conducted using two-sample t-tests. To evaluate differences in final total length and weight among the tag sizes, Kruskal-Wallis One Way Analysis of Variance on Ranks was used. Significance for all tests was predetermined at $P < 0.05$.

3. Results

All of the juvenile brown trout retained their PIT tags, compared to 97.5% of the juvenile rainbow trout (**Table 2**). Tag size-specific retention rates in the rainbow trout were as follows: 8 mm - 95.9%; 9 mm - 98.8%; 10 mm - 98.4%. Only rainbow trout lost tags over the course of the 343-day trial, and all tag ejections occurred before 50 days post-tagging. Three tags were lost within the first eight days, one tag was lost after day nine and before day 15, and two tags were lost between days 22 and 50. There was no significant difference in length or weight in the rainbow trout that either retained or ejected their tags, nor was there any significant difference in retention rates among the three sizes of tags. There were no significant differences in either rainbow trout or brown trout final lengths or weights among the different tag groups. The final tank rearing density was 56.8 kg/m³. No mortalities were observed during the study period.

4. Discussion

This study extended the positive results of tag retention and tagged fish survival

Table 1. Initial minimum, maximum, and mean (SD) total lengths and weights of rainbow trout and brown trout implanted with different size passive integrated transponders.

Species	Tag size	Length (mm)			Weight (g)			N
		Min	Max	Mean (SD)	Min	Max	Mean (SD)	
Rainbow trout	8	80	119	100 (8)	5	20	12 (3)	98
	9	73	117	100 (9)	4	19	12 (3)	82
	10	78	118	99 (8)	6	21	12 (3)	63
	Overall	73	119	100 (8)	6	21	12 (3)	243
Brown trout	8	71	83	76 (3)	4	7	5 (1)	88
	10	71	86	76 (3)	4	8	5 (1)	89
	Overall	71	86	76 (3)	4	8	5 (1)	177

Table 2. Final minimum, maximum, and mean (SD) total lengths, weights, and tag retention of rainbow trout and brown trout implanted with different size passive integrated transponders.

Species	Tag size	Length (mm)			Weight (g)			Ret. (%)	N
		Min	Max	Mean (SD)	Min	Max	Mean (SD)		
Rainbow trout	8	193	339	281 (23)	93	480	300 (71)	95.9	94
	9	178	339	278 (29)	77	534	292 (85)	98.8	81
	10	209	343	283 (24)	156	529	310 (80)	98.4	62
	Overall	178	343	280 (26)	77	534	300 (79)	97.5	237
Brown trout	8	161	289	192 (18)	57	351	99 (35)	100	88
	10	160	292	190 (20)	55	379	97 (45)	100	89
	Overall	160	292	191 (19)	55	379	90 (40)	100	177

reported by Brochert *et al.* [12] by over four months. Thus, juvenile rainbow trout and brown trout at the sizes used in this study can be safely tagged with 8 to 10 mm PIT tags with expectations of no mortality and near-total tag retention for nearly 10 to 12 months, respectively. The durations of other PIT tag studies involving juvenile salmonids and small tag sizes documenting tag retention rates and tagged fish survival similar to this study has been much shorter, ranging from 28 to 64 days [14] [17]. High tag retention of small PIT tags and low tagged fish mortality has also been documented in other small non-salmonid fish [18] [19] [20] [21].

In this study, the tag-to-body ratio never exceeded the 2% recommendation of Winter [22]. It should be noted however, that ratios of up to 6% have been successfully used in brown trout by Richard *et al.* [23]. In addition, the swimming of juvenile rainbow trout is unaffected by ratios approaching 12% [24].

It is possible that the results of this study could have been influenced by the individuals tagging the fish and the conditions where the fish were reared. Different individuals with different levels of tagging experience, but no experience at all with small PIT tags, tagged the rainbow trout and brown trout in this study. The observed high retention rates and high fish survival indicate that the amount of tag experience was not an issue, in contrast to the observations of Dare [25], Meyer *et al.* [26], and Richard *et al.* [23]. Long-term rearing in the circular tank is obviously different than a natural situation with fluctuating water levels and variable environmental conditions that may impact tag retention [27]. However, the relatively high and constant water velocities used in the tank, the relatively crowded conditions potentially causing aggressive behaviors, and the disturbances associated with routine hatchery activities such as tank cleaning, suggest that the observed retention rates may be similar to what would occur in more natural environments.

5. Conclusion

In conclusion, this study indicates that 73 to 119 mm rainbow trout can be successfully implanted with 8, 9, and 10 mm PIT tags with minimal tag ejection and extremely high tagged fish survival for nearly one year. Brown trout ranging from 71 to 86 mm can also be successfully tagged for up to nearly ten months. These results will allow for the long-term monitoring of juvenile salmonids, providing another tool for use by fisheries managers and researchers.

Acknowledgements

We thank Jeremy Kientz, Eric Krebs, Misty Jones, and Charles Mordhorst for their assistance with this study.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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