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Retention of visible implant alphanumeric tags in adult Walleye

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ABSTRACT

In 2010, Northwest Marine Technology introduced a more rigid visible implant alphanumeric (VIA) tag that substantially improved the tag loading and injecting process. To achieve these improvements, VIA tag size and composition was modified, thereby potentially influencing previously examined VIA tag retention rates on Walleye *Sander vitreus*. Effects of total length (TL), sex, and days post-tagging on retention of VIA tags injected underneath the lower mandible of adult Walleye were evaluated from 2012 to 2016. Walleye (n = 2455) collected from natural lakes in Iowa were measured, sexed, and injected with identical VIA tags on each side (left and right) of the lower mandible. Of 366 Walleye recaptured up to four years post-tagging, 241 had both tags; the remaining fish had retained only one tag. Overall, tag retention adjusted for fish that lost both tags (n = 14) was 80% (607 of 760). Retention of VIA tags was not influenced by sex, TL at time of marking, or number of days post-tagging and did not substantially differ from previously examined large-format VIA retention rates. In studies requiring high tag retention in Walleyes, VIA tags injected into the clear tissue underneath the mandible should be avoided.

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Introduction

Fisheries managers routinely estimate fish stock statistics via mark-recapture data (Miranda and Bettoli 2007). Accuracy of these estimates relies on the ability to effectively mark fishes without changing fish behavior (Nielsen 1992). Visible implant alphanumeric (VIA) tags (Northwest Marine Technology [NMT], Inc., Shaw Island, Washington) have a three-digit code that can be read through translucent tissues to identify individual fish with little or no impact on fish growth, condition, or survival (Haw et al. 1990; Bryan and Ney 1994; Zerrenner et al. 1997; Turek et al. 2014). Tag retention of VIA tags has been extensively documented for salmonids tagged in post-orbital or fin ray tissue with variable results (see Turek et al. 2014). Channel Catfish *Ictalurus punctatus* and Walleye *Sander vitreus* injected with VIA tags into clear tissue had retention rates ranging from 0% to 76% (Buckmeier and Irwin 2000; Meerbeek et al. 2013). In general, VIA tag retention has been highly associated with fish length at tagging, with larger fish having higher retention rates (McMahon et al. 1996; Shepard et al. 1996; Meerbeek et al. 2013).

Since their original introduction in the 1990s, composition of VIA tags has changed from polyester to an elastomer film and both were available in either a standard (0.098 × 0.039 × 0.004 in) or large-format (0.138 × 0.059 × 0.004 in) size. In 2010, NMT developed and began marketing a VIA tag (0.106 × 0.047 × 0.004 in) that was easier to load and inject than its predecessors. While

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retention rates of previous VIA tags have been thoroughly investigated (Hughes et al. 2000; Rikardsen et al. 2002; Isely et al. 2004), long-term and tag location retention rates for current standard VIA tag are largely unknown. Recent evaluations of current standard VIA tags have been short-term (< one year) laboratory studies and researchers reported poor (≤ 36%) tag retention for salmonids and cyprinids tagged in the cheek, caudal peduncle, ventral jaw, and anal fin (Wagner et al. 2013; Davis et al. 2014; Neufeld et al. 2015). Retention of VIA tags inserted in post-orbital tissue of salmonids (total length [TL] range of 3.3 - > 11.8 in) and Tiger Muskellunge *Esox masquinongy X E. lucius* (mean TL 3.6 in) ranged from 55% to 100% and in one instance increased with salmonid size (Davis et al. 2014; Turek et al. 2014).

In Iowa, large-format VIA tags were injected in the lower mandible of Walleye from 1990 through 2009 to estimate population parameters. Large-format VIA retention rate for this species in this location was 76% and resulted in erroneous estimates of Walleye abundance, survival, and recruitment (Meerbeek et al. 2013). In 2010, the Iowa Department of Natural Resources (DNR) began injecting current standard VIA tags in Walleye. For results from population models to be meaningful, estimates of tag retention were necessary for VIA tags so that population models could be adjusted accordingly. The objectives of this study were to determine if retention rates of VIA tags differed from large-format VIA tags and if retention was influenced by TL, sex, or days post-tagging.

Methods

Walleye were collected from a chain of lakes in northwestern Iowa during March–April 2012 and 2013 and transported to the Spirit Lake Fish Hatchery using the same procedures as described in Meerbeek et al. (2013). Walleye were measured (TL; in), sexed (determined by extrusion of gametes [Walleye that did not excrete gametes were classified as immature females]), and two identical VIA tags (0.106 × 0.047 × 0.004 in; NMT) were injected via a single-shot syringe just below the soft, clear tissue on the underside of the lower mandible, with each side (left and right) receiving one tag each. All tagging was performed by the same individual. A total of 1253 female Walleye (range = 11.2–29.2 in; mean TL = 20.3 in; standard deviation [SD] = 2.1) and 1202 male Walleye (range = 12.2–25.4 in; mean TL = 19.4 in; SD = 1.9) were implanted with VIA tags collectively in 2012 and 2013. Tagged Walleye were released back to the lake of capture and recaptured during annual gill netting surveys in March-April 2012–2016 and occasionally by angler creel returns. Recaptured Walleye were examined for both tags, measured, and released (unless harvested by an angler).

Tag retention rates were adjusted to account for Walleye that had lost both tags via the formula provided by Krebs (1999):

$$k = \frac{R_A\, R_B}{(R_A + R_{AB})(R_B + R_{AB})},$$

$$c = \frac{1}{1 - k},$$

and

$$\hat{R} = c(R_A + R_B + R_{AB}),$$

where k and c represent the number of recaptured Walleye, R_A is the number of recaptured Walleye with only a left VIA tag, R_B is the number of recaptured Walleye with only a right VIA tag, R_{AB} is the number of recaptured Walleye with both tags, and $\hat{R}$ is the estimated total number of recaptures. Overall retention rates were calculated by summing the number of individual VIA tags observed from recaptures and dividing by the total number of VIA tags expected (corrected for fish that lost both tags). Effects of TL, sex, and days post-tagging (independent variables) on Walleye VIA tag retention (dependent variable) were assessed using logistic regression. Analyses were performed using SAS 9.4 (SAS Institute, Inc., Cary, North Carolina; $\alpha = 0.05$).

Results

Walleye (n = 366; range = 15.7–26.5 in; mean TL = 19.9 in; SD = 1.5) were recaptured up to four years post-tagging (1 – 1472 d). Thirty-seven Walleyes were recaptured within the first year (1 – 192 d), 267 fish were recaptured one to two years (357 – 754 d), and 62 fish were recaptured three to four years (1075 – 1472 d) post-tagging. Collectively, 241 fish retained both VIA tags, and the remaining fish retained either the left tag (n = 42) or right (n = 83) tag only. An estimated 14 fish lost both tags; therefore, 380 Walleye (760 individual VIA tag observations) were used to determine overall retention rates. Tag retention adjusted for fish that lost both tags was 80% (607 of 760 individual VIA tag observations) and was not influenced by Walleye sex, TL at time of marking, or the number of days post-tagging at recapture (logistic regression: df = 1, $P \geq 0.34$).

Discussion

In this study, VIA tag retention in adult Walleye was 80% and was similar to retention of large-format VIA tags inserted in the same location (76%; Meerbeek et al. 2013). However, retention of the VIA tag was not influenced by fish length, as was observed with large-format VIA tags (Walleye TL range = 13.2 – 29.4 in; Meerbeek et al. 2013). Length at time of tagging for recaptured Walleye in this study ranged from 15.7–26.5 and was larger than TLs expected to influence tag retention rates (McMahon et al. 1996; Shepard et al. 1996; Hughes et al. 2000; Rikardsen 2000). However, most (127 of 129) of the fish recaptured in Meerbeek et al. (2013) were tagged at TLs $\geq$ 16.7 in, yet tag retention significantly decreased for Walleye $<$ 24.0 in. The larger injector needle used for large-format VIA tags may explain why smaller Walleye lost tags more frequently in Meerbeek et al. (2013). In addition, it was not uncommon for the current standard VIA tag to be implanted deeply into the lower mandible tissue of Walleye due to the smaller needle size and ease of insertion into the flesh. These instances were recorded during the study and an ad hoc analysis comparing a qualitative assessment of tag retention of deep and shallow inserted VIA tags found that deeply inserted tags had better retention than those assigned as shallow. The simple act of implanting more deep VIA tags in this study could have influenced VIA retention for smaller Walleye. However, since overall tag retention rates between the two VIA tag types were not substantially different, tag placement alone may not result in significant improvements in VIA tag retention. Although tag insertion depth may improve VIA tag retention, it is recommended that a controlled experiment designed at evaluating VIA tag placement depth and retention rates be conducted prior to large-scale application.

Careful consideration must be given when choosing a tag type and location prior to conducting fisheries surveys. The VIA tag has many of the desirable traits of an 'ideal' tag (Nielsen 1992), however, tag retention rates can be less than desirable for studies that need to obtain meaningful estimates of fish population statistics (Meerbeek et al. 2013; this study). Advances in fish tagging equipment and techniques coupled with reductions in cost have increased the ability for agencies and universities to engage in more fisheries research and monitoring projects. Thus the search for the 'ideal' tag continues. Retention rates of the passive integrated transponder (PIT) tag have been the most consistent (>97%) for a variety of species implanted in multiple locations (Wagner et al. 2007; Isermann and Carlson 2008; Daugherty and Buckmeier 2009; Rude et al. 2011). Vandergoot et al. (2012) reported high retention rates (98%) of PIT tags injected subcutaneously into the isthmus of Walleye and the Iowa DNR has been using this method to individually mark Walleye since 2015 with much improved retention rates (99%; unpublished data). This has allowed for more accurate estimation of population statistics without making adjustments to population models and at a similar cost as implanting VIA tags. However, VIA tags do have advantages over PIT tags and other internal tags as they are generally easily visible and can be reported by anglers or during subsequent fisheries surveys without the use of specialized equipment. In studies where returns from these sources are important components of the study design, VIA tags could provide essential recapture data. Given these limitation of VIA tags, managers need to thoroughly review study objectives prior to choosing tag type.

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Disclosure statement

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Notes on contributor

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