Qualitative observations of successful spawning by two species of small-bodied minnows following PIT tagging

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Passive integrated transponder (PIT) tags are commonly used for a variety of purposes in fish ecology and management. Historically, PIT tag use was restricted to large-bodied species (e.g., salmonids; Prentice et al. 1990, Dieterman and Hoxmeier 2009), but the recent availability of smaller tags now allows for tagging of smaller-bodied species (i.e., <100 mm total length [TL]; Bangs et al. 2013, Pennock et al. 2018). As tagging of smaller-bodied species has become more common, so has research into the effects of tagging on fishes, including the effects of PIT tagging on fish survival (Skov et al. 2005, Ficke et al. 2012, Cary et al. 2017), retention of PIT tags (Archdeacon et al. 2009, Clark 2016, Pennock 2017), and behavior of tagged fishes (Ficke et al. 2012). For example, tag retention can be highly variable among species (Clark 2016, Pennock et al. 2016, Pennock 2017) and can differ among sexes due to spawning (Šmejkal et al. 2019). Despite being species-specific, tagging effects remain unstudied for many nongame, small-bodied species.

ABSTRACT.—PIT tags are a common tool used to identify and track movements of fishes. Although technological advances facilitated the use of PIT tags across a wide range of fish body sizes, we do not yet fully understand the effects of PIT tagging on basic aspects of many species’ life histories (e.g., survival, spawning success, or reproductive output). We observed 2 small-bodied fishes, Red Shiner (Cyprinella lutrensis) and Bluntnose Minnow (Pimephales notatus), achieve successful spawns after PIT tagging. Age-0 fish of both species were observed in multiple experimental stream units during an outdoor mesocosm study in which only PIT-tagged fish were stocked. Although these observations suggest that qualitative effects on spawning success of PIT-tagged, small-bodied fish might be negligible, more quantitative studies need to be conducted to test these assumptions. As use of PIT-tagging technology continues to increase, understanding the effects of PIT tags on fish life histories will ensure that tagging studies provide reliable data without negatively impacting fish populations.

RESUMEN.—Las etiquetas transpondedor integrado pasivo (PIT) son una herramienta común que se utiliza para identificar y rastrear los movimientos de los peces. Aunque los avances tecnológicos facilitaron el uso de etiquetas PIT en una amplia gama de tamaños de cuerpos de peces, todavía no comprendemos completamente los efectos del etiquetado PIT en aspectos básicos del ciclo vital de muchas especies (e.g., supervivencia, éxito de desove, o producción reproductiva). Observamos dos peces de cuerpo pequeño, Red Shiner (Cyprinella lutrensis) y Bluntnose Minnow (Pimephales notatus), lograr desoves exitosos después del etiquetado PIT. Peces de edad-0 de ambas especies se observaron en múltiples unidades experimentales durante un estudio de mesocosmos al aire libre en el que sólo se almacenaban peces con etiquetas PIT. Aunque estas observaciones sugieren efectos cualitativos en el éxito del desove de peces pequeños con etiquetas PIT podrían ser insignificantes, es necesario realizar estudios más cuantitativos para probar estos supuestos. Comprender los efectos de las etiquetas PIT en los ciclos vitales de los peces es importante, ya que el uso de esta tecnología sigue aumentando para garantizar que los estudios de etiquetado proporcionen datos fiables sin afectar negativamente a las poblaciones de peces.
for the reliability of results based on tagging studies. Yet, there is a paucity of information on tagging-related effects for many species of fish. Given these assumptions, and considering that once a fish is PIT tagged it will likely carry that tag for the rest of its life, there is a need to assess the impacts of tagging on reproductive fitness to ensure that tagging procedures do not influence the behavior or success of tagged individuals, such as whether tagged individuals spawn or not (reviewed by Cooke et al. 2011). This information is vital to the continued use of PIT tags to provide reliable and unbiased results in tagging studies. Herein, we document qualitative observations made during a mesocosm experiment, whereby we observed the outcome of successful spawning (i.e., the presence of age-0 fishes) following PIT tagging of adults of 2 species of small-bodied stream fishes.

These observations took place at the experimental stream mesocosm facility on Konza Prairie Biological Station near Manhattan, Kansas (39°06′25″N, 96°36′32″W) in the summer of 2019. Stream mesocosms consisted of alternating riffle and pool mesohabitats, with recirculating water creating directional flow. Substrate particles in the mesocosms averaged 25 mm in diameter. Our experiment included a total of 5 experimental units (connected riffle-pool units) for fish recovered from the mesocosms. We first observed age-0 fishes on 22 July 2019 in 2 experimental mesocosm units and had observed age-0 fish in all 5 experimental units by 27 July 2019. As mesocosms were dry and empty prior to stocking fish for this experiment, and as only adult fish were stocked, age-0 fish could have only resulted from successful spawning by stocked PIT-tagged adults, indicating that the presence of PIT tags, or the tagging process, did not prevent spawning.

These observations suggest that PIT tagging did not prevent spawning by 2 species of small-bodied fishes, some of which were in spawning condition prior to being tagged. Given the relatively high tag retention in recovered adults of both species, tag retention appears not to be heavily influenced by spawning activity in these 2 species. The mesocosm experiment wherein we observed the outcome of successful spawning was not designed to quantify the effects of PIT tags on reproductive output. Thus, these opportunistic observations only suggest that PIT

<table>
<thead>
<tr>
<th>Species</th>
<th>Number stocked</th>
<th>Number recovered</th>
<th>Number recovered without PIT tags</th>
<th>Proportion retaining PIT tags</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bluntnose Minnow</td>
<td>343</td>
<td>273</td>
<td>5</td>
<td>0.98</td>
</tr>
<tr>
<td>Red Shiner</td>
<td>343</td>
<td>282</td>
<td>14</td>
<td>0.95</td>
</tr>
</tbody>
</table>

TABLE 1. Number stocked, number recovered, and proportion retaining PIT tags for Bluntnose Minnow (*Pimephales notatus*) and Red Shiner (*Cyprinella lutrensis*) stocked into experimental mesocosms prior to observation of age-0 fish of both species in all 5 experimental units.
tagging does not completely prevent spawning for these species; we lack data on how many fish contributed to spawning as well as quantitative information on how many age-0 fish were produced relative to a group of untagged fish. It is clear that more research on this topic is needed (Cooke et al. 2011), as we are aware of only 2 studies that have assessed the reproductive consequences of PIT tagging in fishes. Gonadal development was not impacted in PIT-tagged Eurasian Perch (Perca fluviatilis) ranging in size from 55 to 96 mm TL (Baras et al. 2000). Similarly, there were no statistically significant differences in gonadal somatic index or number of eggs produced between untagged Black-spotted Topminnows (Fundulus olivaceus) and those with either 8-mm or 12-mm PIT-tags (Clark 2016). Moreover, PIT-tagged females had larger eggs. These 2 studies suggest that PIT tagging might have minimal effects on reproductive output in small-bodied fishes, but no quantitative studies have assessed successful spawning, number or condition of offspring, or successful recruitment of age-0 fish.

Although qualitative, our results provide some evidence that PIT tagging small-bodied fishes does not alter their ability to spawn. If tagged fish are able to spawn, it is reasonable to assume that PIT tags do not significantly alter their ability to devote resources to production of gametes and reproductive behavior (e.g., site preparation, defense, courtship, etc.; reviewed by Wootton and Smith 2015). Limited existing studies suggest that effects on reproductive output are minimal (Baras et al. 2000, Clark 2016), but more work is needed to understand the full range of effects of PIT tagging on spawning ability and overall reproductive success for more species of fish. Future research might explore the number and quality (e.g., size, weight, and condition) of age-0 fish produced by PIT-tagged adults relative to untagged fish. Generally, more research is needed on the effects of PIT tagging on small-bodied nongame fishes, particularly those of conservation concern for which tagging studies can reveal useful ecological information.

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Literature Cited


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