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Short communication

Successful external acoustic tagging of twaite shad *Alosa fallax* (Lacépède 1803)

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ABSTRACT

Although twaite shad (*Alosa fallax* Lacépède 1803) declined substantially in many European rivers, its numbers increased since 2007 in the Belgian Zeeschelde. Since twaite shad is of conservation concern, further knowledge on its migration and reproductive behaviour is needed and acoustic telemetry would be a relevant tool to assess these behaviours. Shads are very sensitive fish showing adverse reactions to handling and anesthesia, specifically twaite shad. Therefore, this species is rather unsuitable for internal implantation of electronic tags, such as acoustic, radio and data storage tags. Preliminary tests are needed to assess the impact of external tagging on twaite shad survival. Here we describe a fish friendly attachment procedure to externally tag the fish. The procedure is quick and may limit additional drag force on swimming as the tags are firmly attached to the body by a rubber plate. This procedure was developed in Belgium in spring 2015 to tag eight shads in the Zeeschelde. Five of these shads showed a migration pattern that generally corresponded with spawning activities observed visually in the river.

1. Introduction

Twaite shad (*Alosa fallax* Lacépède 1803) is an iteroparous, anadromous clupeid occurring along the European coast from Morocco to the Baltic Sea, throughout the Mediterranean Sea and along the Northeastern Atlantic Coast (Aprahamian et al., 2003a; Maitland and Lyle, 2005). It is a marine pelagic fish species, but migrates during spring into the middle and upper reaches of the river to spawn (Maes et al., 2008).

Since the early nineties, a strong decline in twaite shad populations has been observed due to anthropogenic influence, such as water pollution, modification of river habitat and hydrology and overfishing (Assis, 1990; Bervoets et al., 1990; Doherty et al., 2004). Following its decline, the species is classified as vulnerable and listed under the International Union for the Conservation of Nature (IUCN) World Red Data Book (IUCN, 2015), included in Appendix III of the Bern Convention (CE, 1979) and Annexes II and V of the EC Habitats Directive (Aprahamian et al., 2003b, 2010; E.U., 1992). Despite a recent population increase in the Rivers Seine, Rhone, Ebro, Schelde, Elbe and Curonian Lagoon (Belliard et al., 2009; Lebel et al., 2001; López et al., 2007; Maes et al., 2008; Magath and Thiel, 2013; Stankus, 2009), the effect of the above described human impacts on twaite shad remains unsolved. Being an anadromous fish, the species is particularly vulnerable during the estuarine phase due to increased predation risk, diseases or the energetic cost of migrating and osmoregulatory abilities (Lochet et al., 2009). Hence, successful conservation and restoration of twaite shad populations requires insight into the effect of environmental conditions on spawning migration behaviour to aid successful reproduction.

Acoustic telemetry is a relative recent, but commonly applied technique to study fish behaviour (Hussey et al., 2015). Fish are provided with an acoustic transmitter, which emits a signal with a unique ID code that can be detected by an acoustic listening station (ALS). This technique not only reveals the migration routes, but may also provide knowledge on the variables that influence migration and potential migration barriers when detection data, biotic and abiotic data are linked (Verhelst et al., in press). Surgical implantation is often used in tagging studies requiring pre- and post-operative care, anesthetics and confinement (Bridger and Booth, 2003; Huisman et al., 2016; Jepsen et al., 2002; Pauwels et al.,

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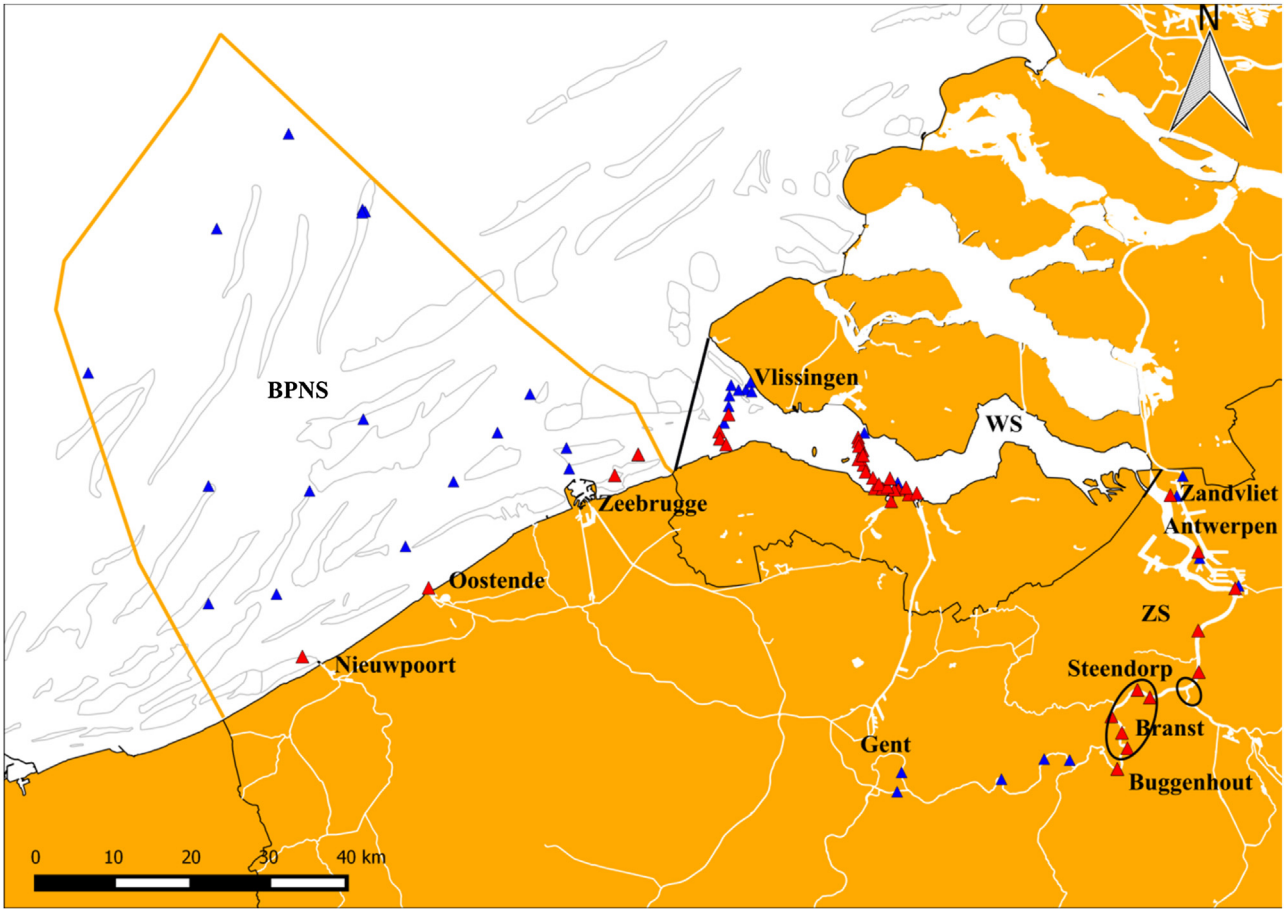

Fig. 1. The locations of the acoustic listening stations (red triangles where shad were detected and blue triangles where shad were not detected) in the Belgian part of the North Sea (BPNS), Westerschelde (WS) and Zeeschelde (ZS). The borders between each of the three systems are indicated by a solid line. Spawning activity visually observed by people within a voluntary network, are indicated by circles.

Table 1
Used tag types and properties.

Transmitter type	Number of shads tagged	length (mm)	diameter (mm)	weight in air (g)	weight in water (g)	battery life time (days)
V7	4	18	7	1,4	0,7	64
V9	4	24	9	3,6	2,2	132

2014). Implantation has the potential to have both lethal and sub-lethal impacts on fish if performed incorrectly (Jepsen et al., 2002; Thiem et al., 2011). Due to the high sensitivity of twaite shad to handling and stress, surgical implantation could result in a high mortality and is therefore inadvisable. Rooney and King (2014) for instance stated that twaite shad shows adverse reaction to handling and sedation and is therefore an unsuitable species for surgical implantation. Telemetry studies on allis (*A. alosa* Linnaeus 1758) and American (*A. sapidissima* Wilson 1811) shad have been conducted by means of gastric implantation of tags (Acolas et al., 2004; Dutterer et al., 2015; Frank et al., 2009; Olney et al., 2006; Tétard et al., 2016). Gastric implantation is a less invasive method than surgical implantation but it might result in regurgitation or mortality due to stomach rupture (Nielsen, 1992; Winter, 1996). However, since twaite shad is more sensitive than allis and American shad (Larinier et al., 2000), few telemetry studies have been conducted on twaite shad. Recently, Rooney et al. (2013) successfully applied external tagging on twaite shad in Ireland. Here, we present a protocol for external tagging of twaite shad, which is partly based on the method of Rooney and King (2014).

2. Material and methods

2.1. Study area

The River Schelde is 435 km long originating on the plateau of Saint-Quentin in France. The Schelde estuary is approximately 160 km long and discharges into the North Sea. The estuary has a complete salinity gradient from polyhaline to a tidal freshwater zone, including extensive freshwater, brackish and salt marshes to its ecosystem. It is a well-mixed estuary characterized by strong currents, high turbidity and a large tidal amplitude up to 6 m (Seys et al., 1999). It can be divided in two sections (downstream to upstream): the Westerschelde (WS) in the Netherlands from Vlissingen to Zandvliet and the Zeeschelde (ZS) in Belgium, from Zandvliet to Gent. Further upstream the river is obstructed by sluices and weirs, which reduces tidal action and saltwater intrusion. Historical observations on the spawning sites of twaite shad in the River Schelde indicate they are located downstream of the first weir in the freshwater tidal reach of the watershed (Vrielynck et al., 2003). Therefore in this study no physical migration barrier was encountered by the fish species.