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Using PIT technology to study the fate of hatchery-reared YOY northern pike released into shallow vegetated areas

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Abstract

This study uses passive integrated transponder (PIT) technology to analyse the fate of 192 PIT-tagged hatchery-reared young-of-the-year northern pike *Esox lucius* (mean fork length FL 51.0 mm ± 5.3 S.D.) released into an experimental area located in the Brière Marsh (France), together with 72 untagged individuals for control. Survival and emigration were studied by trapping and using a portable PIT detector from release (20 May) to complete drying out of the grassland (15 June 2005). Only 19.3% and 6.9% of the PIT-tagged and control fish, respectively, successfully emigrated from the experimental area before drying out. Small individuals (FL <50 mm at tagging) suffered a higher mortality rate, and size-dependent effects of cannibalism rather than PIT-tagging procedure on survival were suspected. No evidence of tag loss was found for surviving fish, and individual growth conformed to values reported in literature. The portable PIT antenna detected 71.4% of the PIT-tagged pike in the flooded grassland. More than 30% of tagged fish disappeared from the experimental area throughout the study period, and predation by birds was suspected. Results support the view that more attention should be paid to limiting the detrimental effects of mortality on the stocking success of northern pike.

Keywords: Passive integrated transponder; Portable detector; *Esox lucius*; Survival; Stocking program

1. Introduction

Northern pike (*Esox lucius*) is a predatory keystone species that tolerates a broad range of environmental conditions and is particularly adapted to shallow freshwater environments (Casselman, 1996). For this species, temporary flooded and vegetated areas are critical spawning and nursery habitats, where larvae and juveniles can find protection against predators and adequate food resources (Souchon, 1983; Wright and Shoesmith, 1988). After a short period of development, juveniles have to emigrate from temporary wetlands to permanent habitats before total drying out (review in Inskip, 1982). Juvenile pike survival and growth patterns have mainly been investigated under experimental or semi-natural conditions (e.g. Wright and Shoesmith, 1988; Bry et al., 1995; Le Louarn and Cloarec, 1997; Skov et al., 2003; Skov and Koed, 2004). More recently, survival of young-of-the-year (YOY) pike has been studied in the wild using mass marking (Gronkjaer et al., 2004; Sutela et al., 2004) but mortality causes were not identified. Insights into the early life history of northern pike are still needed for developing proper management policies.

In the two last decades, the passive integrated transponder (PIT) technology has been developed as a novel method for individually tagging fish (Prentice et al., 1990) and has shown its efficiency in studying fish life-history tactics (e.g. Juanes et al., 2000; Cucherousset et al., 2005a). Stationary PIT antennas have been increasingly used by ichthyologists to study fish habitat use and migration processes (see review in Lucas and Baras, 2000). More recently, portable PIT detectors have been developed to track fish in shallow streams (Roussel et al., 2000; Barbin Zydlewski et al., 2001; Cucherousset et al., 2005b; Hill et al., 2006). Such technological developments have greatly helped to improve our understanding of complex aspects of the early life ecology and behavior of primarily salmonids (e.g. Martin-Smith and Armstrong, 2002; Roussel et al., 2004; Cunjak et al., 2005), but to our knowledge, PIT technology has never been used for the study of YOY northern pike in the wild.

The objective of this work was to investigate the usefulness of PIT technology for studying YOY northern pike in a naturally flooded grassland. We particularly focused on PIT-tag retention,

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post-tagging survival, and the efficiency of a portable PIT detector for studying the fate of hatchery-reared YOY pike after their release in a shallow, still water and vegetated habitat. Such an investigation is crucial since a quantitative assessment of the fate of hatchery YOY pike released in the wild is still needed for improving the effectiveness of stocking programs.

2. Materials and methods

2.1. Study area

The study was carried out in the Brière Marsh (northwest France, Fig. 1), a 7000 ha area composed of a network of permanently flooded ditches and a heterogeneous patchwork of ponds, reed beds and grazed grasslands that are flooded in winter and progressively dry out during spring and summer. The survey was conducted in May and June 2005 in a protected area located in the heart of the Brière Marsh (Fig. 1). A 0.47 ha flooded grassland was subdivided with regularly spaced transect lines in order to delineate 233 rectangular cells (4 m wide and 5 m long). Based on measurements of habitat variables performed in each cell, the substrate consisted exclusively of compact peat with no soft bottom, and the mean water depth was 15.1 cm (±5.6 S.D., maximum water depth 36 cm). Emergent (Poaceae and *Phragmites australis*) and submerged plants (*Ranunculus* spp. and *Callitriche* spp.) covered 47.2% (±28.5 S.D.) of the total area, offering potential spawning substrate for pike (Bry, 1996). The flooded grassland was connected to a temporarily flooded pond by a single connecting point. A fyke net (5 mm mesh) equipped with two wings (1.2 m high and 3 m long) to block the whole water column was set up in a V-shape at this connecting point to trap fish leaving the grassland (Fig. 1). During the experiment, the water level fell down continuously until the grassland dried out totally in late June.

2.2. Fish tagging and stocking

Hatchery-reared YOY pike fed with zooplankton were used for this experiment. A total of 197 YOY pike were anaesthetized with eugenol (0.04 mL L^{-1}), measured (fork length, ±1 mm) and weighed (±0.1 g). The mean fork length and weight were 51.0 mm (±5.3 S.D.) and 0.86 g (±0.3 S.D.), respectively. A PIT tag was inserted into the peritoneal cavity using a sterile needle mounted on an injector, and the left pelvic fin was clipped to assess tag loss. The PIT tags used were 11.5 mm long and 2.1 mm in diameter (ID 100; EID Aalten B.V., Aalten, The Netherlands). In addition, a group of 74 control fish (mean fork length = 54.9 mm ± 4.2 S.D.) were subjected to the same procedure but not PIT-tagged, the right pelvic fin being clipped to distinguish them from PIT-tagged individuals. Fish were given 6–8 h to recover before being transported in plastic bags in groups of 13–15 individuals by boat to the study area (2 h), similarly to local stocking practises. Mortality, cannibalism and tag loss were checked at the end of the recovery period and before release in the grassland. Tagged and control fish were released randomly into the experimental area at 9 p.m. on 20 and 25 May, 2005, respectively. The stocking density (0.06 ind m^{-2}) was similar to the density of wild YOY pike usually observed in the Brière Marsh (Cucherousset, unpublished data), but below stocking densities reported in the literature (e.g. 1–3.3 ind m^{-2} in Lucchetta, 1983 and 0.4–3.6 ind m^{-2} in Sutela et al., 2004) to prevent exacerbation of cannibalism (Bry et al., 1992).

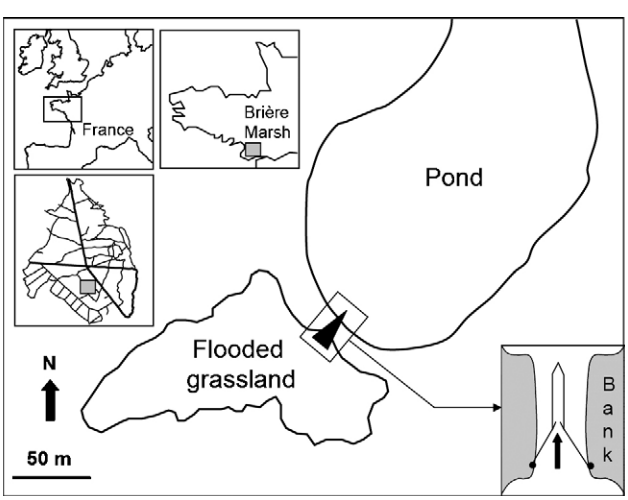

Fig. 1. Map of the study area and description of the trap setting at the single connecting point between the temporarily flooded grassland and the pond.

2.3. Fyke net and PIT detection survey

The fyke net was checked once or twice a day; trapped pike were anaesthetized with eugenol (0.04 mL L^{-1}), measured (fork length, ±1 mm), and checked for PIT tags and fin clips. Then, fish were released into the adjacent pond (Fig. 1). A portable PIT detector was also used once a day in search for lost PIT tags inside and under the fyke net; each transponder detected was picked up by the operator. The detector is composed of one RFID reader (LID 650; EID Aalten B.V., Aalten, The Netherlands) interfaced with a LCD screen and powered by a 12 V battery. The reader is connected to a waterproof antenna (ANT 612; EID Aalten B.V., Aalten, The Netherlands) which is mounted on a 3 m-long aluminium pole. When a PIT tag is detected by the antenna, the tag code is displayed and a piezoelectric buzzer sounds a loud tone to alert the operator. The maximum tag detection distances range from 30 to 36 cm, depending on the orientation of the PIT tag. A thorough description of the portable PIT detector and its performance is given in Cucherousset et al. (2005b). From 21 May to 7 June, the portable PIT detector was used every 3–4 days to check for the presence and location of PIT-tagged fish in the experimental area. The operator (J. Cucherousset) manoeuvred the antenna above the water surface by wading between two transects and the entire wetted area was scanned in 8–10 h. When a PIT tag was detected, its exact position was plotted in relation to the rectangular cells delineated by the transect lines. After June 7, more than 60% of the initial flooded area had completely dried out and the scanning operations were stopped. On 15 June, the fyke net dried out; two 40–50 m^2 pools (mean water depth = 4.97 cm ± 4.1 S.D.) persisted but were disconnected from the pond. These pools were electrofished but no pike were caught. After total drying out, additional operations were performed on 19 July to