Arch. Pol. Fish. (2013) 21: 243-248
10.2478/aopf-2013-0025

RESEARCH ARTICLE

Tagging juvenile pikeperch (*Sander lucioperca* (L.)) in the cheek with Passive Integrated Transponders (PIT) – impact on rearing indexes and tag retention

Zdzisław Zakęś, Marek Hopko

Received – 02 February 2013/Accepted – 11 March 2013. Published online: 31 December 2013; ©Inland Fisheries Institute in Olsztyn, Poland
Citation: Zakęś Z., Hopko M. 2013 – Tagging juvenile pikeperch (*Sander lucioperca* (L.)) in the cheek with Passive Integrated Transponders (PIT) – impact on rearing indexes and tag retention – Arch. Pol. Fish. 21: 243-248.

Abstract. The aim of this study was to determine the impact of implanting passive integrated transponder (PIT) tags in the cheeks of two size classes of pikeperch (mean body weight (BW) – 63 g (S fish) and 105 g (L fish)) on basic rearing indexes and short-term tag retention. Four groups of fish were created: group S-M (smaller fish tagged in the cheek), group S-C (control group of untagged smaller fish), group L-M (larger fish tagged in the cheek) and group L-C (control group of untagged larger fish). After tagging, the fish were held in recirculating systems and reared on formulated feed for 42 days. Significantly lower growth rates and worse feed conversion ratios ($P < 0.05$) in comparison to the control group were noted among the smaller tagged fish (group S-M) after 14 days of rearing. These differences became less distinct in the subsequent days of the study ($P > 0.05$). No period of decreased rearing index values was noted among the larger tagged fish (group L-M). Cheek implantation of PIT tags in pikeperch did not affect fish survival. The short-term retention of tags in both size classes of fish was equal and ranged from 97.4 to 100%. Considering the advantages of the PIT tag cheek implantation method, which includes no negative effect on fish growth, quick recovery following implantation, and high tag retention, as well as the safety of potential consumers, this method can be recommended for tagging pikeperch stocking material and releasing it into open waters.

Z. Zakęś [✉], M. Hopko
Department of Aquaculture
Inland Fisheries Institute in Olsztyn
Oczapowskiego 10, 10-719 Olsztyn, Poland
e-mail: zakes@infish.com.pl

Keywords: PIT, tag retention, pikeperch, *Sander lucioperca*, rearing indexes, tagging

Introduction

The method of tagging individual fish with passive integrated transponders, the so-called PIT tags, became the subject of ichthyological studies in the 1980s (Prentice et al. 1990, Cucherousset et al. 2007, Kaemingk et al. 2011). This type of tag is used to monitor the effectiveness of stocking open waters and for tracking fish migration (Pine et al. 2003, Cucherousset et al. 2007, Leber and Blankenship 2011). These tags are also used at rearing facilities and in aquaculture, where they mainly serve to tag selects and spawners (e.g., Müller-Belecke and Zienert 2008). PIT tags are usually well retained, and they have a negligible impact in the tagged individuals (Baras et al. 2000, Navarro et al. 2006, Wagner et al. 2007, Hopko et al. 2010). These tags are usually implanted either intramuscularly or intraperitoneally (Parker and Rankin 2003, Wagner et al. 2007, Isermann and Carlson 2008, Hopko et al. 2010, Kaemingk et al. 2011). The choice of the PIT tag implantation site for a given species or developmental stage is significant because it can impact tag retention and fish growth and survival (Navarro et al. 2006, Kaemingk et al. 2011). PIT tags are implanted relatively infrequently in fish operculum muscles (Hamel et al. 2013), but this could be an advantageous alternative tagging location because: (I) intramuscular tagging poses a potential risk to consumers consuming PIT tags with fillets (the operculum tagging method eliminates this risk), and (II) intraperitoneal tagging can result in damage to internal organs, and presents a risk of intestine perforation and tag elimination with excrement (Baras and Westerloppe 1999).

The aim of the current study was to determine the impact of PIT cheek tagging on basic rearing indexes and short-term tag retention in two size classes of juvenile pikeperch, *Sander lucioperca* (L.).

Material and methods

The study material was obtained from intense rearing in a recirculating aquaculture system (RAS; Zakęś 2009). Two fish size classes were used in the study: smaller individuals (fish S; body length about 17.5 cm and body weight about 63 g), and larger individuals (fish L – body length about 21 cm and body weight about 105 g) (Table 1). Pikeperch from each of the size classes was stocked into six rearing tanks with a volume of 0.2 m^3 each. Fifteen fish were placed in each tank, and the mean initial stocking biomass was 4.8 kg m^{-3} (fish S) and 7.8 kg m^{-3} (fish L). Four groups of fish were created (each in three replicates), i.e., group S-M (smaller cheek-tagged fish), group S-C (control group of untagged smaller fish), group L-M (larger cheek-tagged fish) and group L-C (control group of untagged larger fish).

The fish were tagged with standard PIT tags (Fish Eagle, Lechlade, Great Britain) (material – bio-glass; length – 12.0 ± 0.4 mm; diameter – 2.12 ± 0.07 mm; tag weight – 93 mg). The tags were implanted in the central part of the operculum using a syringe with a needle (internal diameter of 2.86 mm) at a 30° angle to the operculum. The fish were anesthetized before tagging in an aqueous solution of etomidate (Propiscin, IFI Olsztyn) at a concentration of 2.0 ml l^{-1}. Individuals from the control group (groups S-C and L-C) were subjected to the same procedure excluding the tagging. After tagging, the fish were revived in containers with oxygenated water, and then they were returned to the rearing tanks in which they had been held before tagging. The water flow rate was maintained at 4.0 l min^{-1} (1.2 water exchange h^{-1}). Water temperature and oxygen content were monitored daily. The contents of total ammonia nitrogen (TAN = NH_4^+-N + NH_3-N), nitrite nitrogen (NO_2-N), and pH were determined weekly. Water temperature was maintained at 22.0°C (± 0.1). Oxygen concentration at the rearing tank outflows did not decrease below 5.5 mg O_2 l^{-1} (60% saturation). The content of ammonia nitrogen and nitrite nitrogen measured at the rearing tank outflows did not exceed 0.04 mg TAN l^{-1} and 0.01 mg NO_2-N l^{-1}. The water pH fluctuated around 8.1-8.2.

The fish were fed T-1P Via Ultra feed (Skretting, Norway) with the following chemical composition according to the manufacturer data: total protein – 43.5%, crude lipids – 18.0%, crude fiber – 3.0%, crude ash 6.0%, and granule diameter – 2.5 mm. The digestible energy in the feed was 19.7 MJ kg^{-1} feed. The feed was delivered continually for 19 h d^{-1} by a 4305 FIAP automatic band feeder (Fischtechnik GmbH, Germany). The daily feed ration, which was adjusted weekly during rearing, was set at 0.9% of the stock biomass for fish S and 0.8% of the stock biomass for fish L.

Measurements of individual fish for body length (SL; ± 1.0 mm) and body weight (BW; ± 0.1 g) were taken at the beginning of the experiment (d0), after 14 days (d14), after 28 days (d28), and at the end of the experiment (42^{nd} day; d42). Pikeperch were assessed for tag loss after recovery from anesthesia (d0), and the first (d1), fourth (d4), and seventh (d7) days after tagging, and during individual fish measurements on d14, d28, and d42. The presence of the tags was verified using a hand-held scanner (Fish Eagle, Lechlade, Great Britain). The location of the implanted PIT tags was also checked. The tanks were monitored daily for feed consumed, rejected tags, fish behavior, and mortality. These results were used

Table 1

Growth, condition, survival, and PIT tag retention in two size classes of pikeperch (*Sander lucioperca*) (fish S – untagged (group S-C) and tagged (group S-M) and fish L – untagged (group L-C) and tagged (group L-M)) in subsequent days of rearing (d0 – the day rearing began, d1, d4, d7, d14, d28, d42, respectively, days 1, 4, 7, 14, 28, and 42 of rearing) (mean values ± SD; n = 3). Groups marked with different letter indexes (with a given fish size class) differ significantly statistically ($P \leq 0.05$); * – no statistically significant differences in tag retention were noted in the two pikeperch size classes in subsequent stages of rearing ($P > 0.05$)

	Fish S		Fish L	
Parameter/day of rearing	group S-C	group S-M	group L-C	group L-M
Standard length – SL (cm)				
d0	17.6 ± 0.3	17.7 ± 0.1	20.8 ± 0.2	20.9 ± 0.1
d42	18.8 ± 0.1	18.8 ± 0.1	22.1 ± 0.1	22.1 ± 0.2
Body weight – BW (g)				
d0	62.2 ± 3.9	64.3 ± 0.3	104.8 ± 4.5	104.5 ± 0.7
d14	66.2 ± 3.6	67.1 ± 0.2	112.7 ± 3.9	112.1 ± 1.7
d28	72.7 ± 3.7	71.1 ± 1.5	121.0 ± 4.9	121.5 ± 3.1
d42	78.1 ± 3.3	77.4 ± 0.3	129.0 ± 5.6	129.1 ± 4.1
Daily growth rate – DGR (g d^{-1})				
d0-d14	0.29^{a} ± 0.03	0.20^{b} ± 0.02	0.56 ± 0.11	0.54 ± 0.07
d0-d28	0.34 ± 0.07	0.24 ± 0.06	0.58 ± 0.16	0.61 ± 0.09
d0-d42	0.38 ± 0.14	0.31 ± 0.01	0.58 ± 0.15	0.59 ± 0.09
Specific growth rate – SGR (% d^{-1})				
d0-d14	0.45^{a} ± 0.06	0.30^{b} ± 0.03	0.52 ± 0.11	0.50 ± 0.06
d0-d28	0.51 ± 0.12	0.36 ± 0.08	0.51 ± 0.15	0.54 ± 0.07
d0-d42	0.54 ± 0.13	0.44 ± 0.01	0.50 ± 0.13	0.50 ± 0.06
Condition coefficient – F				
d0	1.15 ± 0.00	1.13 ± 0.02	1.18 ± 0.04	1.18 ± 0.01
d14	1.15 ± 0.00	1.13 ± 0.02	1.18 ± 0.05	1.18 ± 0.01
d28	1.17 ± 0.02	1.14 ± 0.02	1.18 ± 0.04	1.21 ± 0.02
d42	1.18 ± 0.05	1.16 ± 0.02	1.20 ± 0.05	1.19 ± 0.01
Feed conversion ratio – FCR				
d0-d14	1.9^{a} ± 0.2	2.8^{b} ± 0.2	1.5 ± 0.3	1.5 ± 0.2
d0-d28	1.7 ± 0.3	2.1 ± 0.2	1.5 ± 0.4	1.4 ± 0.2
d0-d42	1.5 ± 0.4	1.8 ± 0.1	1.6 ± 0.4	1.5 ± 0.2
Survival – S (%)				
d0-d14	100	100	97.8 ± 3.8	100
d0-d28	97.8 ± 3.8	97.8 ± 3.8	97.8 ± 3.8	100
d0-d42	91.1 ± 10.1	93.3 ± 6.7	95.6 ± 3.8	95.6 ± 3.8
Tag retention – R (%)*				
d0	-	100	-	100
d1	-	100	-	100
d4	-	100	-	100
d7	-	100	-	100
d14	-	100	-	100
d28	-	97.8 ± 3.8	-	100
d42	-	97.4 ± 4.4	-	100

to calculate the following: daily growth rate, DGR (g d^{-1}) = (BW_2 – BW_1) × t^{-1}; specific growth rate, SGR (% d^{-1}) = 100 × ($\ln BW_2$ – $\ln BW_1$) × t^{-1}; Fulton's condition coefficient, F = 100 × (BW × SL^{-3}); feed conversion ratio, FCR = TFS × $(FB - IB)^{-1}$, where: BW_1 – initial fish body weight (g), BW_2 – final fish body weight (g), t – rearing time (days), SL – fish body length (cm), FB – final stock biomass (g), IB – initial stock biomass (g), TFS – total feed supply (g). Fish survival was also calculated, S (%) = 100 × (final number of fish (individuals) × initial number of $fish^{-1}$ (individuals)) and PIT tag retention, R (%) = 100 × (number of fish confirmed to have tags on a given day of rearing (individuals) × number of fish on a given day of $rearing^{-1}$ (individuals)).

One-way analysis of variance (ANOVA; Statistica-StatSoft Poland, Kraków) was used to analyze the results collected. Homogeneity of variance was tested with Levene's test. Percentages were transformed with the arcsin function prior to statistical analysis. When statistically significant differences between groups were obtained, Tukey's test was applied ($P \leq 0.05$).

Results and discussion

Tagging did not have a statistically significant impact on final body weight, body length, or condition coefficient of the pikeperch from the two size classes ($P > 0.05$; Table 1). However, the relative indexes of fish body growth (DGR and SGR) of the pikeperch tagged with PIT tags from the smaller size class (group S-M) after 14 days of rearing were significantly lower than in the control group (group S-C; $P < 0.05$: Table 1). These differences became less pronounced in subsequent weeks of rearing (d28, d42), and were not statistically significant. Reduced growth rates in the first 14 days following tagging were not noted in the larger fish (Table 1). Reduced growth rates in the first weeks of rearing were also observed in perch, *Perca fluviatilis* L., tagged with PITs (Baras et al. 2000), and lowered SGR values were confirmed after seven days of rearing. In subsequent weeks, the differences in growth of the tagged perch in comparison with the control group, which were similar to those in the current study, were no longer statistically significant. Similar observations are reported for juvenile gilthead seabream, *Sparus aurata* L., tagged with PIT tags (Navarro et al. 2006), and also for common seabream, *Pagrus pagrus* (L.) (Soula et al. 2012). Usually no negative impacts on growth rates are noted from seven to 14 days after fish have been tagged with PIT tags (Baras et al. 2000, Navarro et al. 2006, Wagner et al. 2007, Hopko et al. 2010, Soula et al. 2012, present study). Temporary reductions in growth rates are usually observed in fish from smaller size groups (Baras et al. 2000, Navarro et al. 2006, present study).

It should be underscored that after 14 days of rearing the tagged pikeperch from the smaller size class (group S-M) exhibited significantly higher FCR values (2.8 vs 1.9). These differences equalized in further stages of rearing (Table 1). Similarly, tagging juvenile pikeperch (BW about 80 g) with intraperitoneal or intramuscular PIT tags did not have a negative impact on feeding effectiveness (Hopko et al. 2010). The FCR values obtained for both size classes in the present experiment were higher than in the other studies cited. This could be explained by the frequent manipulation of the fish while taking individual measurements and checking tags, or by the different chemical compositions of the feeds (Hopko et al. 2010, present study).

The wounds inflicted during PIT tag intraperitoneal implantation healed quickly. Edema or slight congestion at the implantation site was observed up to four days after the fish had been tagged; these symptoms were noted in 20-30% fish and the percentage of them was independent of pikeperch size. On d7 following tagging, the wounds in both size classes of fish had healed. The wounds in juvenile pikeperch following PIT tag intramuscular implantation were fully healed after 14 days of rearing, while with intraperitoneal tagging healing was not observed until 21 days after the procedure (Hopko et al. 2010). Navarro et al. (2006) report that the wound healing time among gilthead seabream that had had either intramuscular or intraperitoneal PIT tags implanted was 20 days (at a range of 15-26 days). Wound healing time following PIT implantation in different fish species ranged from ten to 47 days (review in Navarro et al. 2006). The preceding indicates that the wounds sustained from implanting PIT tags in cheeks heal quickly, especially in comparison with implantation in the operculum.

Tagging pikeperch with PIT tags did not increase mortality (Table 1). Single instances of fish mortality were not observed in either the control or experimental groups until the third week of rearing. Mortality resulting from PIT tag implantation usually occurs in the first ten days following the procedure (Baras et al. 2000, Dare 2003, Soula et al. 2012). Thus, the losses observed in the current study should be attributed to rearing mortality associated with rearing procedures, and particularly with frequent fish manipulation required by the methodology of the experiment. The PIT tagging method is considered to be safe for fish and does not cause increased losses (Dare 2003, Hopko et al. 2010). One limitation in using standard PIT tags could be their size, which is recommended in fish with a total length of > 5-7 cm (Acolas et al. 2007). Tagging fish of this size is generally possible using intraperitoneal implantation (Kaemingk et al. 2011). Our observations indicate that in the cheek implantation of standard-size PIT tags is possible in and safe for fish with body weights of > 50 g.

The short-term PIT tag retention (42 days) noted in the current study among pikeperch which received cheek implants was high, and these results were similar to those obtained for this same species with intraperitoneally or intramuscularly implanted PIT tags (Hopko et al. 2010). In the current experiment, retention was within the range of 97.4-100% (Table 1), whereas PIT tag retention usually ranges from 85 to 100% (Baras et al. 2000, Dare 2003, Parker and Rankin 2003, Navarro et al. 2006, Hopko et al. 2010, Siepker et al. 2012, Soula et al. 2012). Since fish generally lose PIT tags within the first 30 days of tagging (Dare 2003, Siepker et al. 2012), one could assume that long-term tag retention among pikeperch could also be high. This hypothesis also finds some confirmation in the fact pikeperch spawners tagged in the cheek with PIT tags and held in RAS were confirmed to retain these tags for the subsequent five to six years (Z. Zakęś, unpublished materials).

In summation, it can be concluded that implanting PIT tags in juvenile pikeperch (BW > 50 g) cheeks is a minimally invasive method that produces good tag retention. One limitation is the size of standard PIT tags, and the size of the tagged fish that is associated with this. Testing the effects of implanting miniaturized PIT tags in the cheeks of smaller pikeperch is indicated. Considering the advantages of this method outlined above and the safety of potential consumers of tagged fish, for example recreational fishers, this method can be recommended for tagging pikeperch stocking material that is later released into open waters. PIT cheek implantation facilitates detecting the tags and can also be recommended for use in pikeperch broodstock management.

Acknowledgements. This study was conducted as part of statutory research topic number S007 of the Inland Fisheries Institute in Olsztyn, Poland.

Author contributions. Z.Z. designed the research, M.H. and Z.Z. performed the research, Z.Z. and M.H analyzed the data, Z.Z. wrote the paper.

Reference

Acolas M.L., Roussel J.M., Lebel J.M., Baliniere J.L. 2007 – Laboratory experiment on survival, growth, and tag retention following PIT injection into the body cavity of juvenile brown trout (*Salmo trutta*) – Fish. Res. 86: 280-284.

Baras E., Malbrouck Ch., Houbart M., Kestemont P., Mélard Ch. 2000 – The effect of PIT tags on growth and physiology of age-0 cultured Eurasian perch *Perca fluviatilis* of variable size – Aquaculture 185: 159-173.

Baras E., Westerloppe L. 1999 – Transintestinal expulsion of surgically implanted tags in African catfishes *Heterobranchus longifilis* of different size and age – Trans. Am. Fish. Soc. 128: 737-746.

Cucherousset J., Paillisson J.-M., Roussel J.-M. 2007 – Using PIT technology to study the fate of hatchery-reared YOY northern pike released into shallow vegetated areas – Fish. Res. 85: 159-164.

Dare M.R. 2003 – Mortality and long-term retention of passive integrated transponder tags by spring chinook salmon – N. Am. J. Fish. Manage. 23: 1015-1019.

Hamel M.J., Steffensen K.D., Hammen J.J., Pegg M.A. 2013 – Evaluation of passive integrated transponder tag retention from two tagging locations in juvenile pallid sturgeon – J. Appl. Ichthyol. 29: 41-43.

Hopko M., Zakęś Z., Kowalska A., Partyka K. 2010 – Impact of intraperitoneal and intramuscular PIT tags on survival, growth, and tag retention in juvenile pikeperch, *Sander lucioperca* (L.) – Arch. Pol. Fish. 18: 85-92.

Isermann D.A., Carlson A.J. 2008 – Initial mortality and retention associated with using passive integrated transponders in black crappies – N. Am. J. Fish. Manage. 29: 1157-1159.

Kaemingk M.A., Weber M.J., McKenna P.R., Brown M.L. 2011 – Effect of passive integrated transporter tag implantation site on tag retention, growth, and survival of two sizes of juvenile bluegills and yellow perch – N. Am. J. Fish. Manage. 31: 726-732.

Leber K.M., Blankenship H.L. 2011 – How advances in tagging technology improved progress in new sciences: marine stock enhancement – Am. Fish. Soc. Symp. 76: 1-12.

Müller-Belecke A., Zienert S. 2008 – Out-of-season spawning of pike perch (*Sander lucioperca* L.) without the need for hormonal treatments – Aquac. Res. 39:1279-1285.

Navarro A., Oliva V., Zamorano M.J., Ginés R., Izquierdo M.S., Astorga N., Afonso J.M. 2006 – Evaluation of PIT system as a method to tag fingerlings of gilthead seabream (*Sparus auratus* L.): effects on growth, mortality and tag loss – Aquaculture 257: 309-315.

Parker S.J., Rankin P.S. 2003 – Tag location and retention in black rockfish: feasibility of using PIT tags in a wild marine species – N. Am. J. Fish. Manage. 23: 993-996.

Pine W.E., Pollock K.H., Hightower J.E., Kwak T.J., Rice J.A. 2003 – A review of tagging methods for estimating fish population size and components of mortality – Fisheries 28: 10-23.

Prentice E.F., Flagg T.A., McCutcheon C.S. 1990 – Feasibility of using implantable passive integrated transponder (PIT) tags in salmonids – Am. Fish. Soc. Symp. 7: 317-332.

Siepker M.J., Knuth D.S., Ball E.L., Koppelman J.B. 2012 – Evaluation a novel integrated transponder tag in largemouth bass – N. Am. J. Fish. Manage. 32: 528-532.

Soula M., Navarro A., Hildebrandt S., Zamorano M.J., Roo J., Hernández-Cruz C.M., Afonso J.M. 2012 – Evaluation of VIE (Visible Implant Elastomer) and PIT (Passive Integrated Transponder) physical tagging systems for the identification of red porgy fingerlings (*Pagrus pagrus*) – Aquacult. Int. 20: 571-583.

Wagner C.P., Jennings M.J., Kampa J.M., Wahl D.H. 2007 – Survival, growth, and tag retention in age-0 muskellunge implanted with Passive Integrated Transponders – N. Am. J. Fish. Manage. 27: 873-877.

Zakęś Z. 2009 – Pikeperch. Rearing and cultivation. A guidebook for fish farmers – Wyd. IRS, Olsztyn, 203 p. (in Polish).