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Short communication

Effects of fin-clipping regarding adult return rates in hatchery-reared brown trout

Erik Petersson [a,*], Jörgen Rask [b], Bjarne Ragnarsson [b], Lars Karlsson [b], Jens Persson [c]

[a] *Swedish University of Agricultural Sciences, Dept. Aquatic Resources, Institute of Freshwater Research, Stångholmsvägen 2, SE-178 93 Drottningholm, Sweden*
[b] *Swedish University of Agricultural Sciences, Dept. Aquatic Resources, Fishery Research Station, Brobacken 2, SE-814 94 Älvkarleby, Sweden*
[c] *Swedish University of Agricultural Sciences, Dept. Aquatic Resources, Institute of Freshwater Research, Pappersbruksallén 22, SE-702 15 Örebro, Sweden*

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ABSTRACT

Fin clipping has been used for decades as a marking method for sea-ranched salmonids but there are concerns about the method such as reduced survival and other animal welfare aspects. In this study sea migrating hatchery-reared brown trout juveniles (20–21 months old) were marked in four groups by removing either the adipose fin, left pelvic fin, both pelvic fins or the adipose fin + the left pelvic fin. All groups, together with an unmarked control group, were tagged with coded wire tags and released into the River Dalälven (Sweden). This was repeated over four years and on average the return rate was <1%. Brown trout marked by removing both pelvic fins had ca 30% lower adult return rate compared with the other four groups. The other three fin clipping groups did not differ from the unclipped control group. These results, in combination with earlier studies, indicate that adipose fin removal is least detrimental to the fish and removal of a single paired fin may be used in exceptional cases. We advise against multiple fin removal.

1. Introduction

Management of sea-ranching programs mostly requires reliable and cost-effective marking techniques. Benefits of marking include possibility to separate fish of wild and hatchery origin, to separate different strains or to evaluate stocking programs (Gunnes and Refstie, 1980; Guy et al., 1996; Mohler et al., 2012). Fin clipping is one such method and in most cases the adipose fin or one pelvic fin is removed, although the dorsal fin or pectoral fins also have been removed in various species (Herman, 1946; Parker et al., 1963; Shetter, 1952; Wertheimer et al., 2002). Fin clipping is regarded as a cost-effective marking method (Thompson et al., 2005), but concerns have been raised on how the amputation affects individual fish (Roques et al., 2010). The wound caused by fin clipping potentially exposes the fish to infections and devices for treating the fish with fungicides have been developed (Hager et al., 1981). Ricker (1949) reported reduced survival and growth in fin clipped smallmouth bass (*Micropterus dolomieu*) and similar results have been found for brook trout (*Salvelinus fontinalis*) (Mears and Hatch, 1976). In salmonid fishes, removal of the adipose fin is considered the least harmful fin clip, and removal of the pelvic fin is considered the second least harmful one (Bergstedt, 1985). However, reduced survival has been reported for pink salmon (*Oncorhynchus gorbuscha*) marked by removing one pelvic fin (Parker et al., 1963; Ricker, 1976) and for coho salmon (*Oncorhynchus kisutch*) marked by coded wire tags (CWTs) and adipose fin removal (Vincent-Lang, 1993).

There are few studies in the literature evaluating effect of fin removal on hatchery reared brown trout. In addition, fin removal has been used for several decades in some rivers in Sweden; but without a thorough evaluation. In addition, since 2005 all hatchery-reared salmon and brown trout released into the Baltic Sea and Lake Vänern should be marked with adipose fin removal, according to Swedish legislation. The number of hatchery reared brown trout released annually in Sweden is 600,000–700,000 (ICES, 2013) and concerns have been raised about the method. In this study we investigated the effect of fin clipping on the return rate of adult sea trout on hatchery-reared sea-migrating brown trout (*Salmo trutta*) tagged with coded wire tags and marked with different combinations of fin removals.

2. Material and methods

2.1. Background and strain used

This study was conducted at the Fishery Research Station at Älvkarleby, central Sweden (ca 160 km north of Stockholm). The research station is situated on the River Dalälven that flows into the Gulf of Bothnia, about 10 km from the river mouth. Mean annual charge of the river = 344 m^3/s, mean pH = 7.02 (range 6.82–7.17), mean total organic carbon = 9.0 mg/l (7.3–11.3 mg/l), mean temperature = 7.9 °C (0.05–22.6 °C) (all data recorded at Älvkarleby in 2010; Tröjbom and Lindeström, 2011). Diadromous fishes are prevented from following their natural migration route upstream of Älvkarleby with the hydropower dam being a complete impediment to fish migration. Adult Atlantic salmon and brown trout migrating upstream from the sea to Älvkarleby

* Corresponding author. Tel.: +46 10 478 42 39; fax: +46 10478 42 69.
E-mail address: erik.h.petersson@slu.se (E. Petersson).

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are caught by means of a trap at the dam, and transported to a sorting hall, where they are kept and used for artificial breeding (Petersson et al., 1996). The trap cage is opened 1 May and closed 30 September. The brown trout spawning season in the River Dalälven generally begins the first week of October, peaking two or three weeks later. Fertilized eggs were transported within 6 h to the hatchery; the eggs were kept in 40 × 40 cm hatchery boxes, in continuously running river water, i.e. rearing temperature for the eggs were close to the actual river water temperature. Usually the egg batches from two females were kept mixed in one hatchery box, only large females (80 cm or larger) produce such high number of eggs that one hatchery box per female had to be used. Eggs hatched in end of April or early May. The juveniles were kept in the hatchery boxes until they had absorb their yolk sac and started to feed on commercial pellets. Thereafter the juveniles from each hatchery box were split into five to ten groups (five in 2004, six in 2005, ten in 2006 and eight in 2008) and were moved to 2 × 2 × 0.5 m hatchery tanks where they were kept until being moved to release ponds (see below).

2.2. Tagging, fin clipping and release procedure

Brown trout juveniles from each rearing tank were split into five groups, the fish were anaesthetized with MS222, fin clipped and tagged with sequential coded wire tags (CWTs) (Northwest Marine Technology, Inc.). The CWTs were injected hypodermically in the snout of the fish and fin clips were made using a pair of scissors (smaller sized for adipose fin and larger sized for pelvic fins). The tagging/marking combinations are shown in Table 1. These fin clip combinations, referred to as "treatments" in the following, were chosen because they are commonly used in Sweden. The total lengths of the anaesthetized fish were also measured before they were returned to the tanks. This procedure was done for five tanks in 2004, six in 2005, ten in 2006 and eight in 2008 (number of individuals in Table 1). The fish were fin clipped and tagged in January or February (at age 20–21 months; water temperature 0.1–1.0 °C) and were checked for tag loss four to six weeks later. The fish that have lost their CWT were also stocked, but were further excluded from the study. After the check for CWTs the fish were stocked in two ponds close to the hatchery. The ponds have a continuous through flow of river water and an open outlet making it possible for the fish to leave the ponds and initiate seaward migration whenever it is triggered by internal or environmental conditions. The brown trout smolt migration normally peaks in the third or last week of May.

2.3. Screening of returning fish

From 1 May 2004 to 30 September 2012 all adult brown trout caught in the trap at the research station were scanned for CWTs. The fishes not used in the breeding program were euthanized, fin clip recorded, decapitated and the head were frozen (−20 °C) and were later thawed to retrieve the CWT. The fish used for artificial breeding were euthanized after being used and frozen and the CWTs were retrieved later during the following winter.

2.4. Statistical methods

The number of returning adults was summed for each year and treatment. Return rates were calculated and analyzed using logistic regression with a binomial distribution; we modeled the probability of returning for different treatments. The estimates of dispersion (as measured by Pearson's chi-square, divided by the degrees of freedom) were greater than 1.00, indicating that the data were overdispersed. In order to adjust for this, we first log-transformed the size (weight at return) of the fish, but the overdispersion remained, although lowered. We then added a multiplicative overdispersion factor (Grimm and Yarnold, 1995) to the variance functions of these distributions. Treatment, tagging year (=release year) and rearing tank were used as categorical predictors and fish mean weight at return as a continuous predictor. All analyses were done using SAS® statistical software (version 9.2; SAS, 2002). All $\chi2$ values are Wald $\chi2$ (Allison, 1999).

3. Results

3.1. Adult return rate and time spent at sea

Removing both pelvic fins resulted in the lowest return rate and the control (CWT only) the highest, although not significantly different from the remaining three treatments (overall treatment effect: $\chi^2 = 13.34$, d.f. = 4, $p = 0.0097$; Table 1). There was a tank effect ($\chi^2 = 31.64$, d.f. = 13, $p = 0.0027$) and an effect weight at tagging; larger fish had a higher return rate (estimate = 3.54, $\chi^2 = 37.8$, d.f. = 1, $p < 0.001$). There was also an effect of year ($\chi^2 = 44.98$, d.f. = 3, $p < 0.001$), as the highest return rate was noted for 2006 (1.04%) and the lowest for 2008 (0.46%).

The time spent at sea (time between stocking in the ponds and recapture in the trap) did not differ among treatments ($F_{5,922} = 0.21$, $p = 0.958$) or rearing tanks ($F_{14,922} = 1.14$, $p = 0.317$). There was no effect of release year ($F_{1,922} = 2.64$, $p = 0.105$) or mean weight at tagging of the fish ($F_{1,922} = 1.24$, $p = 0.265$). The mean time spent at sea was 656.6 days (lower CL = 641.3 days, upper CL = 672.3, minimum value = 107 days, maximum 1639 days; estimates from back-transformed logarithmic values).

3.2. Regeneration of fins, tag loss and hatchery mortality

The number of returning adults caught in the trap at the research station was 954, and 97.5% of these could be correctly identified on the basis of fin clipping. The remaining 2.5% had either regenerated their fins or had secondary injuries that made the identification doubtful—if based on fin clipping only. Consequently those fish was only identified using CWT.

Table 1
Return rate (given as percentages) of five fin clipping groups of brown trout [all being tagged with CWT (=coded wire tags)]. The return rates were estimated by logistic regressions. For the values per year fin clipping and hatchery tank were categorical predictors and length at tagging a continuous predictor. Values are mean ± standard error of means; mean denoted in each row with the same letter were not different at the 5% level. The values within parentheses are the number of fish used. The grand total number of fish was 96,681.

Stocking year	Weight (g) Mean ± S.D.	Adipose + CWT	Left pelvic + CWT	Left pelvic + adipose + CWT	Both pelvic + CWT	CWT only (control)
2004	58.05 ± 47.48	0.61 ± 0.20[a] (2482)	0.34 ± 0.13[a] (2491)	0.68 ± 0.21[a] (2491)	0.51 ± 0.17[a] (2491)	0.63 ± 0.20[a] (2390)
2005	120.77 ± 31.23	0.81 ± 0.12[b] (6114)	0.63 ± 0.10[a] (6133)	0.65 ± 0.11[a] (6163)	0.46 ± 0.09[a] (6111)	0.84 ± 0.12[b] (6138)
2006	112.03 ± 30.26	1.38 ± 0.18[ab] (7092)	1.17 ± 0.37[ab] (7072)	1.53 ± 0.20[b] (7085)	1.05 ± 0.15[a] (7084)	1.41 ± 0.19[ab] (7234)
2008	68.49 ± 62.32.	0.35 ± 0.20[ab] (3612)	0.40 ± 0.11[ab] (3648)	0.59 ± 0.14[b] (3601)	0.30 ± 0.17[a] (3647)	0.56 ± 0.14[ab] (3602)
Average (N_{total})		0.72 ± 0.09[b] (19300)	0.70 ± 0.09[b] (19344)	0.77 ± 0.10[b] (19340)	0.53 ± 0.07[a] (19333)	0.80 ± 0.10[b] (19364)