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Source: Folia Zoologica, 60(2) : 122-128

Published By: Institute of Vertebrate Biology, Czech Academy of Sciences

URL: https://doi.org/10.25225/fozo.v60.i2.a6.2011

Folia Zool. – 60 (2): 122–128 (2011)

Fin condition in intensively cultured Eurasian perch (*Perca fluviatilis*)

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Received 9 June 2010; Accepted 15 September 2010

Abstract. Condition of all fins was assessed in intensively cultured perch (n = 300) in comparison with control pond-reared perch (n = 30). Measurements of maximum fins length as well as a four point photographic scale were used. No damage to any fin was visually observed in the pond-reared group. The first dorsal fin showed the least damage in cultured perch with 93 % of fish demonstrating no erosion. The most affected were paired fins, with only 7 % and 2 % of pectoral and ventral fins, respectively, being non-eroded. No difference between culture systems was found in fin length for the first dorsal and the caudal fin. Pectoral, second dorsal, ventral, and anal fins of intensively cultured perch showed reductions up to 52, 49, 35, and 28 %, respectively. The relationship between fin lengths and standard body length (SL) were described for both groups (SL range 104-170 mm). Results of this study are discussed in relation to aesthetic, welfare and fish survival issues.

Key words: intensive culture, percids, fin erosion, fin damage, welfare

Introduction

Eurasian perch are traditionally cultured using an extensive pond polyculture system, but, for the past decade, intensive culture of this species is also increasingly practiced. Currently, intensive culture of perch mainly utilizes recirculation systems with high stocking density (up to 60 kg m^{-3}), at a constant water temperature (23 °C), using commercial feed (Kestemont et al. 1996, Mélard et al. 1996, Fiogbé & Kestemont 2003). Under such conditions, fin damage (FD), or erosion, has been reported in salmonid species (Kindschi et al. 1991, Wagner et al. 1996a, Moutou et al. 1998, Turnbull et al. 1998, MacLean et al. 2000), but no information on similar problems in perch is currently available.

Several authors have presented reasons for FD in fish species, including water parameters (Bosakowski & Wagner 1994a, Winfree et al. 1998), stocking density (Wagner et al. 1996a, Ellis et al. 2002), fish tank design (Bosakowski & Wagner 1995, Wagner et al. 1996b), feeding strategy (Winfree et al. 1998, Gregory & Wood 1999), social rank (Moutou et al. 1998), and interspecific interactions (Abbott & Dill 1985, Kindschi et al. 1991, MacLean et al. 2000) called fin-nipping. Fin damage is generally considered an indicator of fish welfare (Procarione et al. 1999, North et al. 2006). Eroded fins can be a site for microbial infection (Schneider & Nicholson 1980), and may result in partial fin loss (Kindschi et al. 1991). Damaged fins may also interfere with swimming. Fin erosion or absence can also affect acceptance by consumers and reduce the economic value of fish sold whole. Development of a practical means of preventing FD in intensively reared fish is necessary.

The aims of this study were to (1) evaluate the degree of fin damage in cultured perch, (2) compare fin damage in cultured perch with control fish from pond culture, (3) evaluate the relationship between total fin length and standard body length, and (4) evaluate the relationship among total fin score, body weight, and condition coefficient.

Material and Methods

Fish

Two aquaculture systems, differing mainly in the degree of culture intensity and feeding sources, were compared with respect to fish fin condition. The experimental fish included perch reared intensively

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in a recirculating system and fed with formulated feed (IC, initial body weight BW 1.9 ± 0.5 g, total length TL 55 ± 3 mm, final BW 49.2 ± 16.5 g, TL – 162.4 ± 22.6 mm) and fish from earth ponds fed natural food (CP, final BW – 35.5 ± 7.9 g, TL – 142.3 ± 10.4 mm).

Culture history of the IC group was: pond-reared (60 days) and habituated perch stocked was in six 50-L aquaria (25 July). Stocking density was 1-1.5 individuals per litre. The trial duration was nine months. Water quality during experimental rearing was kept at the following levels (mean ± S.D., T = 22.9 ± 1.9 °C; pH = 6.9 ± 0.7; dissolved oxygen = 6.8 ± 1.4 mg L^{-1}; ammonia (TAN) 0.46 ± 0.24 mg·l^{-1}; nitrite 0.12 ± 0.03 mg·l^{-1}; nitrate 26.7 ± 2.5 mg·l^{-1}). The values were within the optimum range for rearing of Eurasian perch (Mélard et al. 1996). Fish were fed the commercial feed Ecolife 60 (BioMar, Nersac, France) in rations according to Fiogbé & Kestemont (2003). Final density of IC group was 32.7 ± 4.8 kg m^{-3}.

The CP group (n = 30), comprised wild fish obtained at the autumn harvest of Láska pond (Fishery of Trebon a.s.) which were reared at a density of 0.2 individuals m^{-3} in pond polyculture with common carp (*Cyprinus carpio*). The natural production of the pond was 250 kg ha^{-1}. Perch lived on natural prey (zooplankton and zoobenthos). The main forage fish was topmouth gudgeon (*Pseudorasbora parva*). Fish were harvested on 22 October according to usual fish farm practice and immediately transported to the laboratory for measurement.

Analysis of fin condition

Visual assessment of fin condition: The modified method developed by Moutou et al. (1998) for rainbow trout was used to visually assess the degree of fin damage, where 0 = no or minimal visible damage (< 5 % of fin missing), 1 = minor damage (5 to 30 % of fin missing), 2 = moderate damage (30 % to 70 % of fin missing), and 3 = severe damage (> 70 % of fin missing). Assessment was carried out by an experienced operator who was provided with a photographic key. Both dorsal, pectoral and ventral fins as well as anal and caudal fin were assessed for calculating of the total fin scores. Examples of the degrees of damage for each fin are shown in Figs. 1 and 2. In total, 300 fish from the IC group and the 30 from the CP group were examined.

Total fin length: At the end of the growing trial, five fish were netted from each tank (six tanks, n = 30), mildly anaesthetised in a bath of clove oil 33 mg·l^{-1} (Velíšek et al. 2009), and weighed (± 0.1 g). Control fish (1 pond, n = 30) were submited to same procedure. Digital images of anaesthetized fish were produced with a Panasonic Lumix FZ 50 camera fixed on a tripod. Fish were positioned on a white background and photographs (n = 180) were taken for documentation of fin condition (first and second dorsal, caudal, anal, pectoral, and pelvic). Each fish

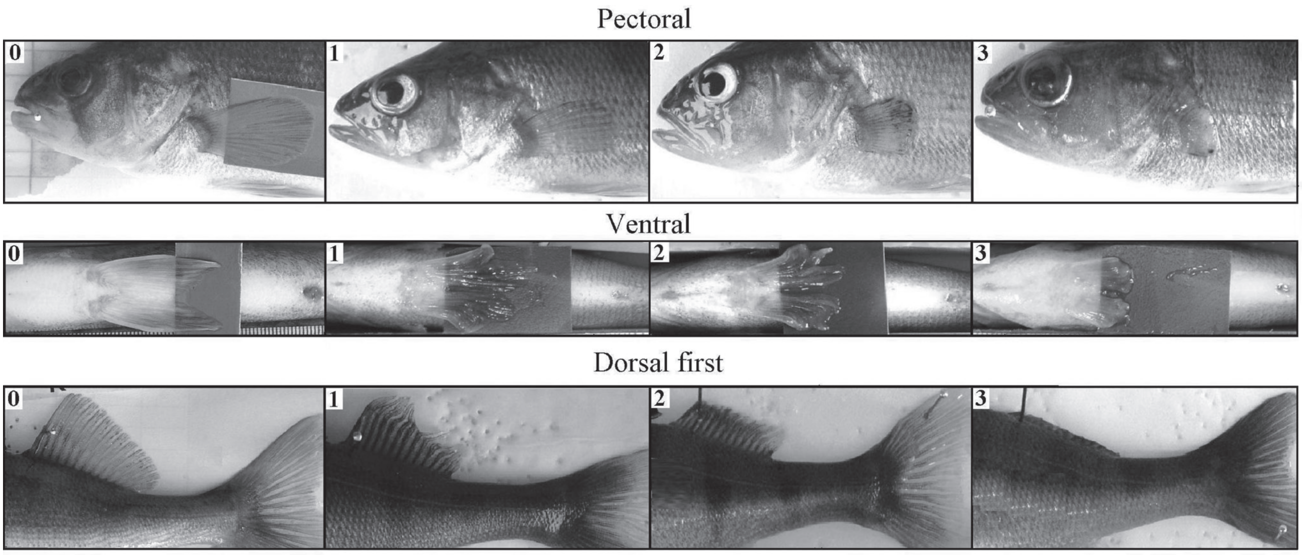

Fig. 1. *Classification of pectoral, ventral and first dorsal fin damage in Eurasian perch. 0 = minimal or no visible damage (< 5 % of fin missing), 1 = minor damage (5-30 % of fin missing), 2 = moderate damage (30-70 % of fin missing), and 3 = severe damage (> 70 % of fin missing).*

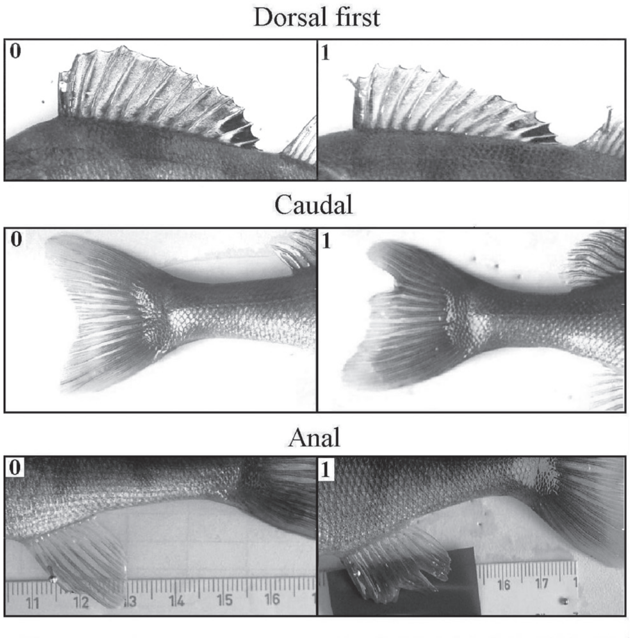

Fig. 2. Classification of anal, caudal, and first dorsal fin damage in Eurasian perch. 0 = minimal or no visible damage (< 5 % of fin missing), 1 = minor damage (> 5 % of fin missing); 2 and 3 were not found.

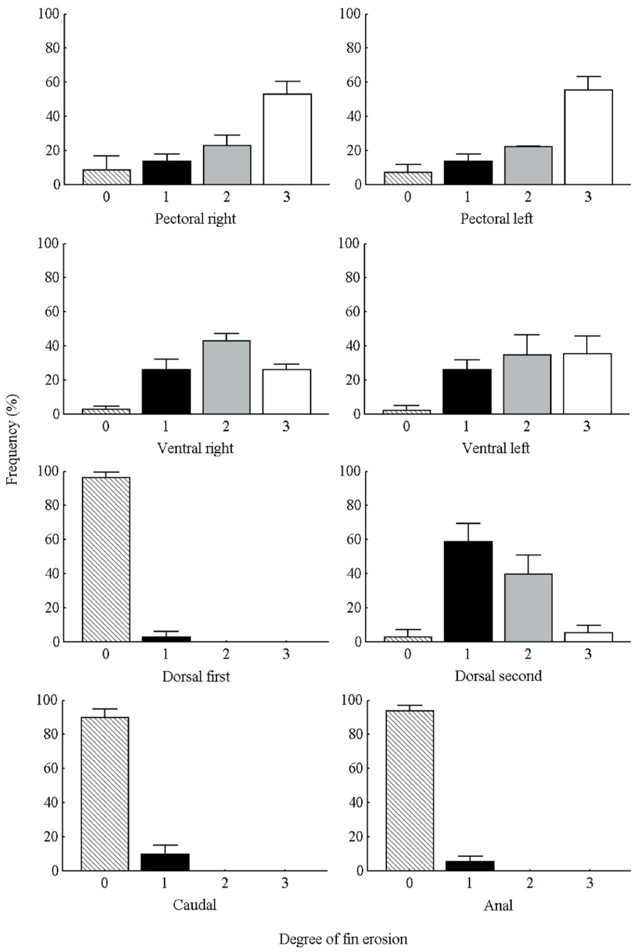

Fig. 3. Occurrence of fin damage categories in intensively cultured Eurasian perch. 0 = minimal or no visible damage (< 5 % of fin missing), 1 = minor damage (5-30 % of fin missing), 2 = moderate damage (30-70 % of fin missing), and 3 = severe damage (> 70 % of fin missing). Whiskers indicate S.D. (n = 300).

was photographed in left and right lateral views, and ventral view. Images (high-resolution TIFF format) were processed with an image analyzer (Olympus MicroImage v. 4.0 sw) using the manual measurement mode. Data on length measured in milimetres were collected, saved, and transferred to Microsoft Excel 2002 for analysis.

Calculations and statistics: Total fin score for each specimen was calculated as the sum of points for each fin. Relative length of each fin was calculated using followed formula: *RFL = total fin length/standard length × 100.*

Data from IC group was gradually sorted according to body weight and condition factor to obtain two cohorts of fish. Cohort of upper 10 % of fish with best conditon and body weight (probably dominant fish) was compared to the rest population.

Parametric data (body weight, total length, condition factor) were analyzed for normality by the Cochran, Hartley, and Bartlet Test prior to statistical tests. Relative fin lengths (arc-sin transformed), total length, and condition factor were normally distributed, so were compared using Student's t-test. Statistical assessment of all data was carried out with STATISTICA 7.0 (StatSoft Inc., Prague, Czech Republic).

Results

Total fin scores showed high individual variability in intensively cultured perch and ranged from 2 to 17. No FD was found by visual assessment in CP for any fin. The first dorsal fin was intact (category 0) in 93.3 % of IC fish (Fig. 3). In IC fish, no damage to 90.8 % of anal fins and 83.3 % of caudal fins was observed. No instances of FD categories two and three to the first dorsal, caudal, or anal fin were recorded. The most affected were paired fins; only 7 % of pectoral and 2 % of ventral fins were classified as category 0. The second dorsal fin was undamaged in only 4 % of IC fish. There was found no difference (t = –0.59, P = 0.558) between dominant fish and the rest of population in IC group. A 3D plot was constructed for demonstration of relationships among condition coefficient, body weight, and total score for FD using the method of least squares (Fig. 4). Using linear regression, the relationship can be described with the formula: *Total score = 17.629 + 0.0236BW – 7.8144CC* where BW is body weight (g) and CC is condition coefficient.

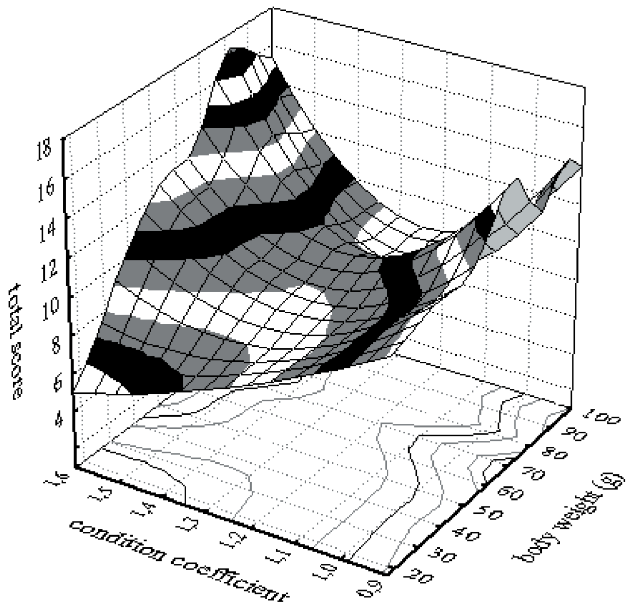

Fig. 4. *Relationships among total body weight, condition coefficient, and total score for fin erosion in cultured Eurasian perch using method of least squares n = 300.*

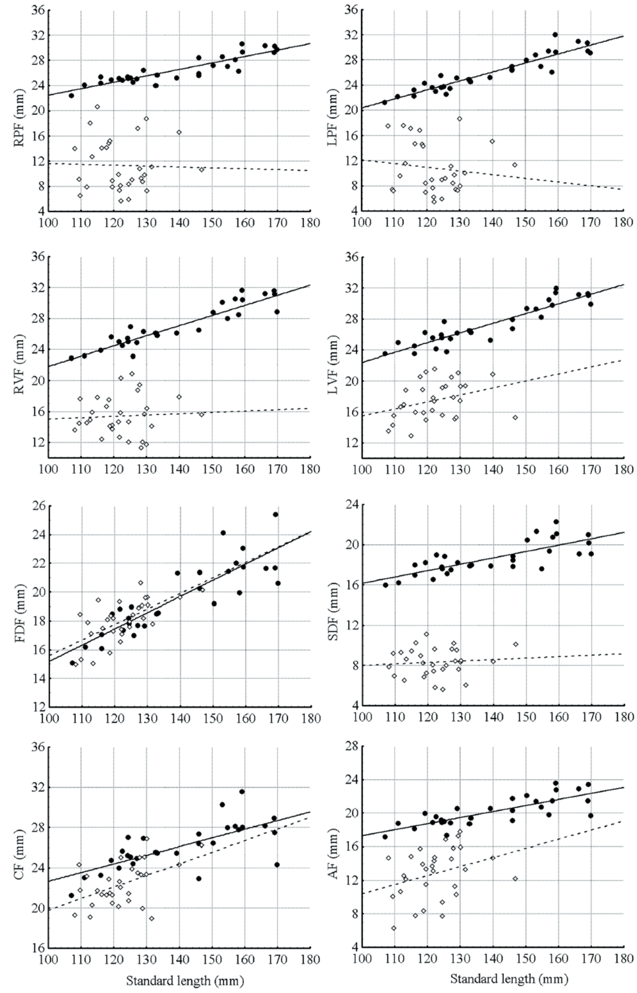

Fig. 5. *Linear regression of maximum fin length to standard body length in control (black circles) and cultured (open diamonds) Eurasian perch (n = 60). LPF = left pectoral fin, RPF = right pectoral fin, RVF = right ventral fin, LVF = left ventral fin, FDF = first dorsal fin, SDF = second dorsal fin, CF = caudal fin, AF = anal fin.*

Linear regression plots were drawn using standard body length to eliminate the effect of eroded caudal fins (Fig. 5). Results demonstrated clear linear relationships between standard length and total fin length for all fins in the control group fish within the sampled range: SL 108-170 mm. Correlation coefficients were greater than 0.72 indicating a strong correlation for all fins in the control group (Table 1). In contrast, in cultured perch, a huge variability in fin length was found for all fins, with the exception of first dorsal and caudal fins.

Comparison of relative fin lengths revealed significant differences between groups in pectoral (left: $t = 14.66$, $P < 0.001$; right: $t = 14.23$, $P < 0.001$), ventral (left: $t = 12.99$, $P < 0.001$; right: $t = 15.07$, $P < 0.001$), second dorsal ($t = 21.45$, $P < 0.001$) and anal ($t = 8.40$, $P < 0.001$) fins (Fig. 6) with lower values for cultured perch. On the other hand, there were no differences in first dorsal ($t = 1.45$, $P < 0.062$) and caudal fin ($t = 1.31$, $P = 0.194$). In addition, both group differ significantly in condition factor ($t = –2.56$, $P = 0.012$), total length ($t = 4.27$, $P < 0.001$) and body weight ($t = 4.37$, $P < 0.001$).

Discussion

Fin damage was observed in the majority of intensively cultured perch, but there was no or minimal damage to the first dorsal and caudal fins. No FD was found in the control pond-reared group for any fin, which confirms other reports (Bosakowski & Wagner 1994a, b). Fin damage was most frequent in the right and left pectoral fin of the IC group. Bosakowski & Wagner (1994a, b) reported the dorsal fin to be the most affected in intensively cultured salmonids, such as brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), rainbow trout (*Oncorhynchus mykiss*), and cutthroat trout (*Oncorhynchus clarki*). These authors reported that 46-90 % of salmonids (with species specific differences) had no affected pectoral fins, in contrast to the fish in this study (Fig. 3). Intensively cultured perch showed a reduction of up to 52 % in pectoral fin length, while salmonids show less reduction of

Table 1. *Regression of maximum fin length with standard body length in cultured (n = 30) and control (n = 30) Eurasian perch. r = correlation coefficient, p = ANOVA probability that slope equals zero, m = slope, b = y-intercept, LPF = left pectoral fin, RPF = right pectoral fin, RVF = right ventral fin, LVF = left ventral fin, FDF = first dorsal fin, SDF = second dorsal fin, CF = caudal fin, AF = anal fin.*

	RPF	LPF	RVF	LVF	FDF	SDF	CF	AF
control	r = 0.89	0.93	0.92	0.91	0.87	0.76	0.72	0.80
	r^2 = 0.79	0.86	0.84	0.83	0.76	0.58	0.51	0.63
	p = < 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	m = 0.103	0.143	0.131	0.125	0.113	0.063	0.086	0.072
	b = 12.164	6.021	8.725	9.858	3.915	9.790	14.100	10.039
cultured	r = 0.03	0.13	0.06	0.33	0.65	0.09	0.48	0.32
	r^2 = < 0.01	0.02	< 0.01	0.10	0.42	< 0.01	0.23	0.10
	p = 0.875	0.495	0.753	0.075	< 0.001	0.630	0.001	0.084
	m = –0.014	–0.059	0.017	0.091	0.108	0.014	0.115	0.107
	b = 13.001	17.996	13.282	6.414	4.808	6.567	8.327	–0.366

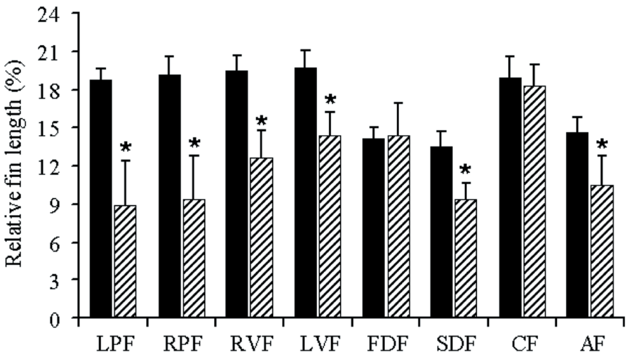

Fig. 6. *Comparison of mean values of relative fin length between control (dark bars) and cultured (striped bars). Asterisks indicate significant differences between bars (p < 0.05). LPF = left pectoral fin, RPF = right pectoral fin, RVF = right ventral fin, LVF = left ventral fin, FDF = first dorsal fin, SDF = second dorsal fin, CF = caudal fin, AF = anal fin. Whiskers indicate S.D. (n = 30).*

length in these fins (Bosakowski & Wagner 1994b). No or minimal FD to the first dorsal fin was observed, probably due to the bony structure of this fin. The second dorsal fin was affected, but with more than 58 % of fish having only minor damage (degree 1). The dorsal fin is also reported to be affected in salmonids at similar levels (40-74 %) (Bosakowski & Wagner 1994a). We found size reductions of up to 49 % in the second dorsal fin, in agreement with results for salmonids (Bosakowski & Wagner 1994b). Only 2 % of perch examined were without damage to ventral fins. Hence, the ventral fin was the most frequently affected, while reduction of length (35 %) was lowest in comparison to pectoral fins. Bosakowski & Wagner (1994b) reported a smaller reduction in ventral fins in salmonids. The present study found no or minimal incidence of FD to caudal fins, similar to results in rainbow trout. On the other hand, 30 % of brook trout and brown trout examined were found to show damage to this fin (Bosakowski & Wagner 1994a).

The suggestion that the largest perch, in best condition (probably dominant fish), would show less FD compared to smaller fish in poorer condition was not confirmed (Fig. 4). On the contrary, a high degree of FD was observed in these fish, possibly as a result of aggressive feeding behaviour and strong competition for food. A similar effect has been observed in Atlantic salmon (*Salmo salar*) where dominant fish compete aggressively and incur fin damage, while less aggressive individuals adopt alternative feeding strategies, which result in lower food intake and growth but reduce the risk of FD (MacLean et al. 2000). Several social cohorts with varying feeding strategies were observed in the perch population. The lowest total score for FD was observed in fish with a CC ranging from 1.1 to 1.3, irrespective of body size (fish growth). Fast-growing fish with significantly higher or lower CC incurred a higher total FD score (Fig. 4). On the other hand, the lowest total FD score was observed in groups of poorly-growing perch with high CC. These were probably less aggressive individuals with alternative feeding strategies resulting in lower food intake and growth, but probably reduced the risk of FD. On the other hand, Moutou et al. (1998) reported that subordinate rainbow trout had higher FD on the dorsal fin.

Fin damage in other intensively cultured fish species has been attributed to high stocking density (Wagner et al. 1996a, Procarione et al. 1999, Ellis et al. 2002), fin-nipping (Abbott & Dill 1985), or abrasion from rough tank surfaces (Bosakowski & Wagner 1995, Wagner et al. 1996b, Moutou et al. 1998). The glass aquaria used in our study minimized tank abrasion. Stocking density was lower than the maximum reported by Mélard et al. (1996), and water quality parameters were kept at optimal levels for perch (Kestemont et al. 1996, Mélard et al. 1996). There was no observed bacterial or fungal disease which could be a causative agent of FD, as has been previously reported (Schneider & Nicholson 1980). Intraspecific fin-nipping behaviour was observed. Therefore, we suggest that fin-nipping was the major cause of FD in our study.

Fin erosion in intensively reared salmonids can affect post-stocking survival, increase the likelihood of disease, and reduce the aesthetic appeal of fish to the consumer (Schneider & Nicholson 1980, Bosakowski & Wagner 1994a). In perch, eroded fins could be niches for secondary pathogens such as saprophytic fungi or bacteria as well as sites of ion loss, especially under wild conditions. Signs of bacterial or fungal diseases were observed when perch with eroded fins were kept in flow-through systems at lower temperatures (8-12 °C); however, no signs were observed in recirculating aquaculture systems, probably due to higher water salinity (Stejskal, unpublished data).

Food fish with FD can have reduced marketability. In some cases it also reduces osmoregulatory control and disrupts homoeostasis. Therefore fin damage is considered an indicator of welfare in a variety of cultured fish (Procarione et al. 1999, European Commission 2004, North et al. 2006). According to Latremouille (2003) there are several possible means of reducing FD in fish (salmonids), including increasing water speed, feeding to satiation, and tank design. Significantly reduced or no FD was observed in perch reared in a recirculating system with lower efficiency of solid waste removal resulting in higher turbidity (Stejskal, unpublished data). Accordingly, water turbidity may play a role in reduction of FD, and the use of clay or other substances to artificially increase turbidity should be evaluated as a protective treatment. Future research on perch should be focused on the impact of water turbidity, rearing density, feeding level, and water velocity, to reduce fin damage.

Our study showed that FD is more frequent in intensively cultured perch. Fish size and condition does not seem to be a substantial factor explaining occurrence and intensity of FD. Pectoral, ventral, and second dorsal fins are the main sites of FD in perch.

Acknowledgements

This work was supported by MSM project (No. 6007665809), NAZV projects (No. QI101C033 and No. QH91310), GAJU project (No. 047/2010/Z), KONTAKT project (No. ME 10126) and project CENAQUA (CZ.1.05/2.1.00/01.0024).

Literature

Abbott J.C. & Dill L.M. 1985: Patterns of aggressive attack in juvenile steelhead trout (*Salmo gairdneri*). *Can. J. Fish. Aquat. Sci. 42: 1702–1706.*

Bosakowski T. & Wagner E.J. 1994a: Assessment of fin erosion by comparison of the relative fin length in hatchery and wild brown trout in Utah. *Can. J. Fish. Aquat. Sci. 51: 636–641.*

Bosakowski T. & Wagner E.J. 1994b: A survey of trout fin erosion, water quality, and rearing conditions at state fish hatcheries in Utah. *J. World Aquac. Soc. 25: 308–316.*

Bosakowski T. & Wagner E.J. 1995: Experimental use of cobble substrates in concrete raceways for improving fin condition of cutthroat (*Oncorhynchus clarki*) and rainbow trout (*O. mykiss*). *Aquaculture 130: 159–165.*

Ellis T., North B., Scott A.P., Bromage N.R., Porter M. & Gadd D. 2002: The relationships between stocking density and welfare in farmed rainbow trout. *J. Fish. Biol. 61: 493–531.*

European Commission 2004: Farmed fish and welfare. *European Commission, Directorate-General for Fisheries, Research and Scientific Analysis Unit (A4). Brussels, Belgium.*

Fiogbé E.D. & Kestemont P. 2003: Optimum daily ratio for Eurasian perch *Perca fluviatilis* L. reared at its optimum growing temperature. *Aquaculture 216: 234–252.*

Gregory T.R. & Wood C.M. 1999: Interactions between individual feeding behaviour, growth, and swimming performance in juvenile rainbow trout (*Onchorhyncus mykkis*) fed different rations. *Can. J. Fish. Aquat. Sci. 56: 479–486.*

Kestemont P., Mélard C., Fiogbé E.D., Vlavonou R. & Masson G. 1996: Nutritional and animal husbandry aspects of rearing early life stages of Eurasian perch *Perca fluviatilis*. *J. Appl. Ichthyol. 12: 157–165.*

Kindschi G.A., Shaw H.T. & Bruhn D.S. 1991: Effect of diet on performance, fin quality and dorsal lesions in steelhead. *J. Appl. Aquacult. 1: 113–120.*

Latremouille D.N. 2003: Fin erosion in aquaculture and natural environments. *Rev. Fish. Sci. 11: 315–335.*
MacLean A., Metcalfe N.B. & Mitchell D. 2000: Alternative competitive strategies in juvenile Atlantic salmon *Salmo salar*: evidence from fin damage. *Aquaculture 184: 291–302.*
Mélard C., Kestemont P. & Grignard J.C. 1996: Intensive culture of juvenile and adult Eurasian perch (*Perca fluviatilis*): effect of major biotic and abiotic factor on growth. *J. Appl. Ichthyol. 12: 175–180.*
Moutou K.A., McCarthy I.D. & Houlihan D.F. 1998: The effect of ration level and social rank on the development of fin damage in juvenile rainbow trout. *J. Fish. Biol. 52: 756–770.*
North B.P., Turnbull J.F., Ellis T., Porter M.J., Migaud H., Bron J. & Bromage N.R. 2006: The impact of stocking density on the welfare of rainbow trout (*Oncorhynchus mykiss*). *Aquaculture 255: 466–479.*
Procarione L.S., Barry T.P. & Malison J.A. 1999: Effects of high rearing densities and loading rates on the growth and stress response of juvenile rainbow trout. *N. Am. J. Aquac. 61: 91–96.*
Schneider R. & Nicholson B.L. 1980: Bacteria associated with fin rot disease in hatchery-reared Atlantic salmon (*Salmo salar*). *Can. J. Fish. Aquat. Sci. 37: 1505–1513.*
Turnbull J.F., Adams C.E., Richards R.H. & Robertson D.A. 1998: Attack site and resultant damage during aggressive encounters in Atlantic salmon (*Salmo salar* L.) parr. *Aquaculture 159: 345–353.*
Velíšek J., Stejskal V., Kouřil J. & Svobodová Z. 2009: Comparison of the effects of four fish anaesthetics on biochemical blood profile of perch (*Perca fluviatilis* L.). *Aquacul. Res. 40: 354–361.*
Wagner E.J., Intelmann S.S. & Routledge D. 1996a: The effects of fry rearing density on hatchery performance, fin condition, and agonistic behaviour of rainbow trout *Oncorhynchus mykiss* fry. *J. World Aquac. Soc. 27: 264–274.*
Wagner E.J., Routledge M.D. & Intelmann S.S. 1996b: Fin condition and health profiles of albino rainbow trout reared in concrete raceways with and without a cobble substrate. *The Progressive Fish-Culturist 58: 38–42.*
Winfree R.A., Kindschi G.A. & Shaw H.T. 1998: Elevated water temperature, crowding, and food deprivation accelerate fin erosion in juvenile steelhead. *Prog. Fish. Cult. 60: 192–199.*