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ISELAW
Integrated Studies of the Effects of Liming Acidified Waters

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Growth and maturity of perch (Perca fluviatilis) in lakes differing in acidity and fish community

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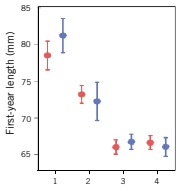

Figure 1. First-year length (mean + 2 SE) of females (red) and males (blue) in lakes 1-4. N = 67–237.

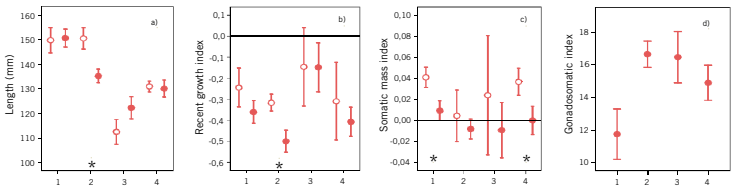

Figure 2. Age 3+ females from lakes 1-4. a) Length, b) recent growth index, c) somatic mass index, and d) gonadosomatic index. All data as mean + 2 SE, within groups of immature (unfilled) and mature (filled) individuals (N as in Table 2).
* = significant difference between groups within lake (t-test, P < 0.01).

Objectives

1) To compare juvenile growth and age- and growth-related maturity between sex and lakes, and 2) to test for female costs of reproduction.

Material and methods

The lakes (Table 1) are situated in forested areas with similar climate. Årsjön (1) is acidic, Stora Envättern (2) is neutral, and Långsjön (3) and Stensjön (4) have been or are still repeatedly limed. There is also a gradient of increasing fish abundance and roach dominance from lake 1 to 4. Perch was sampled in summer (Table 1), and once in late winter (Table 2). Juvenile growth was taken as back-calculated length after the first growth season of year-classes 1998-2003. In winter samples, mature and immature females of age 3+ were compared, with respect to length and fitness-related indices. Negative values of a "recent growth index" means growth reduction between the last two growth seasons. Zero values of a "somatic mass index" means average length-specific somatic mass. "Gonadosomatic index" (in %) is the ratio between gonad mass and somatic mass.

Results

1) Juvenile growth was not different between females and males (Figure 1, nested ANOVA, P = 0.134), but differences between lakes were highly significant (P < 0.001). In spite of high juvenile growth rate in the acidic Årsjön, maturation rates of both sexes tended to be lower than in the other lakes (Table 2), especially at age 3+ and older.

2) At age 3+ (Figure 2), mature females in Stora Envättern were shorter than immature ones, coinciding with a higher reduction in recent growth. Females were shorter in Stensjön than in Årsjön, but there was no significant difference between maturation states. Costs of reproduction were instead expressed as lower somatic growth index, along with tendencies for lowered recent growth index. The gonadosomatic index was remarkably lower in mature females from the acidic Årsjön, than in the other lakes, in spite of similar reproductive costs in terms of reduced somatic mass and/or recent growth indices.

Conclusions

The results are in accordance with previous reports of fast growth of perch in slightly acidic lakes, related to low intra- and inter-specific competition. The novelty is that costs of maturation vary between the perch-dominated acidic lake and three lakes with increasing abundance of competing fish species.

Table 1: Lake characteristics and fish communities

	Årsjön [c]	Stora Envättern	Långsjön	Stensjön
Altitude (m)	51	62	41	35
Lake area (km^2)	0,21	0,37	0,09	0,39
Maximum depth (m)	11	11	8	21
Temperature [a]	18.8	18.1	18.0	17.7
pH a)	5.8	6.6	6.6	6.9
Transparency (m) [a]	3.3	3.8	2.6	3.7
Total-P (_g/L) [a]	4.8	9.0	6.2	6.8
Perch CPUE [b]	20.5	17.3	11.6	8.2
Roach CPUE [b]	--	13.4	32.5	28.8
Pike CPUE [b]	0.04	0.1	0.04	0.1
Ruffe CPUE [b]	1.0	3.2	--	2.8
Bleak CPUE [b]	--	--	--	1.1
Vendace CPUE [b]	--	--	--	1.1
All species CPUE [b]	21.5	34.1	44.1	42.1

[a] mean during May-September, 1999-2003
[b] mean #.benthic gillnet-1
[c] test-fished in 1998, 2002 and 2003, instead of each year during 1998-2003

Table 2: Numbers of perch (N) and % mature individuals, within lake and age group

	Females		Males	
Lake, Year / Age	N	% mature	N	% mature
Årsjön, 2004				
2+	16	19	3	100
3+	16	50	10	90
older	42	67	10	70
Stora Envättern, 2004				
2+	11	82	1	100
3+	33	85	9	100
older	43	86	11	100
Långsjön, 2003				
2+	3	0	4	75
3+	11	82	6	100
older	44	89	48	100
Stensjön, 2002				
2+	6	0	2	50
3+	19	79	6	100
older	34	44	21	100