Aluminium and damage to fish populations in limed streams

CECILIA ANDRÉN[1] and **BJÖRN C. BERGQUIST**[2]

[1] Institute of Applied Environmental Research (ITM), Stockholm University, SE-106 91 Stockholm, Sweden

[2] Institute of Freshwater Research, Swedish National Board of Fisheries, SE-178 93 Drottningholm, Sweden

Correspondence: candren@itm.su.se

ISELAW

Integrated Studies of the Effects of Liming Acidified Waters

1 Objectives

In this study we try to detect effects of acidification and aluminium on fish, by evaluating monitoring data of water quality and fish populations in running waters that are limed, acidified or circumneutral. That acidification of surface waters and elevated levels of aluminium cause damage to fish populations has been known for a long time:

– but can it be observed in monitoring studies and

– what chemical conditions are risk-free based on the experience from monitoring?

2 Material and methods

This study is based upon monthly water sampling and annually autumn electro-fishing data from limed (n=12, 1995-99), acidified (n=3, 1998-99) or neutral reference (n=9, 1998-99) streams in the ISELAW-programme (Integrated Studies of the Effects of Liming Acidified Waters). Primarily the relationships between population abundance of yearlings and older brown trout (*Salmo trutta* L.) and chemical variables (measured or calculated) were studied with focus on inorganic aluminium (Ali). The abundance of young of the year and older trout was expressed as percentage (YoY% and Older % respectively) of the expected abundance estimated by the Swedish Electrofishing Registers with respect to ecoregion, altitude, type of trout population, stream size and physical disturbances. Means of chemical variables were calculated for the hydrological year, October to September. In addition were variables who where expected to have most effect at high flows also considered as extreme values i.e. minimum levels of pH and alkalinity/acidity and maximum levels of the aluminium fractions for the same period. Since the data was not linear or normally distributed we used nonparametric statistics, Mann Whitney U-test, to analyze the relations at critical chemical conditions, such as low/high pH or alkalinity/acidity or level of inorganic aluminium.

3 Results

The relative abundance of brown trout yearlings is related mainly to extreme values of pH (Fig.1), inorganic aluminium (Fig.2) and alkalinity (Fig.3). As illustrated in the figures, pH has to be above 6.0, and alkalinity above 0.05 meqv/l and inorganic aluminimum should not exceed 30 - 50 µg/l if the trout shall breed as expected or better. Note the different stream types in the figures; low abundances are mainly found in acid streams but some limed streams also have low abundances caused by low pH and high levels of aluminium.

The differences in relative abundance of young of the year trout in waters above or below the identified critical levels of pH, alkalinity/acidity and inorganic Al are significant both compared to mean and extreme values (Table1). The differences in relative abundance of older trout were only significant for waters divided by critical levels expressed as mean values and not as extreme values.

Table 1. Significance levels for differences of relative abundance of brown trout analyzed at different levels of inorganic aluminium, pH and alkalinity/acidity with Mann Whitney U-test.

	Range	N	YoY%	Older%
pH	min < 6.0	24	<.001	ns
	min > 6.0	59		
	mean < 6.0	8	<.001	<.001
	mean > 6.0	75		
Alkalinity/ acidity (meqv/l)	min <.05	33	<.001	ns
	min >.05	50		
	mean <.05	9	<.001	0.001
	mean >.05	74		
Inorganic aluminium (µg/l)	max > 30	28	<.001	ns
	max < 30	55		
	mean > 30	10	<.001	0.005
	mean < 30	73		

4 Conclusions

Negative effects of high aluminium levels can be detected by monitoring studies of limed streams.

In limed streams

- pH should not be less than 6.0
- alkalinity should not be less than 0.05 meqv/l
- inorganic Al should not exceed 30 µg/l

if the purpose of the liming is to have good breeding waters for brown trout

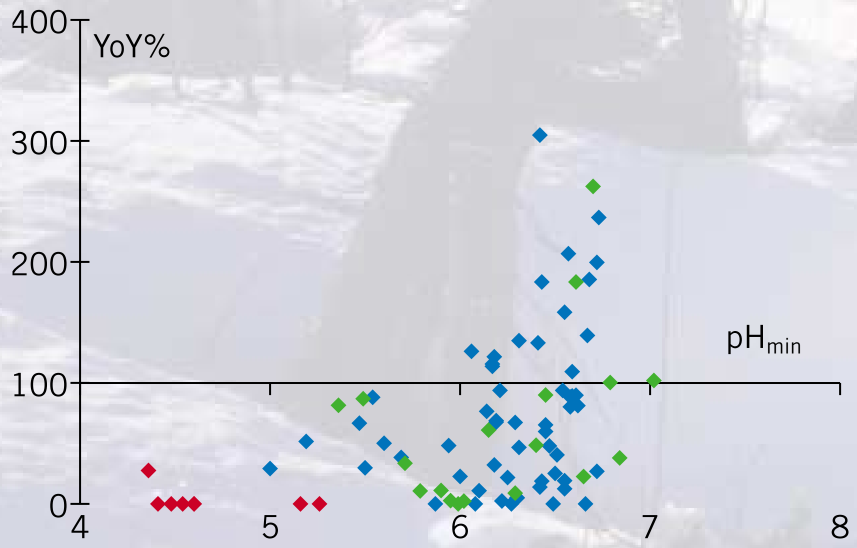

Figure 1. **Relative abundance of young of the year brown trout and minimum level of pH in limed (◆), neutral (◆) and acid (◆) streams.**

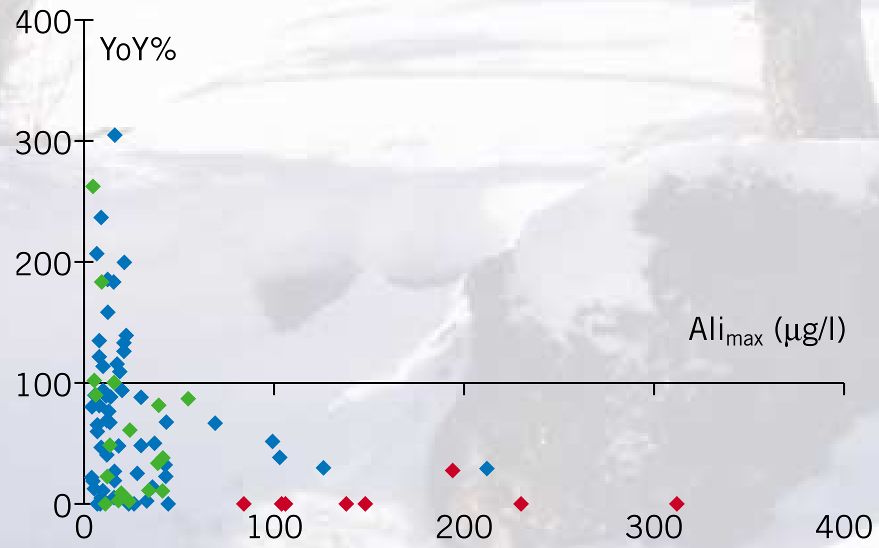

Figure 2. **Relative abundance of young of the year brown trout and maximum level of inorganic aluminium in limed (◆), neutral (◆) and acid (◆) streams.**

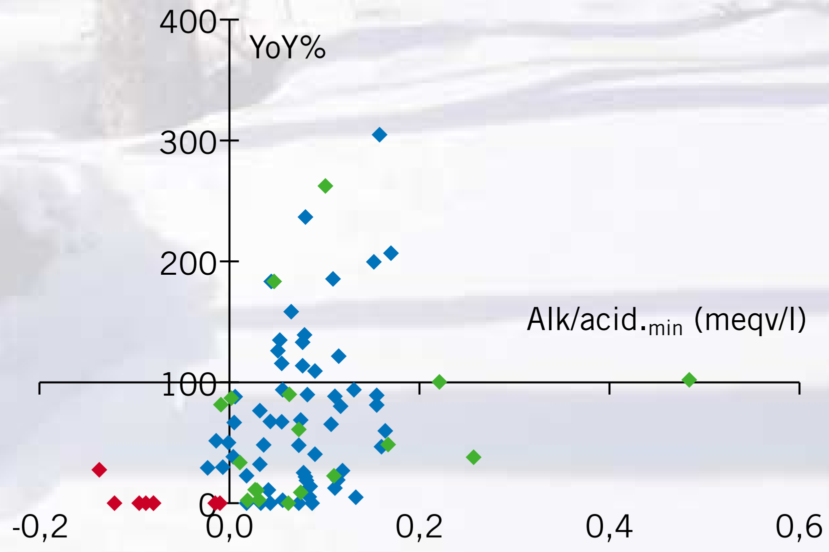

Figure 3. **Relative abundance of young of the year brown trout and minimum level of alkalinity/acidity in limed (◆), neutral (◆) and acid (◆) streams.**

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