Fish and crustaceans

Do they respond differently to improved water quality due to liming?

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The present study from Enningdal watershed in southeastern Norway, shows that crustaceans to a much greater extent than fish have responded to improved water quality from liming.

The highest diversity of aquatic biota in Norway is documented from this region. The watershed is shared between Norway (1/3) and Sweden (2/3) and includes 60 lakes in Norway (>1.0 ha). The water quality in the lower parts is influenced by marine sediments (transgression line: 174 m a.s.l.).

The liming was mainly initiated in the early 1980s, and presently 43% of the lakes, covering 93% of the total lake area, are either being limed or are affected by liming. The liming has caused an improved water quality in formerly acidic lakes (pH: 6.5-7.2 and labile Al: 1-4 µg/L).

Based on earlier studies and inquires, historical data of fish community status was obtained from 42 lakes. In addition, test-fishing and sampling of crustaceans have been conducted in 24 lakes in recent years (2003-2004). Six of these lakes were acidic not limed, three were weakly acid not limed and 15 were limed.

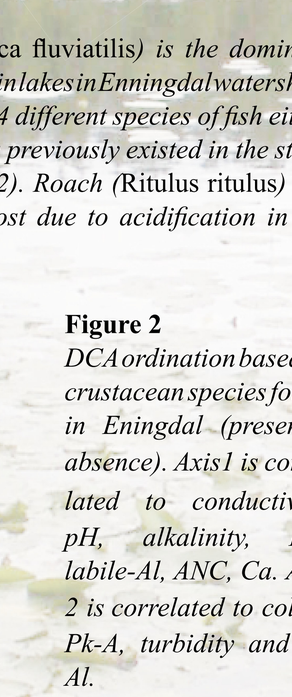
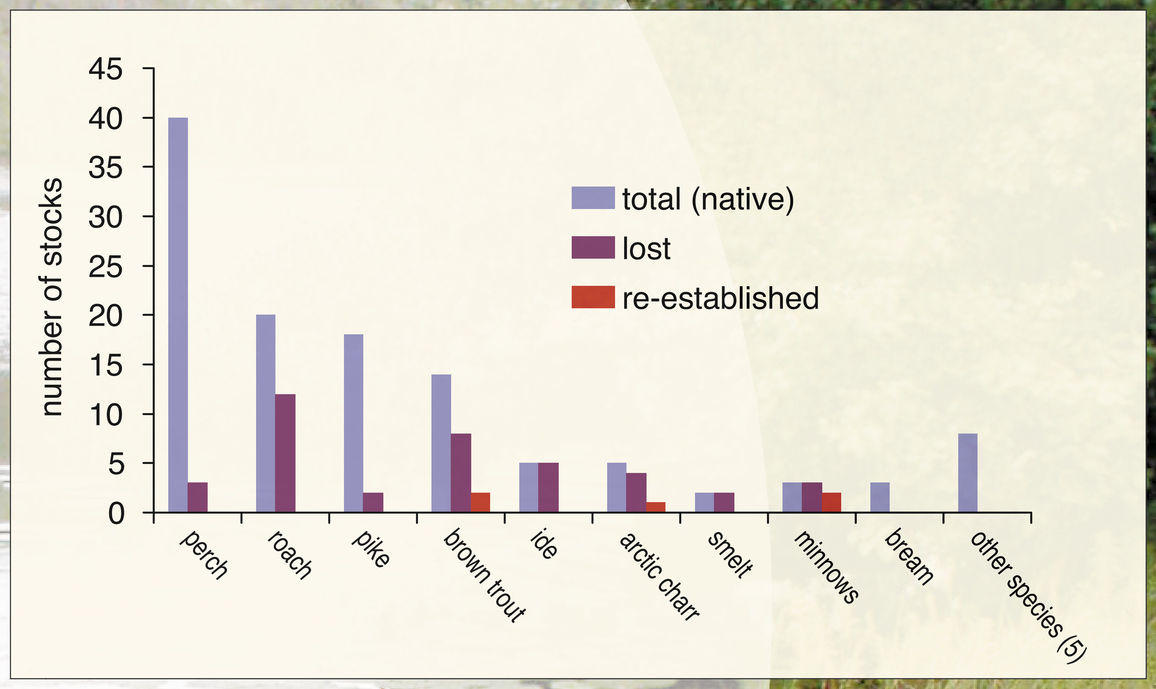


Figure 1
*Perch (*Perca fluviatilis*) is the dominant fish species in lakes in Enningdal watershed. A total of 14 different species of fish either exist or has previously existed in the study lakes (n=42). Roach (*Ritulus ritulus*) has suffered most due to acidification in the study area.*



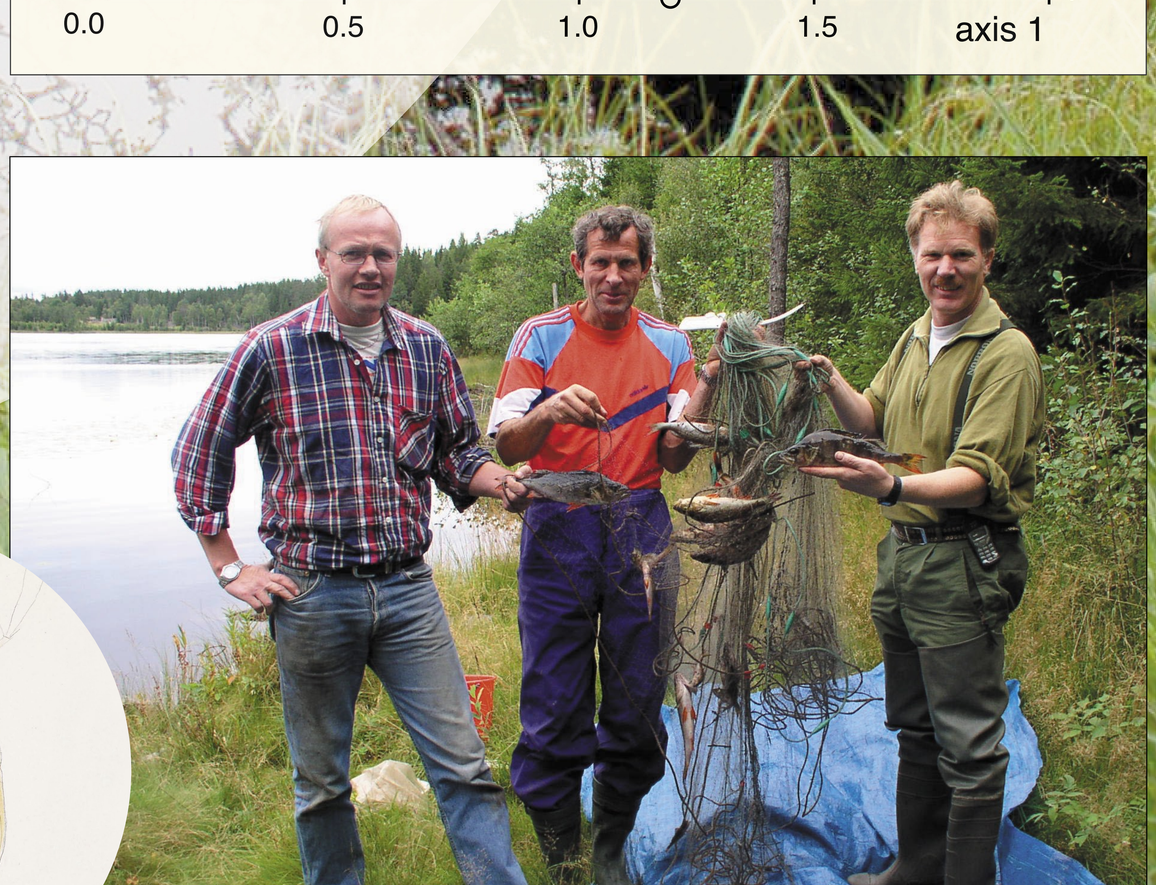


Figure 2
DCA ordination based on crustacean species found in Eningdal (presence/absence). Axis1 is correlated to conductivity, pH, alkalinity, Mg, labile-Al, ANC, Ca. Axis 2 is correlated to colour, Pk-A, turbidity and tot Al.

RESULTS

Fish

- Of a total of 14 species and 120 fish populations, 42 populations (35%) have gone extinct (*figure 1*).
- Only five of the formerly lost fish populations (12 %) have been re-established, all by means of man's introductions.
- The mean number of fish species prior to acidification was 2.9±1.9, as opposed to 1.9±1.2 at present.
- The majority of the lakes are now inhabited by only one species: perch.

Crustaceans

- A mean of 23 species in six acidic not limed lakes
- A mean of 36 species in both weakly acidic not limed lakes and in limed lakes
- Acid tolerant species (i.e. *Acantholeberis curvirostris, Diacyclops nanus*) dominate in the acidic lakes, while 20 acid sensitive species (i.e. *Limnosida frontosa, Ceriodaphnia pulchella, Daphnia cristata, Bosmina longirostris, Ophryoxis gracilis, Alona costata, Alonella exigua, Disparalona rostrata, Heterocope appendiculata, Eucyclops macrurus, E. speratus*) were found in lakes when pH>5.5.

CONCLUSIONS

Physical barriers are considered to be the main factor preventing fish from re-establishing populations after liming. Thus, to restore the original fish fauna in the near future, re-stocking by man is needed. In contrast, crustaceans have to a much greater extent, responded to improved water quality. This is mainly due to their spreading capacity, but also by survival both in refuges within the watershed and as resting-eggs in the sediment.

Acantholeberis curvirostris.
An acid tolerant species.
Ill. by G.O. Sars