NATUR VÅRDS VERKET

SWEDISH ENVIRONMENTAL PROTECTION AGENCY

ISELAW

Integrated Studies of the Effects of Liming Acidified Waters

FISKERIVERKET

Swedish National Board of Fisheries

SLU

Swedish University of Agricultural Sciences

Stockholm University

# Mitigation of acidification in lakes by liming

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The Swedish liming programme started in 1976 in order to counteract effects of anthropogenic acidification of aquatic ecosystems.

About 7 500 lakes and 14 000 km running waters are included in the liming programme today. (Figure 1).

Limestone powder ($CaCO_3$) in fine or more course fractions is spread by boat, helicopter or lime doser.

Ecosystem development in limed waters has been followed since 1989 within the programme Integrated Studies of the Effects of Liming Acidified Waters (ISELAW).

The main objectives are to assess

- long-term ecological effects of liming
- to what extent ecosystems recover to a pre-acidification state
- to elucidate possible detrimental effects of lime treatment.

The programme comprises monitoring of water chemistry, phyto- and zooplankton, macrophytes, benthic invertebrates and fish.

At present the programme includes:
15 limed and 6 reference lakes
18 limed and 17 reference streams

Figure 2-5 show some examples from the ISELAW-programme.

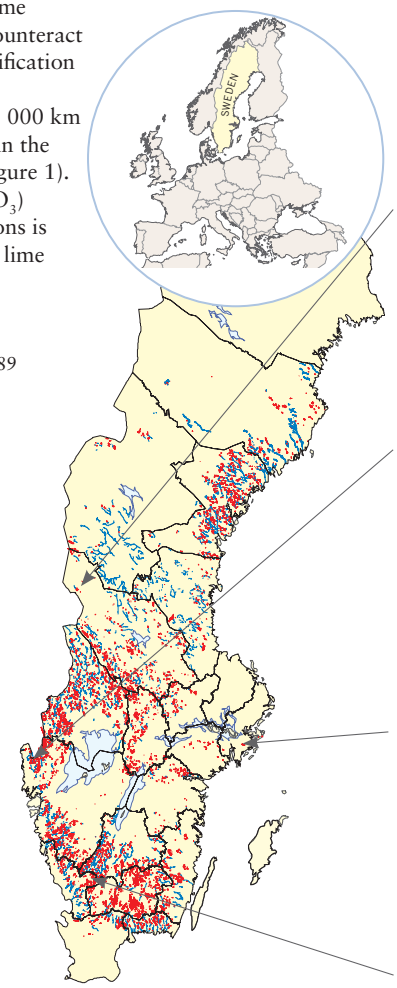


**Figure 1**
Lakes (red) and running waters (blue) in the Swedish Liming Programme

**Changes in pH and alkalinity during acidification and after liming (indicated by vertical lines)**

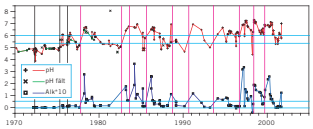

**Figure 2. Lake Nedre Särnamannasjön**
Difficult liming object with poor liming results in remote mountain area. Infrequent in-lake liming ought to be substituted by an automatic lime-doser if environmental conditions permitted. Fish survives in spite of many low-pH periods.

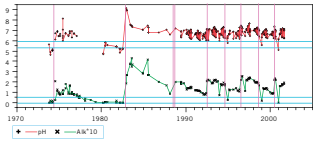

**Figure 3. Lake Ejgdesjön**
Low initial lime dose and subsequent reacidification, followed by an overdose of limeagent. From 1988 more frequent liming in upstream lakes and the lake itself. An ambition to keep pH-values closely above the target has led to some dips during recent wet winters.

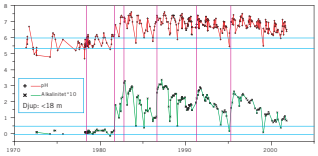

**FIgure 4. Lake Stensjön**
Low initial lime doses followed by lake and discharge area liming with long intervals. Large interannual variation due to large inflows of unlimed water during winter and spring from large areas of bare rocks.

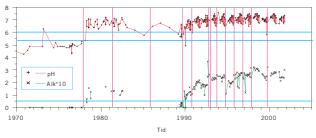

**Figure 5. Lake Stora Härsjön**
Sucessful liming with low interannual pH-variation obtained through unusually frequent liming of many upstream lakes. Warning for unnaturally high pH and alcalinity.

## Some results from the ISELAW programme

- Lime treatment detoxifies the water, even though the extent of chemical and biological recovery varies between and within sites.
- Liming causes immediate changes in water chemistry which generally are large compared to long-term variation. The studies show that in most cases the chemical goals for the liming are fulfilled.
- However, due to re-colonisation failure, several species expected to be present are lacking in the limed waters despite an apparent restoration of the water chemistry. Biota in treated waters still do not seem to recover fully to the conditions expected to occur before acidification.