Impaired chick survival in Black-throated Loon and Red-throated Loon in parts of Sweden

Svenska LOM-föreningen / Projekt LOM

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Black-throated Loon and Red-thorated Loon - ecological differences

	Black-throated Loon *Gavia arctica*	Red-throated Loon *Gavia stellata*
Breeding habitat	**Quite large and oliotrophic clear-water lakes**	**Small lakes and ponds, often devoid of fish.**
Food to the chicks	**Almost entirely fed with food caught in the breeding lake; primarily fish but also aquatic insects.**	**Fish collected in larger clear-water lakes or at sea, up to a distance of around 10 km.**
Preference for lakes with high water transparency	**Yes**	**No**
Fish stocks in the lakes	**No explicit preference for lakes with salmonid fish**	**Preference for foraging lakes with salmonid fish**
Water chemistry in the lakes	**Nutrient-poor lakes, slightly acidic but mostly with good alkalinity (*that might be maintained by lime treatment in previously acidic lakes*)**	**Foraging lakes more acidic and with lower alkalinity** **Higher absorbance – less clear water**

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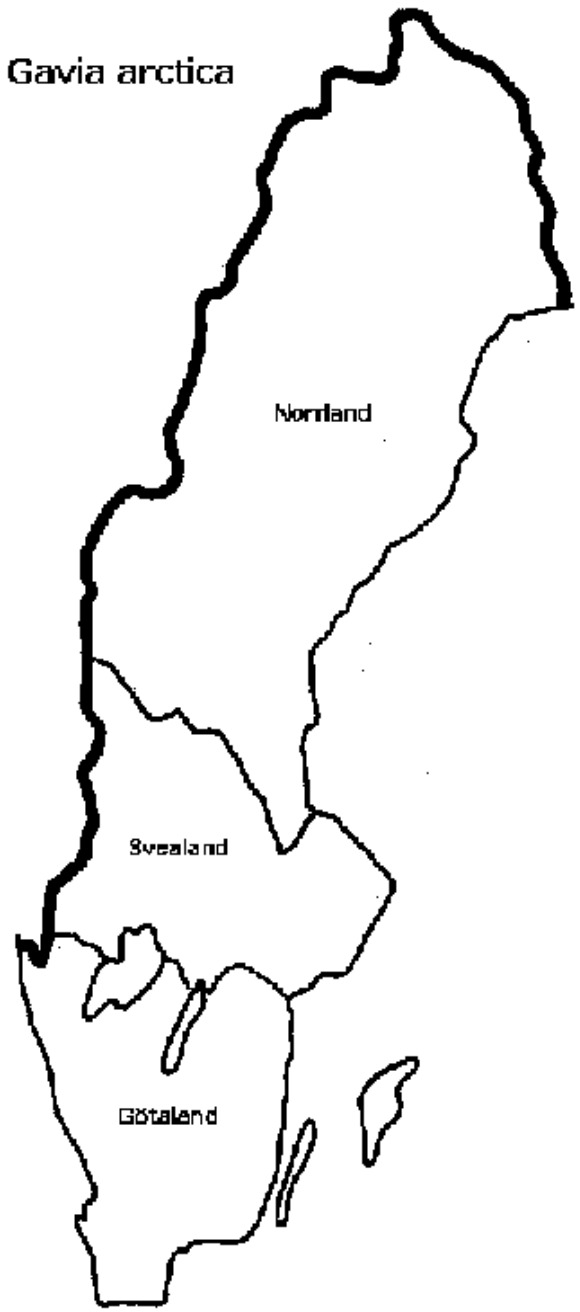
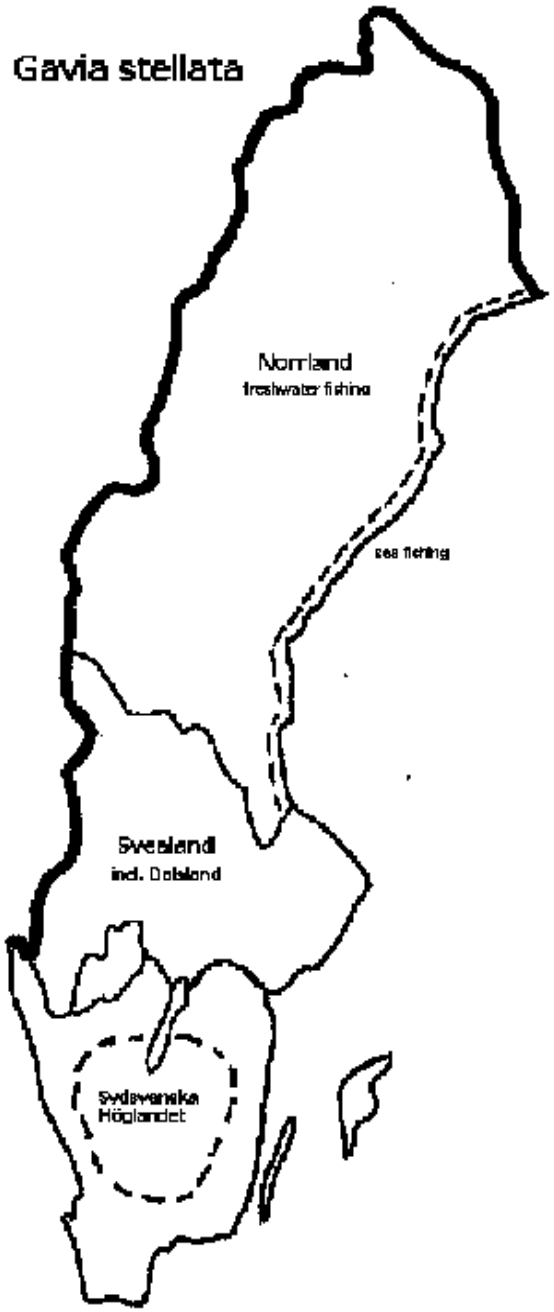
PERCENTAGE OF BROODS WITH 2 CHICKS

- Trends, having in mind that……..
- Chick survival is highly correlated to the parents' food provisioning (*Gavia arctica*, Scotland, Jackson 2003, 2005)

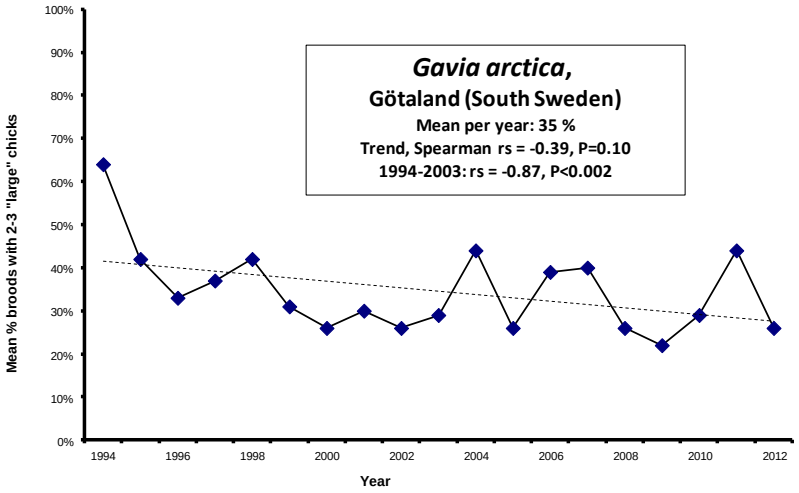
POSSIBLE REASONS

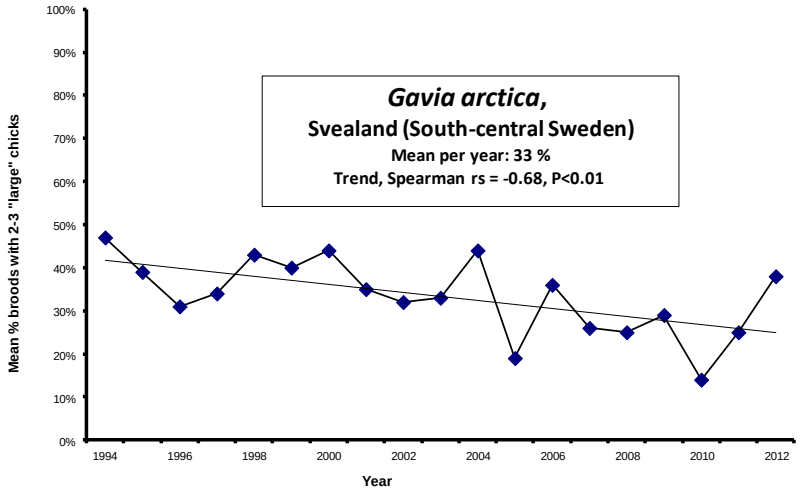
- Decreased abundance of fish
- Increased humus concentrations in the lakes – impaired light penetration
- Increased exposure to methyl-mercury

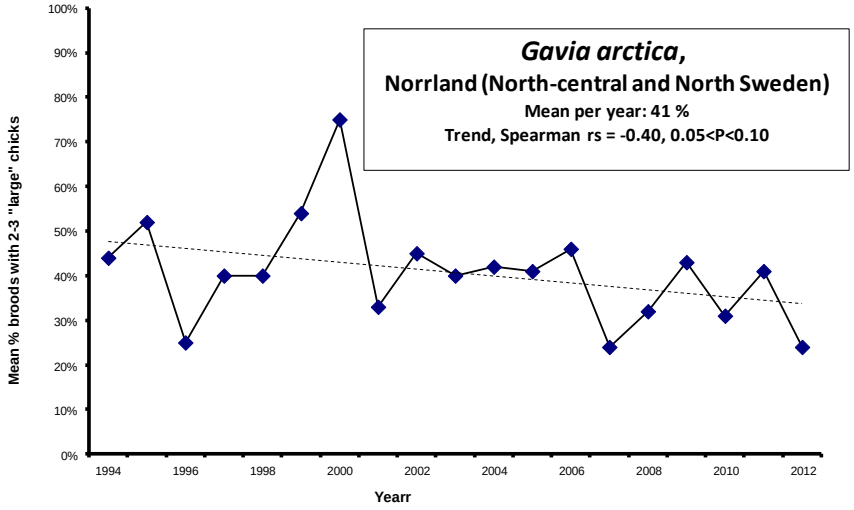

Gavia arctica
Norrland
Svealand
Götaland


Gavia stellata
Norrland
freshwater fishing
sea fishing
Svealand
incl. Dalsland
Sydsvenska
Höglandet

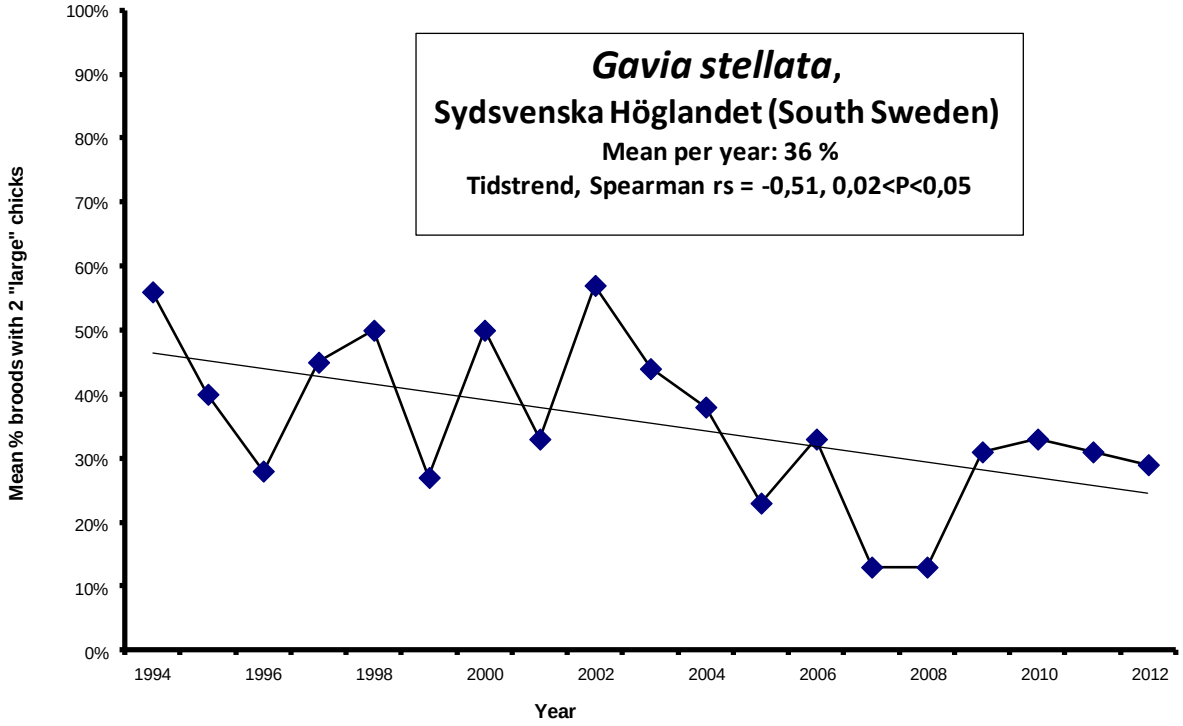
Decreased proportion of broods with 2 chicks







Decreased proportion of broods with 2 chicks



→ **No indication of trends for other parts of Sweden**

Decreased proportion of broods with 2 chicks – to summarize

BLACK-THROATED LOON (*Gavia arctica*)

- **Significant decline in South Sweden (Götaland), 1994-2003, levelled out after that**
- **Significant decline in South-central Sweden (Svealand)**
- **No significant trend in North-central and North Sweden (Norrland)**

RED-THROATED LOON (*Gavia stellata*)

- **Significant decline in South Sweden (Sydsvenska Höglandet)**
- **No indication of trends for other parts of Sweden**

Decreased proportion of broods with 2 chicks – possible reasons

- **Decreased abundance of fish**
- **Increased humus concentrations in the lakes**
- **Increased exposure to methyl-mercury**

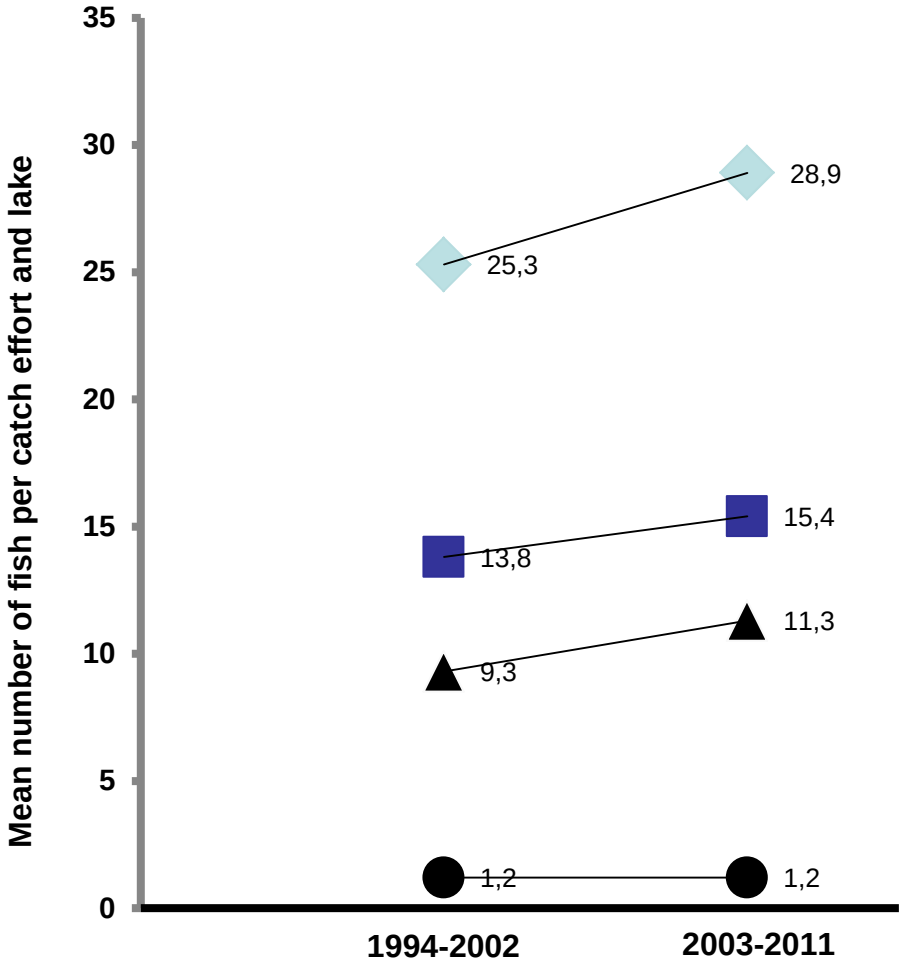
Fish abundance

ABUNDANCE OF FISH?

- **Loons are fish-eating birds, chicks are primarily fed with small-sized fish (< 22 cm)**

- **Chick survival is highly correlated to the parents' food provisioning (*Gavia arctica*, Scotland, Jackson 2003, 2005)**

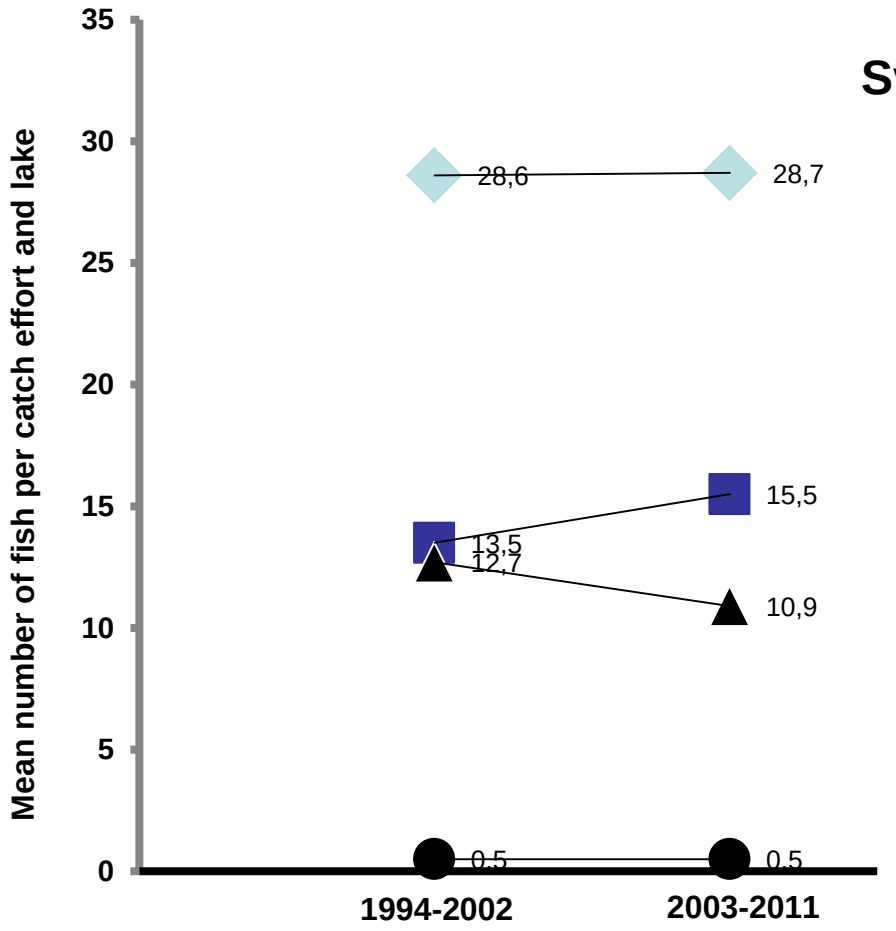
Fish abundance



Götaland (South Sweden)
25 lakes,
pair-wise comparisons

- Total catch, fish <22 cm
- Perca fluviatilis
- Cyprinid fish
- Salmonid fish

Fish abundance



Svealand (South-central Sweden)
8 lakes,
pair-wise comparisons

- Total catch, fish <22 cm
- Perca fluviatilis
- Cyprinid fish
- Salmonid fish

Fish abundance

ABUNDANCE OF FISH?

- Loons are fish-eating birds, chicks are primairly fed with small-sized fish (< 22 cm)
- Chick survival is highly correlated to the parents' food provisioning (*Gavia arctica*, Scotland, Jackson 2003, 2005)

→ **No indication of changes since mid-1990s – fish abundance to be ruled out as a likely explanation**

Light conditions in the lakes

IMPAIRED LIGHT CONDITIONS – HIGHER HUMUS LEVELS IN THE LAKES?

- **Loons are visual feeders, water transparency as important as fish abundance for the selection of lakes and chick survival (*Gavia arctica*, Eriksson 1985, Eriksson & Paltto 2010 – less likely for *Gavia stellata*)**

- **Humus concentrations have increased since ca 1990 in at least southern Sweden and southern Norway**

Light conditions in the lakes

Increased humus concentrations at least in southern Sweden and southern Norway

Proposed explanations:

- **Recovery of lakes affected by acid precipitation**
- **Changes in land-use – forestry practices**
- **Increased frequency of heavy rain-showers and rapid outwash – effect of climate change?**

– but also indications of reverse trend during last years?

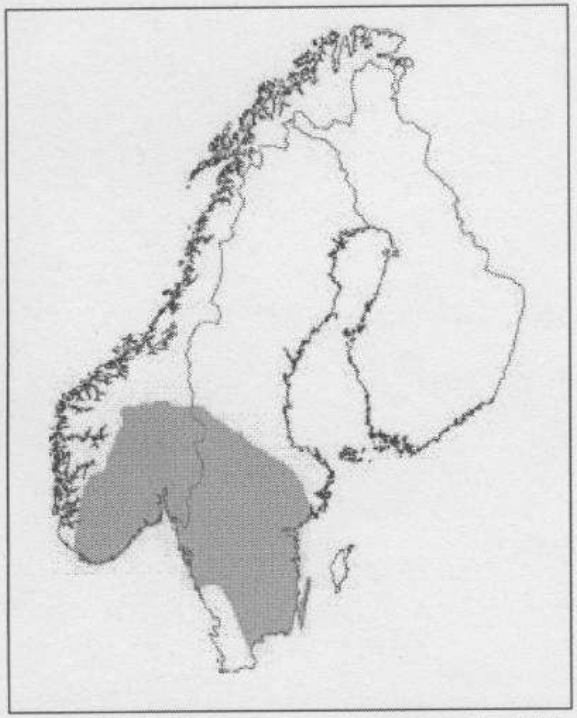
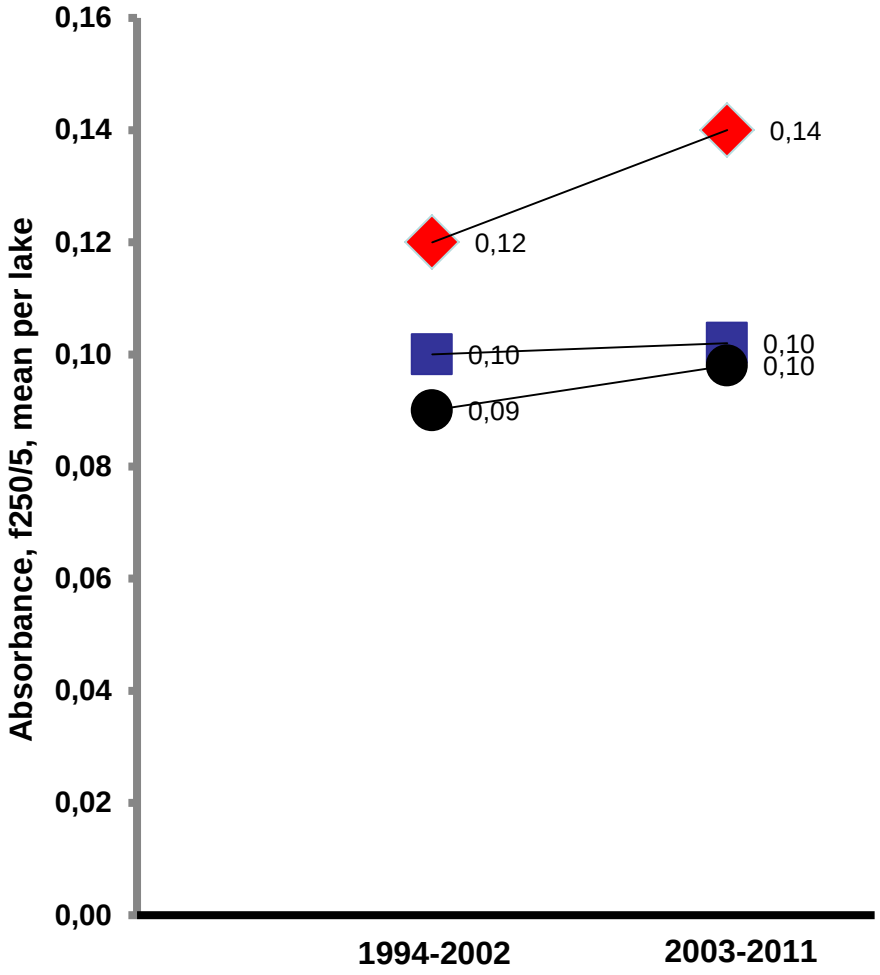


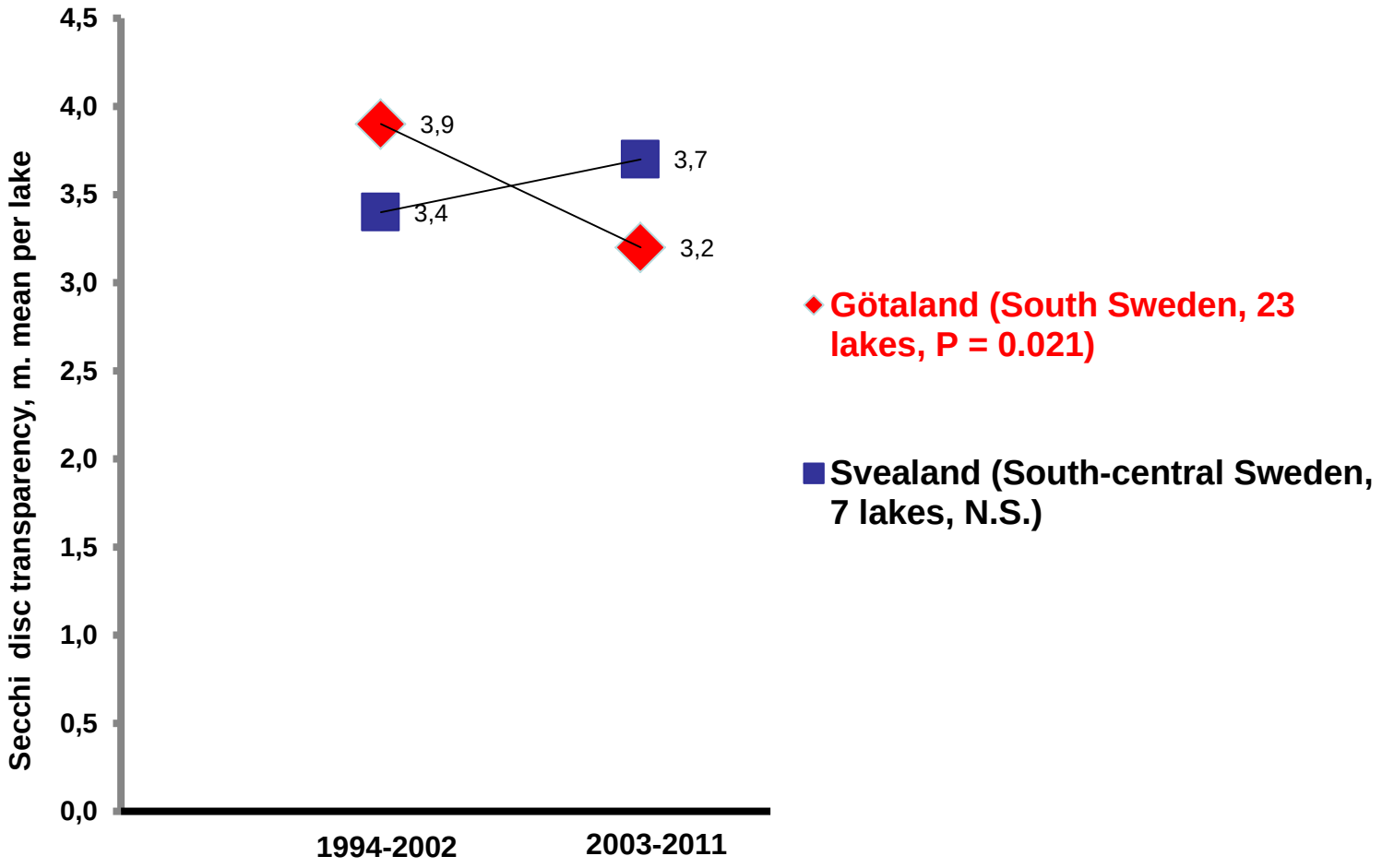
Figure 2. Regional humus trend pattern, measured as TOC, in Fennoscandian lakes. Lakes in the shaded area had a statistically significant increase in humus concentrations over the period 1990-1999. ($p < 0.05$, n_{Tot}=344 lakes, Mann-Kendall)

Light conditions in the lakes



- Götaland (South Sweden, 67 lakes, P = 0.002)
- Svealand (South-central Sweden, 47 lakes, N.S.)
- Norrland (North-central and North Sweden, 11 lakes, N.S.)

Light conditions in the lakes



Light conditions in the lakes

IMPAIRED LIGHT CONDITIONS – HIGHER HUMUS LEVELS IN THE LAKES?

- **Loons are visual feeders, water transparency as important as fish abundance for the selection of lakes and chick survival (*Gavia arctica*, Eriksson 1985, Eriksson & Paltto 2010 – less likely for *Gavia stellata*).**
- **Humus concentrations have increased since ca 1990 in at least southern Sweden and southern Norway.**

- **17-18 % decrease in light penetration in loons' breeding and foraging lakes since mid-1990s in Götaland (South Sweden), but *not* further northwards.**
- **Coincident with decreased % of 2-chick broods in Götaland.**
- **But decreased % of 2-chick broods of *Gavia arctica* also further northwards, where no increased humus levels.**

→ No perfect evidence of any link to impaired light penetration, but not to be ruled out.

Exposure to methyl-mercury

INCREASED EXPOSURE TO METHYL-MERCURY?

- **Hg levels in freshwater fish has increased again after mid-1990s, a declining trend since the 1960s broken.**
- **Run-off of air-borne pollutants deposited in terrestrial habitats and into freshwater habitats, where methylization occurs.**

- **Loons are top predators in freshwater ecosystems, and there is convincing evidence on susceptibility of Hg exposure (primarily *Gavia immer* in North America)**
- **Exposure to Hg may affect egg hatchability as well as the chicks' physical condition.**

Leakage and methylization of mercury from the catchment area to nutrient-poor freshwater lakes with low pH or low alkalinity

- 10 % of the breeding (and foraging) lakes used by Black-throated Loon may be at risk
- 30 % of the foraging lakes used by Red-throated Loon may be at risk
- Increased contents of mercury in freshwater fish

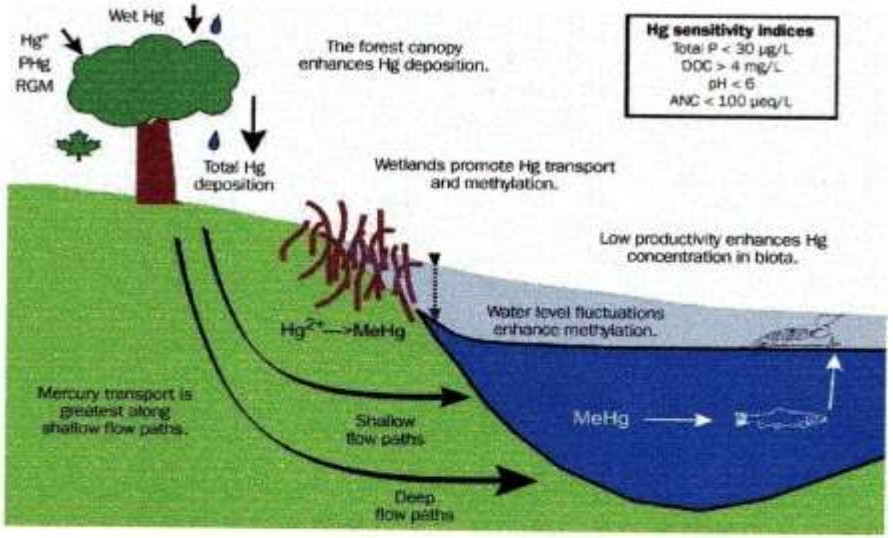


Figure 3. Conceptual figure illustrating important processes controlling the sensitivity of forest and linked aquatic ecosystems to atmospheric mercury (Hg) deposition and artificial water level regulation. The forest canopy enhances dry Hg deposition. Water transported along shallow flow paths supplies greater quantities of Hg than water in deep flow paths. Wetlands are important in the supply of dissolved organic carbon (DOC), which enhances the transport of ionic Hg and methylmercury (MeHg), and are important sites for the production of MeHg. The nutrient status and productivity of surface waters also control concentrations of MeHg in aquatic biota. Indicators of lakes sensitive to Hg inputs are shown in the insert (after Driscoll et al. 2007). Reservoir creation and water-level fluctuation will stimulate MeHg production in the littoral region. Abbreviations: ANC, acid neutralizing capacity; Hg^0, elemental Hg; P, phosphorus; PHg (i.e., Hg[p]), particulate Hg; RGM (i.e., Hg[II]), reactive gaseous Hg.

Exposure to methyl-mercury

PREVIOUS RESULTS FROM SWEDEN

(Eriksson & Lindberg 2005)

- **Around 3 X higher levels in eggs of *Gavia stellata*, in relation to *Gavia arctica* (eggs collected 1981-1997)**
- **Higher Hg concentrations in eggs collected at breeding lakes affected of acid precipitation (*Gavia arctica*)**
- **Hg concentrations in single eggs of *Gavia stellata* exceed the level of risk of impaired reproduction.**

→ No analyses of eggs collected after 1997 (few eggs, financial constraints)

Exposure to methyl-mercury

LEVELS IN *Perca fluviatilis* in Sweden (primarily 1998-2004, Åkerblom & Johansson 2008):

- **< 12 cm (planktivorous): median = 0.14 mg/kg wet weight**
- **12-18 cm: median = 0.20 mg/kg wet weight**
- **> 18 cm (piscivorous) = 0.34 mg/kg wet weight**

RISK LEVELS FOR *Gavia immer* (Burgess & Meyer 2008):

- **Loon productivity drop by 50 %: 0.21 ug/g wet weight**
- **Failed reproduction: 0.41 ug/g wet weight.**

→ Risk for loons must not be neglected – to be further investigated

→ Reduced hatchability of eggs and/or impaired physical condision of chicks?

→ Standardised collection of eggs under strictly supervised conditions?

To summarise

- **The precentage of 2-chick broods has decreased in parts of Sweden since mid-1990s, both for *Gavia arctica* and *Gavia stellata* → indicates an impaired chick survival**

- **Decreased abundance of fish is less likely**
- **Impaired light conditions (and reduced detectability of fish) – no perfect evidence, but not be ruled out**
- **Risks connected to exposure to methyl-mercury cannot be ruled out, but to be further investigated.**

Speculations about other factors:

- **Lack of thiamine (B vitamine)?**
- **Impact on adult birds' physical condition during migration and in winter?**

Lessons and considerations for the future – not only for the loons but for the freshwater habitats in general

- **Exposure to mercury – an over-looked environmental problem in the Nordic countries – hardly under any debate**

- **Long-term climate effects on the freshwater habitats**

Data sources

- **Surveys of breeding success, 1994-2012 (Projekt LOM),** http://www.projekt-lom.com/lom.invres.htm

- **Data on fish communities (NORS database, Swedish University of Agriculture),** http://www.slu.se/sv/fakulteter/nl-fakulteten/om-fakulteten/institutioner/akvatiska-resurser/databaser/databas-for-sjoprovfiske-nors/

- **National surveys of water chemistry (Swedish University of Agriculture),** http://info1.ma.slu.se/ri/www_ri.acgi$Project?ID=Intro

THANK YOU!