United Nations Economic Commission for Europe
Convention on Long-range Transboundary Air Pollution

Benefits of air pollution control for biodiversity and ecosystem services

Working Group on Effects
of the
Convention on Long-range Transboundary Air Pollution

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Effects of climate change on air pollution impacts and response strategies for European ecosystems

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Biodiversity, ecosystem services and human well-being

Air pollution control has great benefits for ecosystem functioning, biodiversity and associated ecosystem services. Such benefits will be advantageous indirectly for human well-being, adding to the direct benefits of air pollution control for human health. The full benefits of these indirect effects on ecosystem services and biodiversity are often not included in (economical) valuations.

Millennium Ecosystem Assessment

Ecosystem services:

- **Supporting** *('underpinning role')*
  (e.g. biomass production, soil formation, nutrient and water cycling)
- **Provisioning**
  (e.g. food, fresh water, fuel, wood)
- **Regulating**
  (e.g. water purification, water and climate regulation, pollination)
- **Cultural**
  (e.g. education, recreation, aesthetic)

LIFE ON EARTH - BIODIVERSITY

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HUMAN WELL-BEING

'Biodiversity enhances the ability of ecosystems to maintain multiple functions'
(Maestre et al. 2012. Science)

'Species-richness has positive impacts on ecosystem services'
(Gamfeldt et al. 2013. Nature Comm.)

Intergovernmental Platform on Biodiversity and Ecosystem Services' (IPBES) was established in 2012

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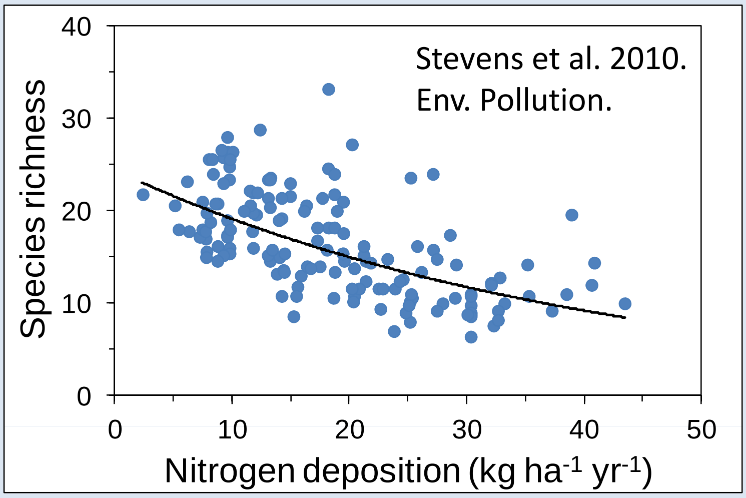
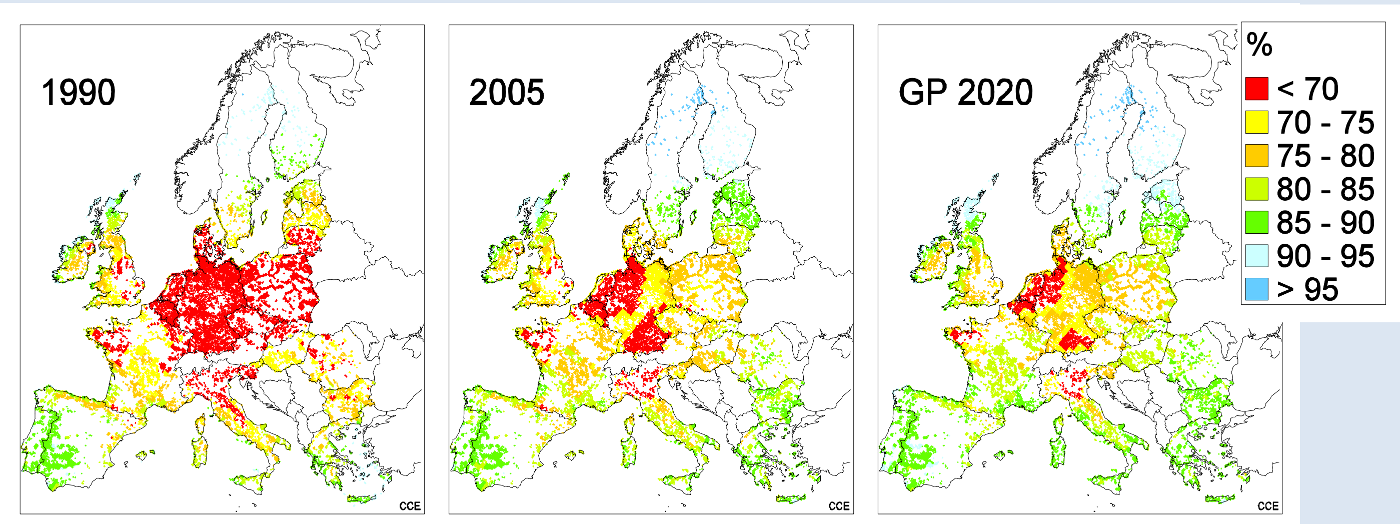
Benefits for biodiversity

Decreasing nitrogen deposition enhances plant species diversity …



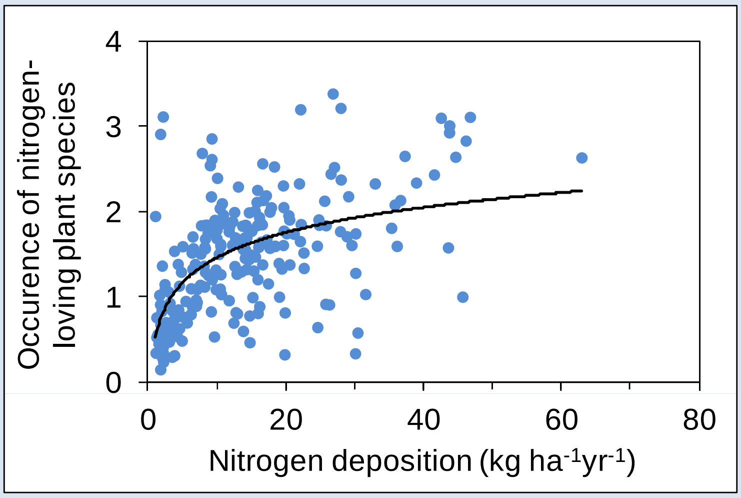
… and relative species richness (%) in Natura2000 grasslands

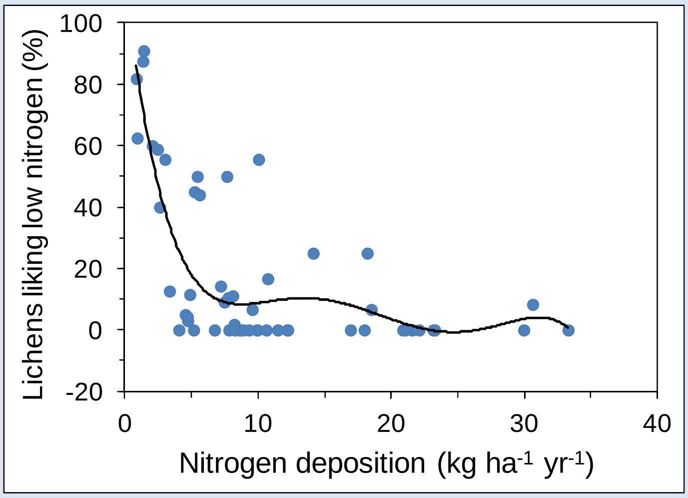


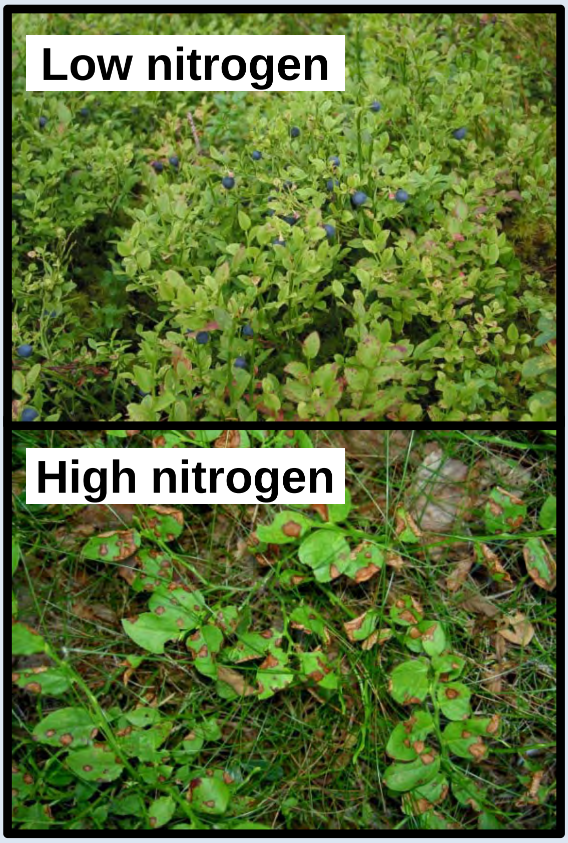
The average species richness in Natura2000 grasslands (EUNIS classes E1, E2, E3) was computed to be 72% in 1990, 78% in 2005 and 81% in 2020. Although the pressure is diminishing under the revised Gothenburg Protocol (GP) by 2020, there is still net loss of biodiversity.

The above assessment should be extended to other ecosystems and biodiversity indicators (e.g. presence of red list species, soil organisms) for a comprehensive analysis of impacts of excessive nitrogen on biodiversity. Little is known about the recovery from nitrogen pollution. Evidence so far shows that ozone impacts on species richness are habitat-dependant.

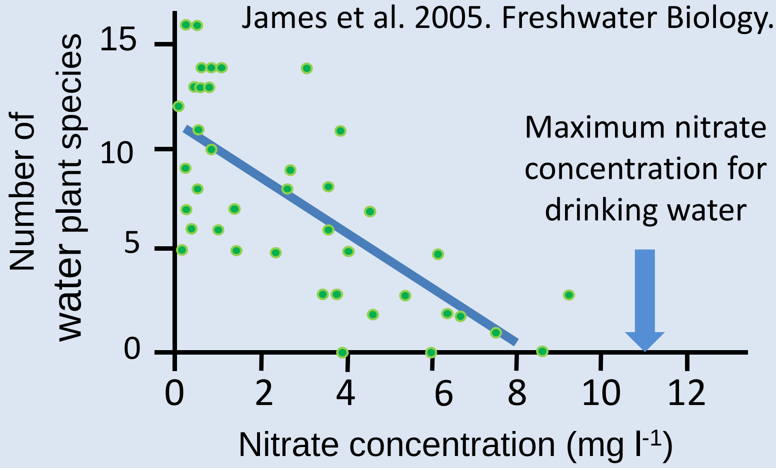
Excessive nitrogen stimulates the presence of nitrogen-loving plant species but reduces the occurrence of plant species adapted to low nitrogen availability







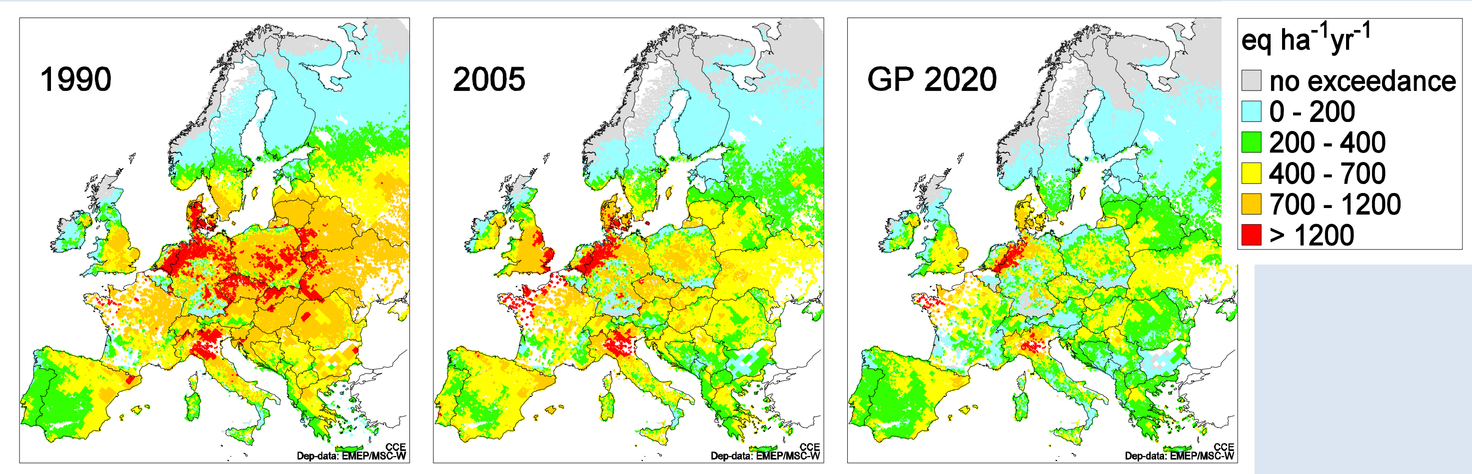
Concentration limit of nitrate in drinking water is too high to protect natural ecosystems



Nitrogen decreases the resilience of forests to other environmental stresses such as drought, high wind, frost, pests and diseases .

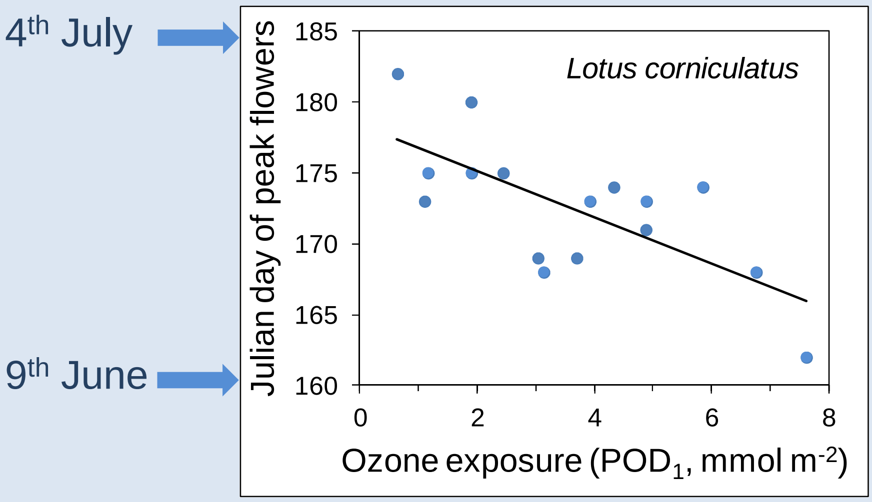
Widespread exceedance of nitrogen critical loads

Nitrogen deposition in excess of critical loads causes adverse effects on the structure and function of ecosystems. These effects may not occur instantaneously, it may take several decades over which the resilience of soils and plants is weakened. Emission projections based on the revised Gothenburg Protocol show that the area at risk will diminish from 73% in 1990, 51% in 2005 to 42% in 2020. Additional air pollution abatement measures are required to further reduce the risk of nitrogen critical load exceedance beyond 2020.



Ozone damages vegetation and ecosystem functioning

Ground-level ozone (a secondary air pollutant formed from nitrogen oxides and other compounds) also causes adverse effects on the structure and functioning of ecosystems.



Ozone can promote early flowering, affecting the synchronisation of pollinators and flowers.

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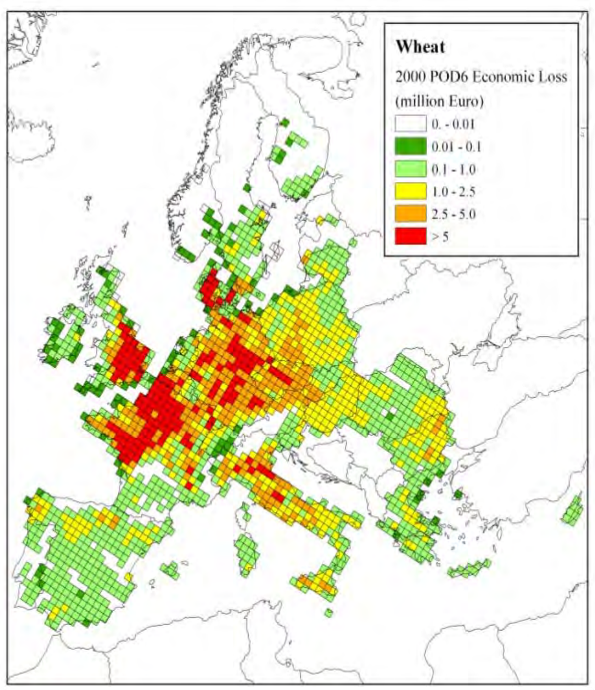
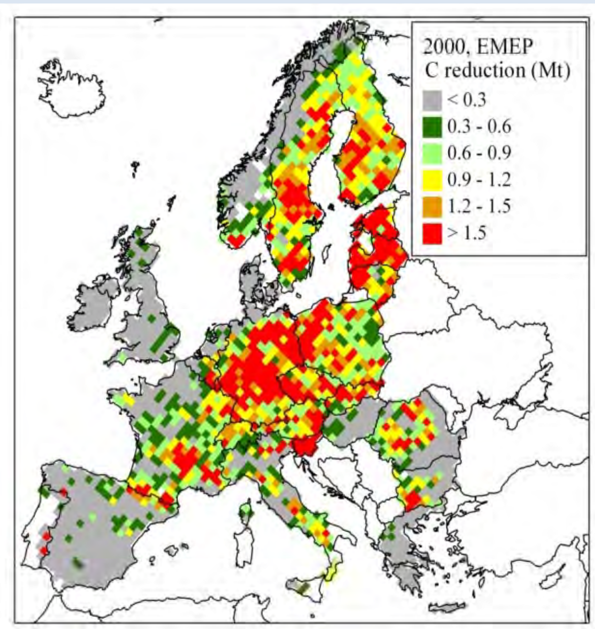
Benefits for ecosystem services

Ozone threatens food security and carbon sequestration



In 2000, ozone pollution reduced wheat yield by 14%, **a loss of €3.2 billion in EU27+CH+NO**.

Ozone damage to leaves of salad crops reduces their market value.



In 2000, ozone pollution reduced potential carbon sequestration in tree biomass by 14% in Europe. **Forest production in Sweden was reduced by €38 million.**

Ozone is also the third most important greenhouse gas. Negative impacts on vegetation reduces the sink capacity for carbon dioxide and ozone, enhancing their atmospheric concentrations and affecting the global water cycle (Sitch et al., 2007. Nature).

Areas at highest risk from ozone damage are those with moderate to high ozone concentrations in air and climate conditions conducive to high ozone uptake. Ozone damage to vegetation is widespread across Europe, including southern parts of Northern Europe. In Europe, peak levels of ozone are declining but background concentrations are rising to levels where they harm vegetation.

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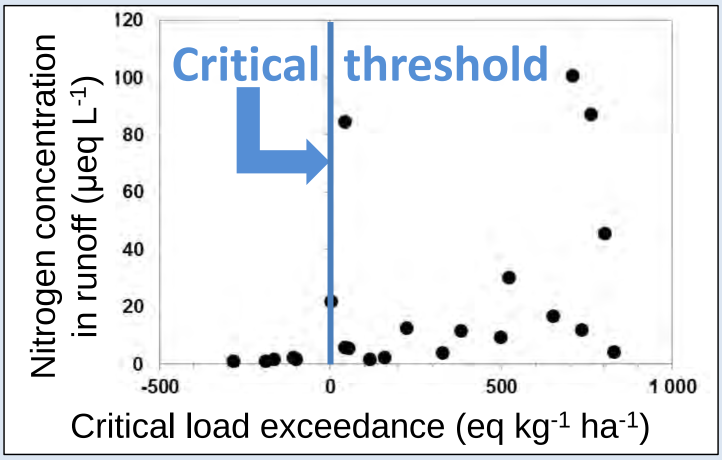
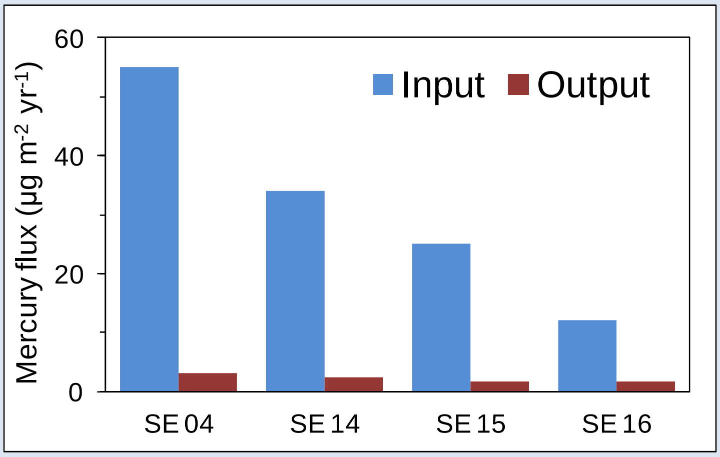
Soil and water quality

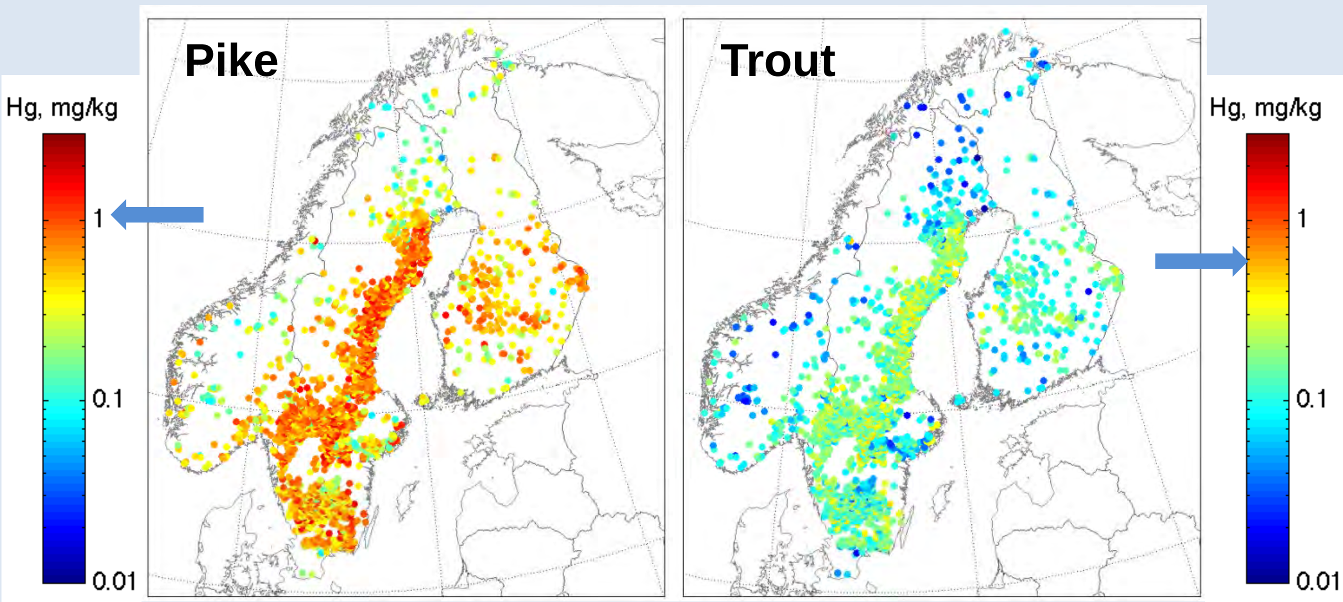
Soils store air pollutants temporarily and therefore play an important role in water purification. However, the stored pollutants will adversely affect soil functioning (e.g. microbes and invertebrates) and create problems when the retention capacity is reached or disturbed, and pollutants start leaching to surface and drinking water, and coastal zones. Nitrogen leaches from forest soil at a C:N ratio below 23 in the organic layer. Excessive nitrogen input in lakes will enhance algal growth.



Above the critical threshold **nitrogen** leaches from soils
(Holmberg et al. 2013. Ecol. Ind.)



Mercury accumulation in soils affects soil functioning

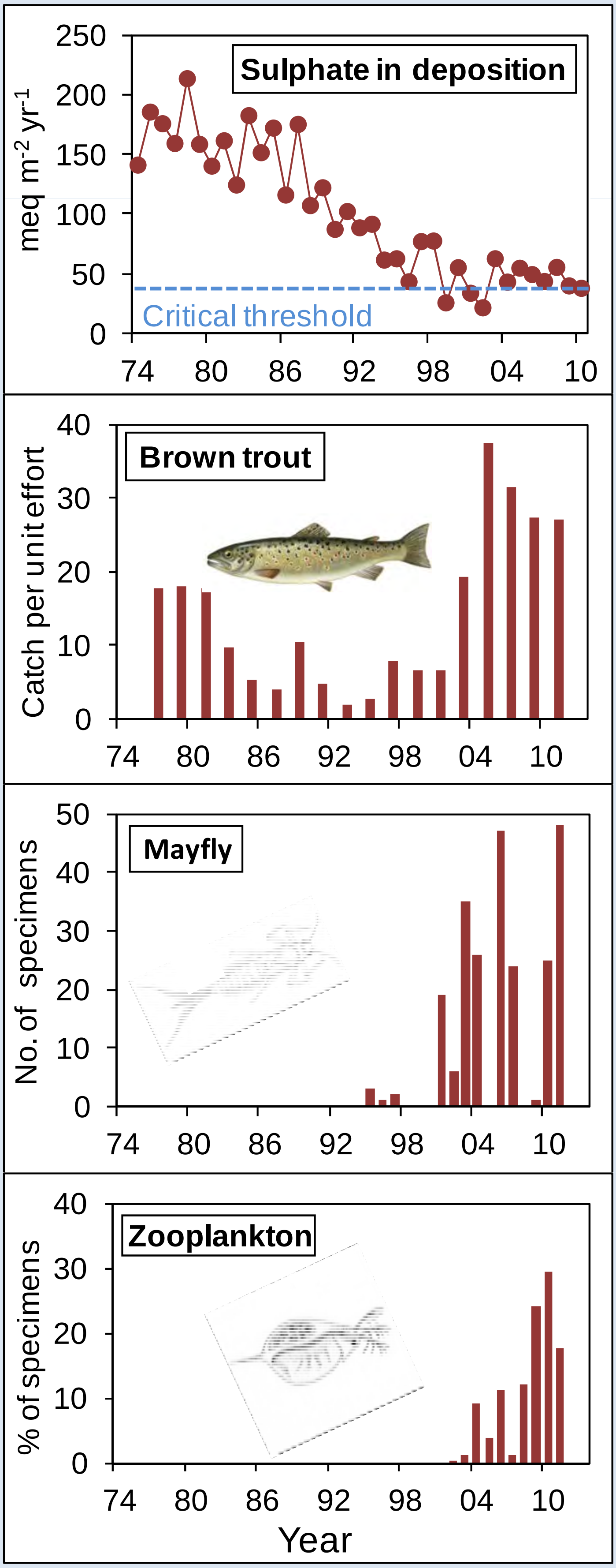


In over half of the lakes in Sweden, the **mercury (Hg)** level in fish is higher than the recommended values for human consumption (1 mg kg^{-1} for pike, 0.5 mg kg^{-1} for trout).

Reductions in sulphur deposition is slowly leading to recovery

Lake Saudlandsvatn, Norway

(Modified after Hesthagen et al. 2011. STOTEN)



Biological recovery from acidification at Lake Saudlandsvatn, a typical lake in southern Norway, has started in the last decade.

There has been a delay between reduced pollution and biological recovery.

Fishing has long been impaired in regions with acidified surface waters. In Sweden, recreational fishing exceeds the economical value of commercial fishing.

Liming of acidified lakes is expensive.

Acidification of soils (from both sulphur and nitrogen deposition) negatively affects the nutrient balance in soils required for healthy plant growth and productivity.

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Conclusions

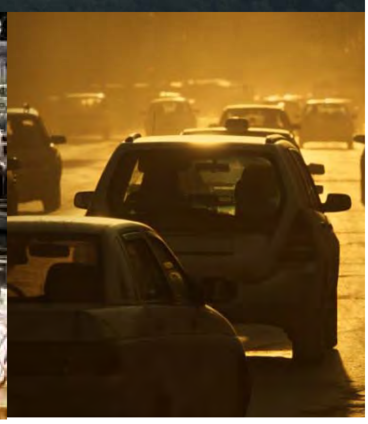
- ‘No net loss of biodiversity’ will not be achieved by 2020 under the revised Gothenburg Protocol.

- Further air pollution abatement will reduce the threat to loss of biodiversity and associated ecosystem services such as air, soil and water quality, and food security.

- It is uncertain whether full recovery of biodiversity from adverse effects of historic air pollution will be possible.

- Further air pollution abatement policies will improve the resilience of biodiversity and ecosystem services to climate change.

- Awareness of ecosystem services in both monetary and non-monetary terms will help to assess the real benefits of air pollution control.



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Policy recommendations

- ❑ To halt biodiversity loss and adverse impacts of air pollution on human well-being, policy negotiations should take into account the benefits of air pollution control for ecosystem services in addition to the direct benefits for human health.

- ❑ More stringent air pollution abatement measures beyond the revised Gothenburg Protocol are required to achieve ‘no net loss of biodiversity’.

- ❑ The full benefits of air pollution abatement for ecosystem services have to be assessed and weighed up against the costs of more stringent air pollution controls.

- ❑ The effects-based integrated assessment of policies that address driving forces of environmental issues (in the EU) could be further balanced by including ‘no net loss of biodiversity and ecosystem services’ in air, waters, soils and vegetation as an explicit endpoint.

This booklet was produced by the Working Group on Effects of the UNECE Convention on Long-range Transboundary Air Pollution.
The following International Cooperative Programmes (ICPs) have contributed:

- **ICP Forest:** http://icp-forests.net
- **ICP Integrated Monitoring:** http://www.environment.fi/syke/im
- **ICP Modelling and Mapping:** http://www.icpmapping.org
  Coordination Centre for Effects (CCE): http://www.rivm.nl/cce
- **ICP Vegetation:** http://icpvegetation.ceh.ac.uk
- **ICP Waters:** http://www.icp-waters.no

The **Joint Expert Group on Dynamic Modelling** has also contributed.

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