

LAKE WOLLINGST

Is restauration of this primarily oligotrophic, now eutrophicated water feasible ?

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The small Lake Wollingst (Wollingster See) is situated in the sandy Saalian moraine landscape east of Bremerhaven (northern Germany), just on the watershed at about 15 m NN. It covers an area of only 5 hectares. However, it is 14.5 m deep and comprises 132 000 m³. The origin of this structure is still in discussion; but, according to MERKT & KLEINMANN (1998), a Pingo genesis during the last glaciation period is most plausible. There are no visible inflows and only poor groundwater supplies to the lake, which is partly adjacent to a degenerated raised bog.

By its morphology and hydrology with slow water renewal and an unfavourable relation of the epi- and hypolimnion (2.6), the lake ecosystem is very sensitive especially to burdening by plant nutrients (RACHOR, 1998). While LUNDBECK (1934) regarded Lake Wollingst a prototype of a „primarily oligotrophic lake“, it is now eutrophicated by P- and N-compounds. This trophic stage is also indicated by oxygen depletion in its deep water body during summer and the lack of any profundal fauna, while a relict oligotrophent vascular plant association is still existent in the shallows (with *Lobelia dortmanna*, *Isoetes lacustris* and *Littorella uniflora*, see VAHLE, 1990). To protect this rare, in Germany almost extinct plant assemblage and associated organisms, the lake with its direct surroundings is a nature reserve since 1932. Nevertheless, recreation activities lake bathing and angling are still tolerated.

A comparison of relevant nutrient measurements in 1978 and 1996-1998 is presented in the following Table:

Table: Nutrient concentrations in Lake Wollingst
(in mg N or P per litre water), acc. to RACHOR, 1998

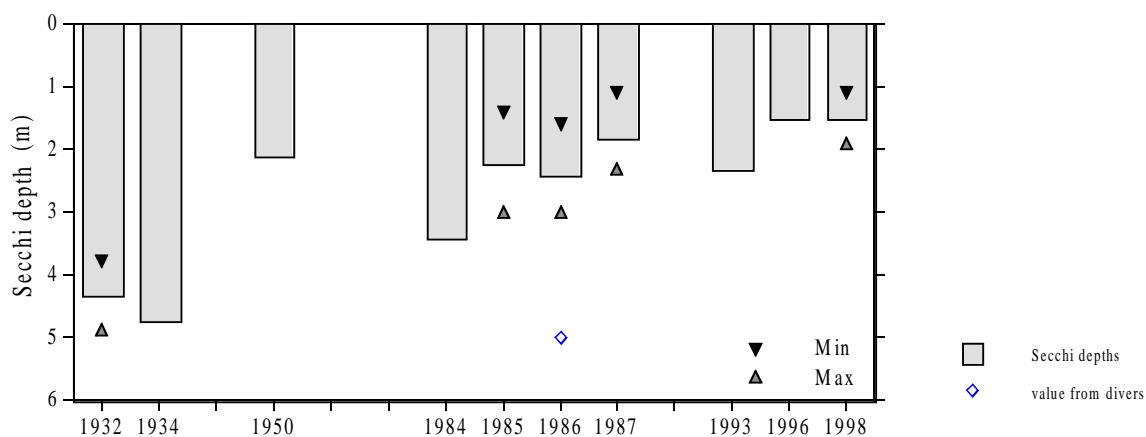
	<u>Oct. 1978</u>	<u>Aug. 1996</u>	<u>March 1998</u>
Ammonium-N	<0.05	<0.078	0.21-0.23
Nitrate-N	0.16	<0.01	0.13-0,19
total N	1.3	0.6-0,7	1.0
o-Phosphate-P	-	<0.01	<0.0009
total P	0.04	0.06-0.07	0.08

The atmospheric immisions of nutrients into the lake are almost sufficient today, to keep it in its critical trophic stage, with a total phosphate concentration between 0.06 and 0.08 mg P per litre in 1996 and 1998. According to immision measurements near-by, 11.5 kg of ammonium- and nitrate-N and 0.25 kg of phosphate-P per hectare are annually deposited from the atmosphere. Accordingly, and considering the poor water renewal rate of the lake, the amount of dissolved inorganic N may be renewed each year, while P may be replenished within a few years.

The pH of the weekly acid water (about 5.5) has not substantially changed during decades, may-be even centuries, although precipitation in the area has a lower pH of about 4.6. By the accelerated eutrophication process the emergent vegetation has rapidly increased since the fifties, with *Sphagnum* and other paludal plants dominating.

This means an acceleration also of the dystrophication process, which, in principle, is a natural succession phenomenon in such a lake. The resulting yellowish colouration of the water, its increased turbidity by phytoplankton, and the clogging of plants by nutrient-favoured periphyton and great amounts of detritus provide light conditions even in the shallow waters that are disadvantageous to the rare *Lobelion*-association.

The Secchi depth changes since 1932, indicating the degradation of the light conditions in the lake, are presented in the following Figure:



As atmospheric inputs of nutrients are significant to keep the trophic stage high in Lake Wollingst, additional burdens and immissions as well as internal nutrient (P) sources have to be kept short or to be reduced, if meso- or even oligotrophic conditions are to re-appear. First simple measures like abandonment of intensive pasture land use directly adjacent to the lake, closure of treated waste water effluents from a "Naturfreunde" guest house at the lake, cutting down of deciduous trees from the lake bank area, and removal of live and dead plant material from the water edge have been taken since 1996.

An abatement of the recreational uses of the lake was already brought about in the eighties; but, the actual bathing stress during warm summer periods is still too high.

Before stronger restauration measures can be recommended, the production, the fluxes of nutrients, considering especially internal sources of P, and the possible dystrophication influences from the adjacent raised bog and the emergent vegetation have to be investigated and the effectiveness of the measures taken so far has to be evaluated.

References (all in German):

LUNDBECK, J. (1934): Über den "primär oligotrophen" Seetypus und den Wollingster See als dessen mitteleuropäischen Vertreter. - Archiv Hydrobiologie 27, 221- 250.

MERKT, J. & A. KLEINMANN (1998): Die Entstehung und Entwicklung des Wollingster Sees und seiner Ablagerungen. - Mitteilungen Arbeitsgem. Geobotanik Schlesw.-Holst. u. Hamburg, vol. 57, 17-27.

RACHOR, E. (1998): Der Wollingster See. Allgemeines, Hydrologie, und Nährstoffverhältnisse. - Mitt. Arbeitsgem. Geobot. Schlesw.-Holst. u. Hamburg, vol. 57, 1-17. - In this article, which includes an English abstract, more references are found.

VAHLE, H.-C. (1990): Grundlagen zum Schutz der Vegetation oligotropher Stillgewässer in Nordwestdeutschland. - Naturschutz u. Landschaftspflege in Niedersachsen H. 22, 1-157.