Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB)
Department of Experimental Limnology

Sampling of Lake Stechlin (Germany): Metadata description for the period 2007-2016

Peter Kasprzak, Judit Padisák, …..

__Site description__: Lake Stechlin (Figure 1) is a deep clear-water lake located in a nature reserve approximately 80 km north of Berlin, Germany (53°10'N, 13°02'E) at 59 m elevation. The lake basin was formed during the last continental glaciation some 12,000 years ago and is today situated at the transition between temperate maritime and temperate continental climate (Fraedrich et al. 2001). The drainage basin is almost completely covered by forest (95%), with the exception of the area of a former nuclear power plant and a small village, which diverts its wastewater into a different drainage basin. The shoreline is largely undeveloped with no notable infrastructure. The seepage lake is essentially fed by precipitation and groundwater, resulting in a theoretical water retention time of greater than 40 years (Holzbecher and others 1999; Koschel 1995). There are virtually no river inflows. Some characteristics of the lake and its catchment are summarized in Table 1. From 1966 to 1990, Lake Stechlin received a total about 300,000 m^3 d^{-1} of cooling water from the nearby power plant, which was withdrawn from neighbouring Lake Nehmitz and discharged into Lake Stechlin at an average temperature approximately 10°C higher than the ambient surface water. Further anthropogenic impacts during the second half of the twentieth century include lowering of the water level by approximately 1.2 m in 1960 as well as nutrient loading from a neighbouring, previously eutrophic lake and poorly treated municipal wastewater from the power plant (Koschel 1995). For more general information, see Casper (1985), Koschel & Casper (1986), Casper & Koschel (1995) Koschel and Adams (2003).

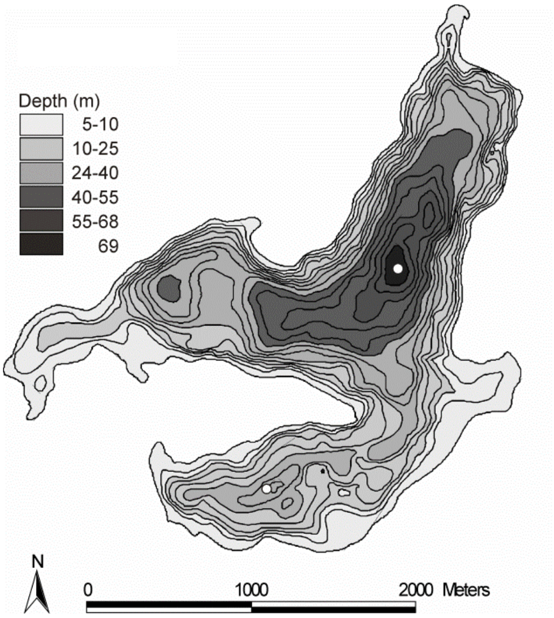

Fig. 1: Contour map of Lake Stechlin.

Table 1: Topographical, morphological, hydrological, and chemical characteristics of Lake Stechlin (Krey, 1985, IGB unpublished data).

Characteristic	**Mean ± 1 SD**
Drainage basin (km^2)	12.6
Forested area in drainage basin (%)	95
Maximum depth (m)	69.5
Mean depth (m)	23.3
Surface area (km^2)	4.3
Volume (m^3)	96.9×10^6
Effective fetch (m)	2,000
Water retention time (yrs)	>40
Secchi transparency* (m)	6.4 ± 1.7
Calcium** (mg L^{-1})	48.6 ± 7.2
Dissolved inorganic carbon** (mg L^{-1})	20.6 ± 1.9
NO_3^-nitrogen** (µg L^{-1})	16 ± 24
NH_4^+-nitrogen** (µg L^{-1})	32 ± 30
Total phosphorus** (µg L^{-1})	11 ± 3
Soluble reactive phosphorus** (µg L^{-1})	2 ± 1

* Average between May-September, 2001-2010

** Average between May-September, 2001-2010, pooled samples from upper 10m

All limnological data (physical, chemical biological) were recorded at the deepest site of the lake (69.5 m). Both temporal and spatial resolution varied over time. From May – September fortnightly samples have usually been taken. Outside this period monthly results are almost always available. Concerning physical and chemical parameters, spatial resolution was oriented according to thermal stratification patterns. Vertical profiles collected with probes had a high resolution (1 – 5 m). For chemical analysis 2 – 3 separate samples were taken and afterwards pooled representing the situation of mixed layer (epilimnion). This is indicated in the respective data sheet by identical readings. Another 3 – 4 samples were collected but not mixed in order to reflect the situation in the deep water (hypolimnion). Sampling of phytoplankton and crustacean plankton is specified below.

Secchi transparency: white disc 25 - 30 cm in diameter; readings were done on the shady side of the boat. To reduce the impact of refection and glittering, a bathyscope was used

Underwater photo-synthetically active radiation (PAR): LI-COR LI 193 spherical quantum sensor, LI-COR, Lincoln, Nebraska, USA

Vertical profiles of water temperature, oxygen concentration, oxygen saturation pH and electric conductivity: multi-parameter probes, YSI, Yellow Springs, OH, USA

Total phosphorus (TP), soluble reactive phosphorus (SRP), total nitrogen (TN), nitrite (NO_2), nitrate (NO_3), ammonium (NH_4); soluble calcium (Ca), aluminium (Al), iron (FE) and silicate (Si): were determined photometric following standardised protocols or methods outlined in the user manual of the respective instrument. Dissolved components were estimated after filtration of the sample through a 0.45 µm membrane. TP and TN were measured after wet digestion of unfiltered subsamples in an autoclave (potassium peroxodisulfate, TP 30 min., 134 °C; TN 40 min., 121 °C).

- TP, SRP – Foss FIAstar 5000 Analyzer, Foss Analytical AB, Höganäs, Sweden; Water quality, determination of orthophosphate and total phosphorus contents by flow analysis (FIA and CFA) - Part 1: Method by flow injection analysis (FIA) (ISO 15681-1:2003)
- TN, NO_2, NO_3 NH_4 - Foss FIAstar 5000 Analyzer, Foss Analytical AB, Höganäs, Sweden; Water quality, determination of nitrite nitrogen and nitrate nitrogen and the sum of both by flow analysis (CFA and FIA) and spectrometric detection (ISO 13395:1996)
- Ca – Foss FIAstar 5000 Analyzer, Foss Analytical AB, Höganäs, Sweden; Determination of dissolved calcium in water by FIAstar, Application note 5261, Foss Analytical AB, Höganäs, Sweden, 2003
- Al – FIAcompact, Bestimmung des gesamten gelösten Aluminiums im Wasser. Arbeitsanleitung, Medizin- und Labortechnik GmbH, Dresden, Deutschland 2004
- Fe - FIAcompact, Medizin- und Labortechnik GmbH, Dresden, Deutschland 2004, German standard methods for the examination of water, waste water and sludge; cations (group E); determination of iron (E 1), DIN 38404-1:1983-05
- Si – Foss FIAstar 5000 Analyzer, Foss Analytical AB, Höganäs, Sweden; Water quality, determination of soluble silicates by flow analysis (FIA and CFA) ISO 16264:2002

Total inorganic carbon (TIC), non-purgeable organics carbon (NPOC): were estimated using an unfiltered sample following the methods suggested in the user manual, SHIMADZU, TOC analyser V_{CPH}/ASI-V, Kyoto, Japan,

Dissolved anions, chloride (Cl) and sulfate (SO_4) and cations - sodium (Na), potassium (K), and magnesium (Mg) were determined by ion chromatography using conductivity detection (Dionex Corp., Sunnyvale, USA) following standardised protocols outlined in the user manual. All ions were estimated after filtration of the sample through a 0.45 µm membrane. Filtered samples were stored frozen (-20°C) until analysis.

- Anions – Dionex ICS 1000; with eluent suppression; column IonPac AS14
- Cations – Dionex ICS 1000; with eluent suppression, column IonPac CS12A

Calcium carbonate ($CaCO_3$): was determined by filtering aliquots through membranes (cellulose acetate, pore size 0.45 µm, Sartorius, Göttingen) which were stored in a desiccator until further analysis. Samples were then dissolved in 10 % hydrochloric acid and the released CO_2 was measured using an infrared gas analyser (Infralyt 50 Saxon, Junkalor, Dessau, Germany; see Proft 1984). To recalculate from CO_2-C into $CaCO_3$ a factor of 8.3 was used.

Alkalinity: was ascertained titrimetric, Titrando 888, Metronom, Filderstadt, Germany). Water quality, determination of alkalinity - Part 1: Determination of total and composite alkalinity (ISO 9963-1:1994)

Chlorophyll a: was measured photometric, Hitachi spectrophotometer U-2900; German standard methods for the examination of water, waste water and sludge; test methods using water organisms (group L); determination of chlorophyll a in surface water (L 16), DIN 38412-16:1985-12

Phytoplankton: Phytoplankton samples were taken at the deepest site of the lake in 5 m increments. After mixing the subsamples from 0-25 m layer (euphotic zone), and an integral sample was got for counting. Phytoplankton species were identified using the most up-to date phycological manuals and literature. A minimum of 400 settling units (cells, filaments or colonies) were counted in an inverted microscope in each Lugol-fixed sample giving a counting accuracy of ± 10 % for total phytoplankton. Phytoplankton biomass was estimated by geometrical approximations using OPTICOUNT (2008) computerized plankton counter. Autotrophic picoplankton (APP) was counted preferably immediately after sampling in unpreserved samples. If it was not possible, unpreserved samples were deep-frozen within 1 hour after sampling and APP was counted in melted samples no later than one month after sampling. APP cells were concentrated on black membranes and then embedded in ~ 30 % glycerine solution. Samples were analysed by means of epifluorescence microscopy using a Zeiss-Axiovert 35 inverted microscope equipped with an Osram HBO 5W/AC mercury short arc lamp. Only blue excitation (Zeiss filter set 45 17 66, exciter filter 450-490 nm, FT 510, LP 520) was used for picoplankton counting because in previous trials, no significant difference had been found between counting with blue and green excitation and green eukaryotic picoalgal cells that occasionally occur in Lake Stechlin were easier to distinguish with blue excitation.

Crustacean plankton: Crustacean plankton was collected by vertical net hauls from 0-22/22-65 m using a plankton net of 90 µm mesh size (Hydrobios, Kiel, Germany). The net had a cone-shaped cap, an opening of 0.02 m^2, a length of 1.2 m and a filtration efficiency of approximately 1. Each sample was preserved in 4 % formalin–sugar solution (Haney and Hall 1973). Using sedimentation chambers, three subsamples containing a total of at least 100 individuals of the dominant group (except for nauplii) were counted in an inverted microscope at 60x magnification. Mean length was estimated by measuring 15 individuals of each group using a computer-aided microscopy system (TSO-VID-MESS-HY, Pulsnitz, Germany). Dry weight was calculated from published length–weight relationships (Bottrell et al., 1976, Kasprzak 1984) and converted into fresh mass according to Winberg et al., (1971). Taxonomical classification was ascertained based on Kiefer & Fryer (1978), Einsle (1993) and Flössner (2000).

References:

Bottrell, H. H., Duncan, A., Gliwicz, Z. M., Grygierek, E., Hillbricht-Ilkowska, A., Kurasawa, H., Larsson, P., Weglenska, T., 1976: A review of some problems in zooplankton production studies. Norw. J. Zool. 24, 419 – 456.

Casper, S. J., 1985: Lae Stechlin. A temperate oligotrophic lake. Dr. W. Junk Publishers, Dordrecht, Boston, Lancaster, 553 pp.

Casper, P. Koschel, R., 1995: Description of Lake Stechlin. Limnologica 25, 281 – 284.

Einsle, U., 1993: Crustacea, Copepoda, Calanoida und Cyclopoida. In. Süßwasserfauna von Mitteleuropa, Band 8/4-1, Fischer, Suttgart 1993, 208 S.

Flößner, D., 2000: Die Haplopoda und Cladocera (ohne Bosminidae) Mitteleuropas. Bachhuys, Leiden, Niederlande, 428 S

Fraedrich K, Gerstengarbe FW, Werner PC. 2001: Climate shifts during the last century. Climate Change 50, 405–17.

Haney, F. J., Hall, D. J., 1973: Sugar-coated Daphnia – a preservation technique for cladocera. Limnol. Oceanogr. 18, 331 – 333.

Holzbecher E, Nützmann G, Ginzel G. 1999: Water and component mass balances in the catchment of Lake Stechlin. Int. Assoc Hydrol Sci 258, 37 – 46.

Kasprzak, P., 1984: Bestimmung des Körperkohlenstoffs von Planktoncrustaceen. Limnologica (Berlin) 15, 191 – 194.

Kiefer, F., Fryer, G., 1978: Das Zooplankton der Binnengewässer. In: Die Binnengewässer, Band 26, 2. Teil, E. Schwizerbart, Stuttgart 1978, 380 S.

Koschel R. 1995: Manipulation of whole-lake ecosystems and long-term limnological observations in the Brandenburg-Mecklenburg Lake District, Germany. Int. Rev. Ges. Hydrobiol, 80, 507 – 18.

Koschel,. R, Casper, S. J., 1986: Die ökologische Bedeutung des Kernkraftwerkes I der DDR ‘Rheinsberg‘ für den Stechlinsee. Biologische Rundschau 24, 179 – 195.

Koschel, R., Adams, D. D., 2003: An approach to understanding a temperate oligotrophic lowland lake. Arch. Hydrobiol. Adv. Limnol. 58, 1 – 9.

Proft, G., 1984. The pelagic precipitation of calcite and the carbon content of sediments of Pleistocene lakes. Acta Hydrochimica et Hydrobiologica 12, 321-32

Winber, G., 1971: Symbols, units and conversion factors of freshwater productivity. IBP Control Office, London, 23 pp.