Chemical data (spectrophotometry) at Lake Stechlin 1970-2020

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Data

Sampling site

Lake Stechlin is a deep, dimictic, formerly oligotrophic clear-water lake that has been undergoing eutrophication since the early 2000s and especially since 2010. The lake is located in a nature reserve approximately 80 km north of Berlin, Germany (53°9'5.6"N, 13°1'34.2"E) at 59 m altitude. Lake Stechlin has a maximum depth of 69.5 m, a mean depth of 23.3 m, a surface area of 4.3 km^2 and a volume of 96.9 x 10^6 m^3 (Casper 1985). The lake basin was formed during the last continental glaciation ca. 12,000 years ago and is today situated at the transition between temperate maritime and temperate continental climate (Fraedrich et al. 2001). The catchment has a size of 12.6 km^2 and is almost completely covered by managed forest (95%). The main species is Scots pine (*Pinus sylvestris*), although beech (*Fagus sylvatica*) is the dominant tree species along the shoreline. Non-forested areas are the site of a former nuclear power plant (KKW Rheinsberg) and the small village of Neuglobsow with about 300 residents (up to 1000 during the tourist season in summer), whose wastewater is diverted to a different catchment. The shoreline is largely

undeveloped with no notable infrastructure except on the small beach and the boat rental, the properties of a fisherman, the Federal German Environment Agency and the Leibniz Institute of Freshwater Ecology and Inland Fisheries. The seepage lake is mainly fed by precipitation and groundwater, resulting in a theoretical water retention time of more than 40 years (Koschel 1995, Holzbecher et al. 1999). There are no river inflows except for occasional discharge from a small stream channel that is dry in most years. The water level of Lake Stechlin is regulated. From 1966 to 1990, the lake received a total of about 300,000 $m^3 d^{-1}$ of cooling water from the nearby nuclear power plant. The cooling water was withdrawn from neighbouring Lake Nehmitz (North basin) and discharged into Lake Stechlin at an average temperature of approximately 10 °C above the ambient surface water temperature. This resulted in an average increase in water temperature by 1-2 °C during the power plant operation (1966-1990) and decreased the retention time of Lake Stechlin. For more information, see Casper (1985), Koschel and Casper (1986), Casper and Koschel (1995), Koschel and Adams (2003) and Kirillin et al. (2013).

Time span   1970-2020

Sampling method

Water samples for chemical analyses have been taken at the deepest point of the lake (69.5 m) in the main basin (53°9'19.5"N, 13°1'52.9"E) since 1970. Additional samples were collected in the west (53°9'15.1"N, 13°0'30.5"E) and south (53°8'37.0"N, 13°1'14.9"E) basin from 1985 onwards, complemented between 1994 and 2018 by samples from the eastern bay that occasionally received surface flow. Sampling frequency varied over the years. In the main basin, fortnightly samples were usually taken from May to September, although various measurements were only made monthly. Monthly samples were also taken during the rest of the year, unless winter ice conditions prevented access to the sampling sites either by boat or on foot. In the south and west basin, sampling was restricted to the end of summer stratification in either November or December. Both basins have been sampled four times a year in 2020. Water samples were taken from the surface mixed layer using a 1 L or 2 L Ruttner-sampler from 1970-1990, and a 2.6 L or 3.5 L Limnos water sampler (Limnos Oy, Turku, Finland) from 1991 onwards. From 1985 onwards occasionally a 5 L water sampler (Hydro-Bios, Kiel, Germany) was used. Epilimnion (surface mixed layer) samples were taken in 2.5 m intervals from 0 to 10 m depth before 1992 and separately analyzed. Since 1992 they were taken at 5 m increments and then pooled, containing the samples from 0 and 5 m depth, and additionally a sample from 10 m when the epilimnion was deep enough, occasionally, for periods with a very shallow epilimnion depth a pooled sample from 0 and 2.5 m depth was used. Hypolimnetic water was collected at 15, 20, 40, 60 and 65 m depth before 1992, and at 40, 60 and 65 m depth since 1992 until 2008. These discrete deep-water samples were separately analyzed. Since 2009, additional discrete samples have been taken during summer stratification at 5 m intervals between 15 and 55 m depth.

Total phosphorus (TP), soluble reactive phosphorus (SRP), total nitrogen (TN), ammonium (NH_4^+), nitrite (NO_2^-), nitrate (NO_3^-), dissolved calcium (Ca^{2+}), dissolved aluminum (Al), dissolved iron (Fe: sum of Fe^{2+} and Fe^{3+}) and dissolved silicon (Si), total inorganic carbon (TIC), non-purgeable organic carbon (NPOC) (i.e. the fraction of organic carbon remaining after sparging an acidified aqueous

sample with gas to remove all volatile carbon constituents), dissolved organic carbon (DOC), calcium carbonate ($CaCO_3$), total alkalinity (alkalinity) and Chlorophyll *a* (chl *a*) were determined following standard methods or protocols outlined in the user manual of the respective instrument (see below for details). All analyses of dissolved components (SRP, NO_2^-, NO_3^-, NH_4^+, Ca, Al, Fe, Si, DOC) were performed on water samples passed through NC60 membrane filters (0.6 µm pore size, Whatman, Little Chalfont, United Kingdom) before July 2010, cellulose nitrate membrane filters (0.45 µm pore size, Whatman, Little Chalfont, United Kingdom) between July 2010 and April 2012, and cellulose acetate membrane filters (0.45 µm pore size, Sartorius AG, Göttingen, Germany) since May 2012. Unless analysed immediately after filtration, samples were stored at -20 °C. The residual filters were used for $CaCO_3$ determination, were dried at 60 °C overnight and stored in adesiccator until analysis, while filters for chl *a* analysis were stored at -20 °C. TP and TN were measured after wet digestion of unfiltered aliquots in an autoclave using 50 g L^{-1} potassium peroxodisulfate as oxidant for TP (30 min at 134 °C) and oxidizing decomposition reagent (Oxisolv®,Merck, Germany) for TN (45 min at 120 °C).

Details of the analytical methods are as follows:

- TP, SRP: Spectrophotometry

    - Before 1992, manual spectrophotometric analysis as described in Vogler 1965, 1966a,b, Mothes 1974, Mothes 1981

    - From 1992 to December 2005, flow-injection analysis with spectrophotometric detection: FIAstar (Tecator AB, Höganäs, Sweden) Application Note 60/83, ASN 60-03/83 (Determination of orthophosphate in water by flow injection analysis) and ASN 60-04/83 (Determination of total phosphate in water by flow injection analysis)

    - From January 2006 to December 2014, flow-injection analysis with spectrophotometric detection: FIAcompact (Medizin- und Labortechnik GmbH, Dresden, Germany). Arbeitsanleitung Orthophosphat in Wasser/ Abwasser/ Bodenextrakten, fotometrisch über Phosphomolybdat und Reduktion zu Molybdänblau, 2005, based on DIN EN ISO 15681-1

    - Since January 2015 flow-injection analysis with spectrophotometric detection FIAstar 5000 Analyzer (Foss Analytical AB, Höganäs, Sweden). Application Notes 5240 (Determination of ortho-phosphate in water by FIAstar 5000) and 5241 (Determination of total phosphorus in water by FIAstar 5000) according to ISO 15681-1.

- TN, NO_2^-, NO_3^-, NH_4^+: Spectrophotometry

    - Before 1992, flow stream analysis as described in Vogler 1975a,b, which was conducted by Wasserwirtschaftsdirektion Havel, Potsdam, German Democratic Republic (Mothes 1981)

    - From 1992 till October 2009, flow-injection analysis with spectrophotometric detection: FIAstar (Tecator AB, Höganäs, Sweden) Application Note 62/83, ASN 110-01/92 (Determination of the sum of nitrate and nitrite in water by flow injection analysis) and ASN 110-03/92 (Determination of total nitrogen in water by flow

injection analysis); and Application Note 50/84, ASN 151-01/92 (Determination of ammonia nitrogen in water by flow injection analysis according to DIN 38406 (E23))

- Since November 2009 flow-injection analysis with spectrophotometric detection FIAstar 5000 Analyzer (Foss Analytical AB, Höganäs, Sweden). Application Notes 5201 (Determination of the sum of nitrate and nitrite in water by FIAstar 5000) according to ISO 13395-1996, Application Note 5202 (Determination of total oxidized nitrogen in water by FIAstar 5000) according to ISO 11905 and ISO 13395, and Application Note 550 (Determination of ammonium in water by FIAstar 5000) according to ISO 11732.

- Ca^{2+}: Spectrophotometry,

  - 1992-10/2009, flow-injection analysis with spectrophotometric detection: FIAstar (Tecator AB, Höganäs, Sweden) Application Note 48/83, ASN 48-03/84 (Determination of calcium in water by flow injection analysis)

  - since 11/2009 flow-injection analysis with spectrophotometric detection FIAstar 5000 Analyzer (Foss Analytical AB, Höganäs, Sweden). Application Note 5261 (Determination of dissolved calcium in water by FIAstar 5000) according to DIN 38406-3

- Al: Spectrophotometry, FIAcompact (Medizin- und Labortechnik GmbH, Dresden, Germany). Arbeitsanleitung Gesamt-Aluminium in Wasser/Abwasser, Brenzcatechinviolettmethode, 2004, based on APHA 3500-Al and ISO 10566

- Fe: Spectrophotometry,

  - From 1996 until August 2005, flow-injection analysis with spectrophotometric detection: FIAstar (Tecator AB, Höganäs, Sweden) Application Note ASN 72-01/84 (Determination of iron in water by flow injection analysis (TPTZ method))

  - Since September 2005, flow-injection analysis with spectrophotometric detection: FIAcompact (Medizin- und Labortechnik GmbH, Dresden, Germany). Arbeitsanleitung Gesamt-Eisen/Eisen (II) in Wasser/Abwasser, Labormethode für FIAcompact, Laboranleitung für FIAcompact, 2004, based on DIN 38406 Part 1 with ferrozine used instead of ortho-phenanthroline

- Si: Spectrophotometry,

  - Before 1992, flow stream analysis as described in Vogler (1975c), which was conducted by Wasserwirtschaftsdirektion Havel, Potsdam, German Democratic Republic (Mothes 1981)

  - 1992-2009, flow-injection analysis with spectrophotometric detection: FIAstar (Tecator AB, Höganäs, Sweden) Application Short Note 4/92 (Determination of silica in water by flow injection analysis)

  - since 2009 flow-injection analysis with spectrophotometric detection FIAstar 5000 Analyzer (Foss Analytical AB, Höganäs, Sweden). Application Note 5240 (Determination of silicate in water by FIAstar 5000) according to ISO 16264

- TIC and NPOC: catalytic oxidation, nondispersive infrared sensor (NDIR), quantification of CO_2 released at high temperature from unfiltered water samples before and after acidification following the procedures described in the user manual.

    - Between 1994 and October 2007, TOC-5000/5050 Analyzer, (Shimadzu, Kyoto, Japan)

    - From November 2007 to November 2009, multi N/C 3100 Analyzer (Analytik Jena, Jena, Germany)

    - Between December 2009 and 2018, TOC-VCPH Analyzer (Shimadzu, Kyoto, Japan)

    - Between 2019 and 2020, TOC-LCPH Analyzer (Shimadzu Kyoto, Japan)

- DOC: catalytic oxidation, NDIR, TOC Analyzer (Shimadzu VCPH analyzer, Kyoto, Japan), determination of CO_2 release from pre-filtered (0.45 µm pore size, filters as described above) water samples, following the methods described in the user manual.

- $CaCO_3$: infrared gas analyzer (Infralyt 50 Saxon, Junkalor, Dessau, Germany) (Proft 1984, Lenz 2018), determination of CO_2 released from dry filtration ((0.45 µm pore size, filters as described above)) residue of water samples after dissolution in 10% hydrochloric acid. CO_2-C was converted to $CaCO_3$ by applying a multiplication factor of 8.3, according to the stoichiometry of $CaCO_3$.

- Alkalinity: Titrimetry,

    - Before 1991: Manual titrimetric analysis with methylorange or phenolphthalein (Legler 1986)
    - 1991-2010: Titroprocessor 686 (Metrohm, Filderstadt, Germany), titration to pH 4.3, according to ISO 9963-1:1994
    - Since 2011: Titrando 888 (Metrohm, Filderstadt, Germany), titration to pH 4.3, according to ISO 9963-1:1994

- Chl *a*: Spectrophotometry after overnight extraction in 90% acetone modified from references Strickland & Parsons (1968), Kasprzak et al. (2008), using membrane filters (ME 28, 47 mm 1.2µm pore size, Whatman, Little Chalfont, United Kingdom). Before 1997, data were rounded to the nearest integer (µg L^{-1}), thereafter to the nearest 0.1 µg L^{-1}

    - Until 2008, Lambda 2 spectrophotometer (Perkin Elmer, Waltham, MA, USA)
    - Since 2009, U-2900 spectrophotometer (Hitachi, Tokio, Japan)

- Parameters

    - lake – sampled lake

    - site – measurement site

    - date – date of measurement [YYYY-MM-DD]

    - depth – depth of measurement [m]

- tp – total phosphorus [mg L^{-1}]

- srp – soluble reactive phosphorus [mg L^{-1}]

- tn – total nitrogen [mg L^{-1}]

- no2 – nitrite [mg L^{-1}]

- no3 – nitrate [mg L^{-1}]

- nh4 – ammonium [mg L^{-1}]

- ca – soluble calcium [mg L^{-1}]

- al – aluminium [mg L^{-1}]

- fe – iron [mg L^{-1}]

- si – silicate [mg L^{-1}]

- npoc – non-purgeable organic carbon [mg L^{-1}]

- tic – total inorganic carbon [mg L^{-1}]

- doc – dissolved organic carbon [mg L^{-1}]

- caco3 – calcium carbonate [mg L^{-1}]

- alkalinity – alkalinity [mmol L^{-1}]

- chla – chlorophyll a [µg L^{-1}]

- epi_int_depth – indicating the integrated depth of the epilimnion sample [m]

- comment – comments

- comment_eng – English translation of original German comments given in column "comment"

Data Cleaning

Laboratory workflows followed standard protocols. Laboratory measurements were documented in laboratory note books and manually entered into a local database. Quality assurance of analytical procedures involved occasional participation in round-robin tests with multiple laboratories. The data were checked by an automated procedure to identify values beyond reasonable bounds as well as by visual inspection. In cases of doubt, data entries were compared with the original records in laboratory note books. Discontinuities in trends were detected for three parameters (NPOC, TIC, Ca^{2+}), the breakpoints coinciding with times when methods or instruments were changed. The data curation for these three parameters is described in detail in the following sections:

Non-Purgeable Organic Carbon (NPOC)

Non-purgeable organic carbon (NPOC) concentrations were measured on four different instruments, a Shimadzu TOC-5000/5050 Analyzer between 08/1994 and 10/2007, an Analytik Jena TOC Analyzer multi N/C 3100 from 11/2007 to 11/2009, a Shimadzu TOC-VCPH analyzer between 12/2009 and 12/2018, and a Shimadzu TOC-LCPH analyzer between 01/2019 and 12/2020. Good laboratory practices were ensured throughout, including routine calibrations. Nevertheless, five periods stood out where the measured concentrations deviated by more than 20% from the values expected based on the long-term trendlines (Table 2), whereas similar deviations were not observed for any other variables. Furthermore, NPOC concentrations during these periods departed from the long-term trends also in two other clear-water lakes (Breiter Luzin and Lake Tiefwaren) and a brown-water lake (Grosse Fuchskuhle) included in IGB's lake monitoring program. These discrepancies suggest that measurement errors occurred during the five suspicious periods.

For the two periods from April 2003 to December 2006 and December 2009 to September 2010, the slopes of the calibration curves differed by more than 20% from the slopes obtained both before and after these periods (Table 2). Consequently, we recalculated all concentrations based on the calibration slopes determined before and after the suspicious periods, resulting in 25% higher and 20% lower concentrations than originally measured during the first and second critical period, respectively.

In 2014, NPOC and TIC concentrations, which were measured on the same instruments, both deviated from the respective long-term trends, suggesting instrument rather than calibration issues, an explanation that is also likely for the two periods from 2007-2008 and 2008-2009, because potential calibration errors could not be identified. To correct the NPOC data for these three periods, we first calculated an overall linear regression for the period from January 2004 to December 2017, ignoring all periods with identified issues. The last three years of the time series were not included due to an increasingly steep rise in concentration (see Fig. 1a-d). The linear regression yielded an R^2 of 0.13 with a median value of 5.8±1.0 mg/L. Next, we interpolated the missing values based on the linear regression and then calculated ratios of the median values of the originally measured concentrations (8.745, 9.12, 7.9 mg/L) and the median of the interpolation (5.48, 5.53, 6.03 mg/L) for each of the respective periods (2007-2008, 2008-2009, and 2014). Multiplication of these ratios with the originally measured concentrations resulted in corrected concentrations consistent with the long-term trend (median of respective time periods after correction: 5.51±0.75, 5.54±0.94, 6.34±0.5), while maintaining the full variability of the original data (Table 2, Fig. 1a,b).

Total Inorganic Carbon (TIC)

Total inorganic carbon (TIC) concentrations were determined with the same instruments used for the NPOC analyses. However, since different methods and calibration curves were used and calibrations were not always performed at the same time, periods with TIC calibration issues differed from those identified for NPOC (Table 1, Fig. 1c,d). An exception was in 2014 when the instrument issue affected both measurements. A calibration issue was identified for TIC samples taken between December 2009 and December 2010, differed by more than 20% from the slopes obtained both before and after this period. For this period, concentrations were recalculated based on a calibration curve established in February 2011, resulting in 40% reduced

concentrations than originally measured during the critical period. For the periods from May until December 2006 and April until September 2014, we used the interpolation approach as described for NPOC, based on an overall linear regression calculated over the period from 2004 until 2017, with both suspicious periods excluded, resulting in a median of 21.5±2.1 mg/L. We calculated correction factors (1.33 and 0.74) as the difference between the median values of the originally measured (16.4 and 29.1 mg/L) and the interpolated concentrations (21.7 and 21.5 mg/L), resulting in a corrected median of 21.8±3.2 and 21.5±2.6 mg/L for 2006 and 2014, respectively. In contrast to the NPOC data, no deviation from the general trend was observed for TIC concentrations during the operation of the Analytik Jena instrument between 2007 and 2009, probably because frequently encountered problems with the combustion tube or catalyst affected NPOC but not TIC measurements.

Dissolved calcium

The spectrophotometric analyses of dissolved calcium (Ca^{2+}) indicated increased concentrations between January 2003 to May 2003, August 2003 to July 2006 and January 2007 to December 2012, that were not apparent in the ion chromatographic analyses. Specifically, the spectrophotometrically determined data exceeded those determined by ion chromatograph by 30% between 2003 and 2007 and by 20% between 2007 and 2012. The reported spectrophotometric data have been corrected for the three periods, resulting in 30%, 30% and 20% reduced concentrations than originally measured (Fig. 1e,f).
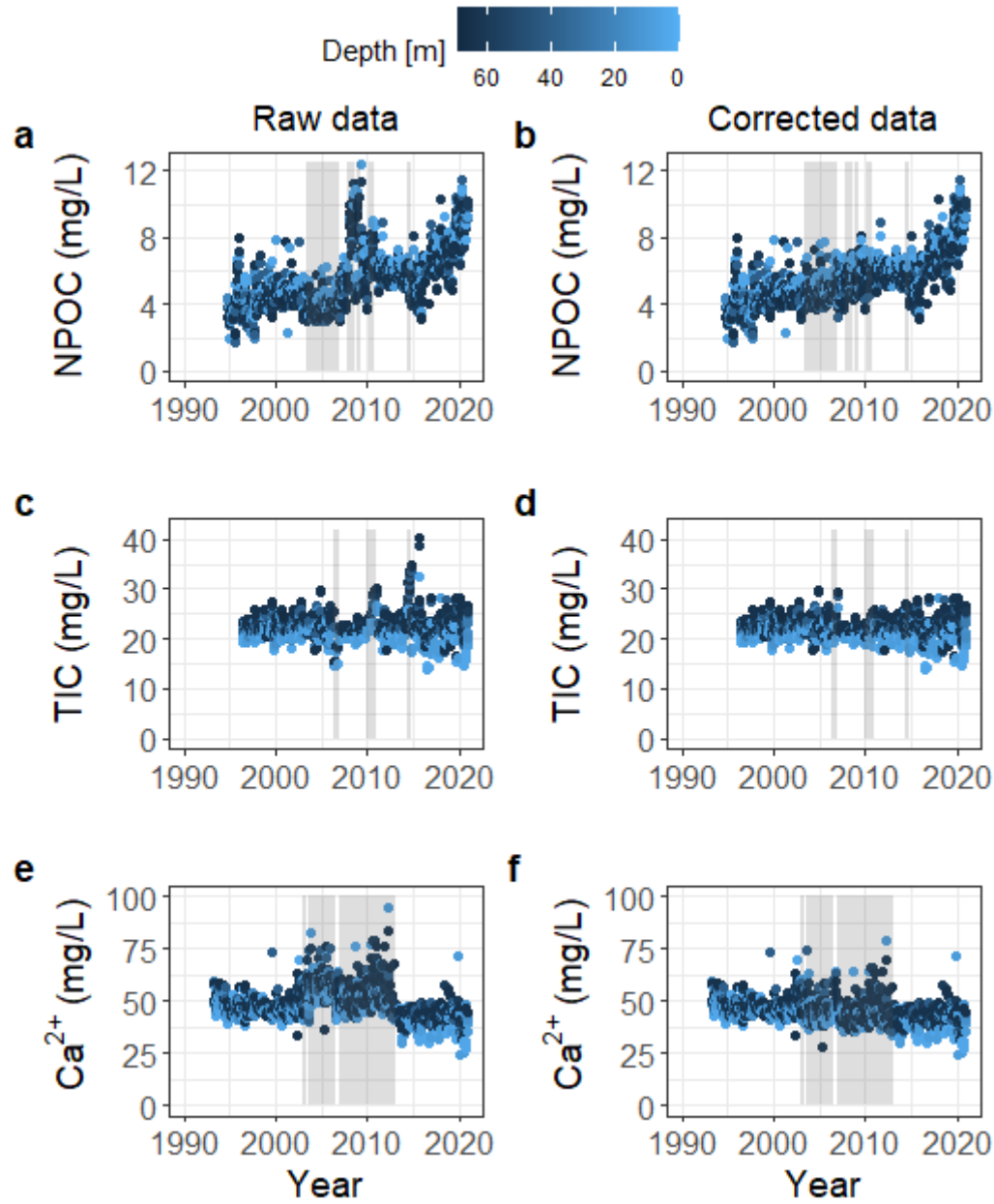
Fig. 1 Time series for NPOC (a, b), TIC (c, d) and spectrophotometrically determined calcium concentrations (e, f) determined in the main basin of Lake Stechlin, illustrating the effect of raw data corrections on temporal dynamics. Areas highlighted in grey indicate the affected time periods. Symbols of sampling values are coloured according to sampling depth, ranging from surface measurements (0 m) in light blue to 65 m below surface in black.

Table 1. Summary of corrections applied to the raw data on non-purgeable organic carbon (NPOC) and total inorganic carbon (TIC) concentrations during different periods

Parameter	Instrument	Period	Basis of correction	Correction factor
NPOC	Shimadzu TOC-5000/5050 Analyzer	April 2003 - Dec 2006	calibration curve	x 1.25
NPOC	Analytik Jena TOC Analyzer	Nov 2007 -July 2008	interpolation	x 0.8
NPOC	Analytik Jena TOC Analyzer	Dec 2008 - March 2009	interpolation	x 0.63
NPOC	Shimadzu TOC-VCPH Analyzer	Dec 2009 – Sep 2010	calibration curve	x 0.58
NPOC	Shimadzu TOC-VCPH Analyzer	May 2014- Sep 2014	interpolation	x 1.25
TIC	Shimadzu TOC-5000/5050 Analyzer	May 2006-Dec 2006	interpolation	x 1.33
TIC	Shimadzu TOC-VCPH Analyzer	Dec 2009-Dec 2010	calibration curve	x 0.86
TIC	Shimadzu TOC-VCPH Analyzer	April 2014 – Sep 2014	interpolation	x 0.74

References

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

Casper SJ. 1985: Lake Stechlin. A temperate oligotrophic lake. Dr. W. Junk Publishers, Dordrecht, Boston, Lancaster, 553 pp.

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

Holzbecher E, Nützmann G, Ginzel G. 1999: Water and component mass balances in the catchment of Lake Stechlin. Integrated Methods in Catchment Hydrology - Tracer, Remote Sensing and New Hydrometric Techniques, IAHS Publication 258, 37–44.

Kasprzak, P., Padisák, J., Koschel, R., Krienitz, L. & Gervais, F. Chlorophyll a concentration across a trophic gradient of lakes: An estimator of phytoplankton biomass? Limnologica 38, 327-338 (2008)

Kirillin G, Shatwell T, Kasprzak P. 2013: Consequences of thermal pollution from a nuclear plant on lake temperature and mixing regime. Journal of Hydrology 496, 47-56.

Koschel R, Adams DD. 2003: An approach to understanding a temperate oligotrophic lowland lake. Archiv für Hydrobiologie Special Issues - Advances in Limnology 58, 1–9.

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

Koschel R. 1995: Manipulation of whole-lake ecosystems and long-term limnological observations in the Brandenburg-Mecklenburg Lake District, Germany. Internationale Revue der gesamten Hydrobiologie 80, 507–518.

Legler, Ch., Breitig, G., Steppuhn, G., Vobach, V. (wiss. Redaktion). Ausgewählte Methoden der Wasseruntersuchung. Band I: Chemische, physikalisch-chemische und physikalische Methoden. Jena (1986)

Lenz, S., Gruenert, U., Geist, J., Stiefel, M., Lentz, M., Raeder, U. Calcite production by the calcifying green alga Phacotus lenticularis. J. Limnol. 77, 209-219 (2018)

Mothes, G. Phosphatbestimmungen im Pelagial des Stechlinsees (1970-1971. Limnologica 9, 157-169 (1974).

Mothes, G. Physikalische und chemische Parameter der Wasserbeschaffenheit des Stechlinseegebietes. Limnologica 13, 1-53 (1981).

Proft, G. Die pelagische Calcitfällung und der Carbonatgehalt von Sedimenten pleistozäner Seen. Acta hydrochim. hydrobiol. 12, 321-326 (1984).

Strickland, J. D. H., Parsons, I. R. A practical handbook of seawater analysis. Fisheries Research Canada 167, 207-211 (1968)

Vogler, P. Analysenautomation in Wasserlaboratorien mit flow-stream-Automaten. II. Die kombinierte automatische Bestimmung von Orthophosphat und Orthosilikat in Wässern. Acta hydrochim. et hydrobiol. 3, 145-158 (1975b)

Vogler, P. Analysenautomation in Wasserlaboratorien mit flow-stream-Automaten. III. Die kombinierte automatische Bestimmung von Ammonium und Gesamtsalzgehalt in Wässern. Acta hydrochim. et hydrobiol. 3, 307-326 (1975c)

Vogler, P. Analysenautomation in Wasserlaboratorien mit flow-stream-Automaten. I. Einsatzgebiete, Anwendungsgrenzen und Nutzen von flow-stream-Automaten in Wasserlaboratorien. Acta hydrochim. et hydrobiol. 3, 133-144 (1975a)

Vogler, P. Probleme der Phosphatanalytik in der Limnologie und ein neues Verfahren zur Bestimmung von gelöstem Orthophosphat neben kondensierten Phosphaten und organischen Phosphor-säureestern. Internat. Rev. ges. Hydrobiol 50, 33-48 (1965)

Vogler, P. Zur Analytik der Phosphorverbindungen in Gewässern. Limnologica 4, 437-444 (1966a)

Vogler, P. Zur Analytik kondensierter Phosphate und organischer Phosphate bei limnologischen Untersuchungen. Ebenda 51, 775-785. (1966b)

Change log

- 2020/2021 Silke R. Schmidt: Chla values should be exchanged: a higher accuracy is available in raw data, however, values were rounded to the units digits.
- 2022 Jason N. Woodhouse/Sabine Wollrab: Extensive data cleaning. NPOC, TIC, Ca^{2+} values adjusted for calibration failure/instrument changes (see Data Cleaning section). Chla values from 1997 onwards have been exchanged for high resolution values.
- 2024 Christine Kiel/Sabine Wollrab: update of metadata description, specifically on sampling procedures and changes in methods over time.
- 2024 Jason N. Woodhouse/Sabine Wollrab: Update on correction of identified issues and data cleaning procedures for NPOC, TIC, and Ca^{2+} data (see updated text in Data Cleaning section).
- 2024 Sabine Wollrab: Minor corrections on chla data, sometimes value for 5m was missing if integrated measure between 0 and 10m was taken. Figure 1 was updated as for TIC some data were previously not displayed.
- 2025/01 Christine Kiel/ Sabine Wollrab: Correction of metadata information on iron, TP and SRP detection method and on preparations of samples for TP and TN detection. Rights of usage has been updated.
- 2025/05 Sabine Wollrab: changed format of csv file from semi-colon to comma separated, added column with English translation of original (German) comments, additional comments recorded with the higher precision chla values have been merged with original comments on chemistry data