Description of sampling surveys for fish in Lake Stechlin

A total of 13 fish species inhabit the lake, but the pelagic fish community is dominated by two sympatric species of ciscoes, *Coregonus albula* and *C. fontanae*. We have been performing fishing surveys annually every June (since 2008). Additional surveys have been performed irregularly in October or November in some years. We have used two types of gear: a midwater trawl, and hydroacoustics.

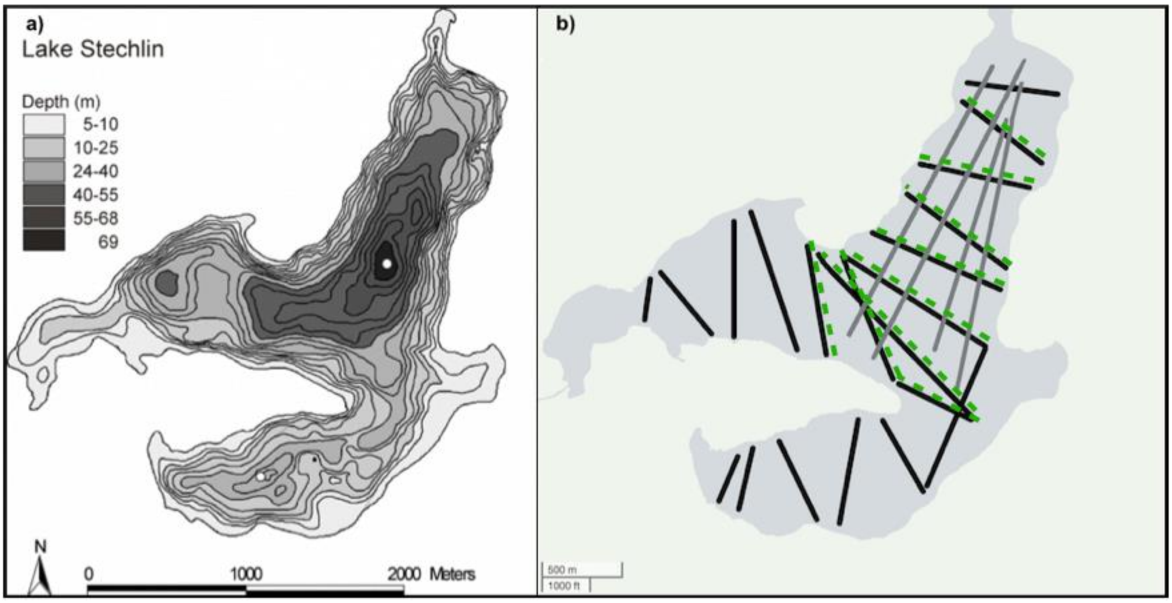

Figure 1. Bathymetric map of Lake Stechlin (a) and diagram with transects from hydroacoustic surveys of whole lake (WL; black), midwater trawling (grey) and with transects from hydroacoustic surveys in the central and northern basin (CB) that overlap with trawling transects (green, b).

Fish assessment - trawling

Pelagic midwater trawl surveys covering several depth layers can be conducted only in the deep central and northern basin of Lake Stechlin. The morphometry of the lake (horizontal extension of certain depth layers per basin) is very variable (see Figure 1a), and hence hauls with a minimum of 500 m towed distance in depths deeper than about 15 m could be realized only in the central and northern parts of the lake.

A pelagic trawl with 28/20/10 mm mesh size, 10 mm mesh size in the cod-end and a total length of 14.8 m (stretched on land) was utilized. The net with an opening area of approximately 10 m^2 (opening width 3.5 m) was towed by a boat (length 7 m, width 2 m), which was driven by a 60 hp engine over four longitudinal transects in the deepest lake basins. Trawling speed (mean ± SD) was 6.5 ± 0.6 km h^{-1} (1.8 ± 0.2 m s^{-1}), while towed distance, as the product of trawling speed and trawling time, ranged between 500 m and 1600 m (mean 840 m) with an average towing time (±SD) of 7.8 min (±1.9). During each survey, a total of four hauls were conducted at approximately 12 m ± 0.65 m, 15 m ± 1.09 m, 25 m ± 2.08 m and 32 m ± 0.90 m (mean ± SD) depth, whereby the two deeper hauls had shorter trawling times and slightly slower hauling speeds. Due to limited spatial extension of water layers with more than 35 m depth, deeper hauls could not be performed. The actual sampling depth was recorded with a diving computer attached on the trawl's head rope. The depth variability during each tow never exceeded 3 m. At the end of each haul, the trawl was quickly lifted by hydraulic winches at speeds comparable to the trawling speeds, thus preventing escapement of fish from the net. Fish were counted, and individually measured to determine total length (TL in mm) and body mass (wet mass, wm in gram). Only subsamples were measured and weighted when catches were too large. The abundance (number of fish per 1000 m^3) and biomass (g wet mass per 1000 m^3) were estimated from the towed distance and the opening area of the trawl. Due to the shorter hauled distance in the deeper layers, the mean from four hauls would have been biased. Therefore, the average was calculated as distance-weighted mean from the four hauls.

Catches consisted of vendace (*C. albula*) and Fontane cisco (*C. fontanae*). Reliable species identification has been possible based on length-frequency distributions until about 2015. In the subsequent years, estimates of the proportion of Fontane cisco in the catches were based on individuals that were close to spawning (ripe) in June. Because some ciscoes may have spawned before June, the proportion of Fontane cisco is certainly underestimated since 2016.

Hydroacoustic fish assessment

Hydroacoustic surveys were completed as a series of transects using a SIMRAD (Kongsberg) EY60 split-beam hydroacoustic unit (120 kHz, circular transducers, beam width 7° x 7°, pulse duration 128 ms, ping rate 3 pings s^{-1}). After calibration with standard spheres provided by the manufacturer, the surveys were conducted during daytime (usually starting at around 3 pm) and during complete darkness starting 1 h after sunset every June since 2008. Individual fish are more dispersed during night-time and hence the abundance and biomass data are more reliable from nighttime than from day-time surveys. Surveys were performed with vertical beaming along 20 transects (total distance about 12 km, transects fixed by GPS tracks) across this tri-basin lake, with transect length ranging from 635 m to 1330 m (see Figure 1b). Data were stored in a computer, processed and analysed by the postprocessing Sonar5 Pro software (CageEye AS, Oslo, Norway).

The lower target strength (TS) threshold (as a measure of fish body length in dB) was set to -55 dB for the SED echogram corresponding to fish of an approximate total length of 4.2 cm and 0.42 g wet mass. Parameters for amplitude echograms were set 6 dB lower (-61 dB) to accept targets out of the half power edge of the sound beam. Echograms were manually cleaned of noise and non-fish echoes, while bottom detection was run automatically using the software parameter settings. A backstep margin of 2 m was used. The upper limit of the analysed echogram area was set to 1 m below the surface, while the bottom line was set as the lower limit. The TS (dB) of the targets was converted into fish total length (cm) and body wet mass (g) using the equation obtained for *Coregonus* spp. from Lake Stechlin:

$$(1)\ \text{TL (cm)} = 10^{\left(\frac{(\text{TS} + 70.9)}{25.5}\right)},$$
$$(2)\ \text{wet mass (g)} = 0.00507 \times (\text{TL (cm)}^{3.088}).$$

For analyses, data were calculated in 13 5-m thick water layers per transect, starting at 1 m below the surface (1-6 m, 6-11 m, …61-66 m). Fish abundance is expressed as volumetric densities (individuals per 1000 m³), calculated as average of the 13 depth layers per transect. Fish biomass is expressed as areal biomass (kg wet mass hectare^{-1}), calculated as sum of the biomasses of the 13 layers. Lake-wide means are calculated as ping-weighted averages from the 20 transects, giving more weight to the longer transects. Mean mass of individual fish (g wet mass) is calculated from the frequency distribution of single echo detections, converted in fish wet mass, from all transects.