Windermere Fish Abundance (1940-2012)

Dataset Documentation

Windermere Fish Abundance 1940-2012

Document Version: 1. 26-3-2013

Description:

This dataset consists of information regarding the abundance of fish species from Windermere, and includes long-term data on Arctic Charr (*Salvelinus alpinus*), Pike (*Esox lucius*), Perch (*Perca fluviatilis*) and some recent data on Roach (*Rutilus rutilus*) from net and trap sampling, together with data on total fish abundance from hydroacoustics. Data collection began in 1940. With the exception of the hydroacoustics, the data were initially collected by the Freshwater Biological Association (FBA) but have been collected by CEH and its predecessor Institute of Freshwater Ecology (IFE) since 1989. The hydroacoustics data have been collected by CEH/IFE since 1990. The data available to download originate from Windermere North and South Basins and are given as yearly averages.

Windermere_fish_1940_2012.csv file details:

- *Format: comma separated values (csv)*
- *Size: 24kb*

Columns:

YEAR	Year in which measurements were taken
SITE	Site name (Windermere North basin/ Windermere South basin
DETERMINAND	Fish species name (see below)
ANNUAL_AVERAGE	Mean for year in question
UNITOFMEASUREMENT	CPUE = Catch per unit effort (fish species data only) fish ha-1 = Fish per ha (for hydroacoustics data only)

Sampling site location: Windermere lake, Cumbria, Great Britain.
Approximate grid reference of lake centre:
SD393960 (OS Grid Reference)
339385,496080 (OSGB36 Easting/Northing)
54.360193 -2.935836 (WGS84)

Fish Species Measured (DETERMINAND):

Esox lucius	Pike
Perca fluviatilis	Perch
Rutilus rutilus	Roach
Salvelinus alpinus	Arctic charr
Total fish (hydroacoustics)	All detectable fish species

- *Details for each determinand are outlined below.*

Pike (*Esox lucius)*

Experimental design/Sampling regime

Pike have been monitored in the north and south basins (SITE) by gill netting with variations in sampling sites and efforts from 1944 to the present.

Collection Methods & Fieldwork and Laboratory instrumentation

The first gill-nets used in the 1940s had a mesh of 5 inches when stretched (64 mm knot to knot) and were 30 yards x 10 feet (27 m x 3 m) in size. They were set on the bottom in shallow water at sites all round the lake, being lifted every two or three days, and were moved to a new site when it appeared that no more pike were being caught. The mesh was large enough to avoid catching any other species except the very occasional large trout and perch. This methodology had variations until 1982 (refer to Le Cren, 2001)[1].

Since 1982, the methodology has been standardised as follows. Pike were sampled by means of 64 mm bar mesh multifilament gill nets. Each net was 40 m in length and 3 m in depth and set singly on the bottom between mid-October and late December at depths of approximately 4–5 m at 10 sites in each of the north and south basins.

Nets were usually set at five sites during daylight on a Monday, inspected and catch removed during daylight on a Wednesday and then lifted during daylight on a Friday, although the precise time of lifting was occasionally influenced by weather conditions. The settings were then repeated at that site during the following week. All pike taken in the nets were killed and taken to the laboratory for processing. Five nets were in the water at any one time and the sites fished were rotated during the course of a sampling season, ensuring a systematic coverage of the entire lake. Any one site was thus fished for two weeks during each sampling season. A small amount of additional such netting was undertaken within the same months during the period from 1982 to 1989, resulting in a total annual sampling effort for that period of c. 348 net days distributed approximately equally between the two basins.

Since 1990 the total annual sampling effort has been held at c. 240 net days, again distributed approximately equally between the two basins.

Analytical Methods

In the laboratory, each pike was measured (fork length to 1 mm) and weighed (wet weight to 100 g), before being dissected to determine sex. The left opercular bone was removed and aged as described by Frost & Kipling (1959)[2] with a nominal birth date of 1 April.

The above data were used to calculate mean (with 95% confidence limits) catch-per-unit-effort (CPUE) by numbers of pike for the north and south basins for each year (This is the data in the column ANNUAL_AVERAGE for DETERMINAND: *Esox lucius* and UNITOFMEASURMENT: *CPUE)*.

Quality Control

For quality control, measurements are taken and checked by permutations of three individuals.

[1]Le Cren, E. D., 2001. The Windermere perch and pike project. Freshwater Forum 15: 3–34.

[2]Frost, W. E. & Kipling, C. (1959). The determination of the age and growth of the pike (Esox lucius L.) from scales and opercular bones. Journal du Conseil permanent international pour VExploration de la Mer 24, 314-341.

Eurasian perch *(Perca fluviatilis)*

Experimental design/Sampling regime

Eurasian perch have been monitored in the north and south basins (SITE) by a standardised trapping technique from 1943 to the present, primarily during the months of April to June.

Collection Methods & Fieldwork and Laboratory instrumentation

Initially, some 300 traps were manufactured from fencing wire covered with ½ inch (12 mm) mesh wire netting, with a funnel entrance and a small door for removal of the catch.
Following trials with traps of different colours, after 1941 all traps were dipped in black tar-varnish to increase both their catches and their life. The first traps made were cylindrical but, after a number were lost from rolling down the steeper slopes of the littoral, they were given flat bottoms. Each trap was provided with a 10-metre rope and two glass floats. Much later, the traps still being used for sampling have been on submerged lines to prevent tampering from inquisitive people in boats.

Analytical Methods

Data from single sampling sites in the north and south basins were used to calculate CPUE by numbers for each year from 1982 to 2012 (This is the data in the column ANNUAL_AVERAGE for DETERMINAND: *Perca fluviatilis* and UNITOFMEASURMENT: *CPUE)*, although very high intra-annual variation in such catches prevented the calculation of meaningful confidence limits.

Quality Control

For quality control, measurements are taken and checked by permutations of three individuals.

Roach *(Rutilus rutilus)*

Experimental design/Sampling regime

The roach population was sampled in both basins (SITE) in 1995, 2000, 2005 and 2012.

Collection Methods & Fieldwork and Laboratory instrumentation

Bottom-set survey gill nets were set overnight at 15 inshore sites (5 and 10 sites in the north and south basins, respectively) of depth c. 4 m during September.

In 1995, each survey gill net was 60 m long and 1.5 m deep and comprised bar mesh sizes of 8, 10, 12, 16, 22, 25, 30, 33, 38 and 43 mm.

In 2000, each survey gill net was again 60 m long and 1.5 m deep but comprised bar mesh sizes of 8, 10, 13, 16, 19, 25, 30, 33, 38 and 45 mm. In 2005, each survey gill net was of the standard Norden design, i.e. 30 m long and 1.5 m deep with bar mesh sizes of 5, 6.25, 8, 10, 12.5, 15.5, 19.5, 24, 29, 35, 43 and 55 mm.

In 2005, each survey gill net was of the newly developed standard Norden (formerly Nordic) design, i.e. 30 m long and 1.5 m deep with bar mesh sizes of 5, 6.25, 8, 10, 12.5, 15.5, 19.5, 24, 29, 35, 43 and 55 mm.

In 2010, survey details were identical to those of 2005.

Analytical Methods

All catches were frozen at -20^{o}C to await future processing in the laboratory where all individuals were identified to species and enumerated.
Data were used to calculate catch-per-unit-effort (CPUE, as number of fish 100 m2 net^{-1} day^{-1}) of small (<c. 200 mm) and large (‡c. 200 mm) roach for each basin for each year (This is the data in the column ANNUAL_AVERAGE for DETERMINAND: *Rutilus rutilus* and UNITOFMEASURMENT: *CPUE).*

Quality Control

For quality control, measurements are taken and checked by permutations of three individuals.

Arctic charr *(Salvelinus alpines)*

Experimental design/Sampling regime
Arctic charr were monitored in the north basin (SITE) from 1940 to 2012.

Collection Methods & Fieldwork and Laboratory instrumentation
A gill net was used, c. 28 m long and 1.8 m deep (with some minor variations pre-1970s as described in detail by Kipling (1984)[1] of bar mesh size 32 mm. The gill net was repeatedly set overnight from October to December of each year at a depth of c. 2 m on a spawning ground (Low Wray Bay 1939–1973 (54°24.174' N, 2°57.652' W), North Thompson Holme 1975– 2012 (54°21.993' N, 2°56.293' W)).

Analytical Methods
All fish caught were identified and measured (fork length, mm) before being immediately returned alive, with the rare exception of accidental mortalities which were retained for further examination.

These data were used to calculate CPUEs (as number of fish net^{-1} day^{-1}) of spawning Arctic charr for the month of November of each year, during which catches peaked (this is the data in the column ANNUAL_AVERAGE for DETERMINAND: *Salvelinus alpines* and UNITOFMEASURMENT: *CPUE).*

[1]Kipling C (1984) Some observations on autumn-spawning charr, Salvelinus alpinus L., in Windermere, 1939–1982. J Fish Biol 24:229–234

[2]Elliott JM, Fletcher JM (2001) A comparison of three methods for assessing the abundance of Arctic charr, Salvelinus alpinus, in Windermere (northwest England). Fish Res 53:39–46

Hydroacoustics

Experimental design/Sampling regime

Day- and night-time hydroacoustic surveys of the fish populations of the north and south basins (SITE) of Windermere were conducted at approximately monthly intervals, starting in 1990.

Collection Methods & Fieldwork and Laboratory instrumentation

In the early years of the surveys, a zig-zag design, with a coverage ratio of 3.1:1 and single-beam system (Simrad EY-M echo sounder with 70 kHz vertical transducer (Simrad Subsea A/S, Horten, Norway)) and data analysis (HADAS Lindem Data Acquisition Systems, University of Oslo, Norway)) were used. Full details are given in Baroudy and Elliott (1993)[1].

From 2002 onwards, a more sophisticated split-beam system (BioSonics DT6000 or DT-X echo sounder with 200 kHz vertical transducer (BioSonics Inc, Seattle, USA) and data analysis (Echoview, Sonar- Data, Hobart, Australia)) was used on the same transects, including inter- calibrations between the two systems. Full details are given in Winfield et al. (2006)[2].

Calibration steps and values

Periodic field and laboratory calibration of the hydroacoustic system according to manufacturer's instructions.

Analytical Methods

For each basin, data were used to calculate the night-time abundance of all detectable fish in the entire water column, which gives the best estimate of total fish abundance in Windermere

Data were also used to calculate the day-time abundance of large (‡c.200 mm) fish in the upper 20 m of the water column, which gives the best assessment of the abundance of fish of legally exploitable length in the part of the water column exploited by the Arctic charr fishery, which is itself confined to daylight hours. For each year, summary data for the above two parameters were calculated as means ±95% confidence limits based on the monthly data (This is the data in the column ANNUAL_AVERAGE for Total fish (hydroacoustics/fish ha^{-1})).

Quality Control

For quality control, measurements are taken and checked by two individuals.

[1]Baroudy E, Elliott JM (1993) The effect of large-scale spatial variation of pelagic fish on hydroacoustics estimates of their population density in Windermere (northwest England). Ecol Freshwat Fish 2:160–166

[2]Winfield IJ, Fletcher JM, James JB (2006) The Urban Waste Water Treatment Directive: Monitoring the Arctic charr population of Windermere, 2005. Unpublished Report from Centre for Ecology & Hydrology to Environment Agency, North West Region. LA/C01752/15, 56 pp

Further reading:

Arctic charr netting, Hydroacoustics

- Winfield, I. J., Fletcher, J. M. & James, J. B. (2008). The Arctic charr (Salvelinus alpinus) populations of Windermere, U.K.: population trends associated with eutrophication, climate change and increased abundance of roach (Rutilus rutilus). Environmental Biology of Fishes 83, 25-35.

Perch trapping, Pike netting, Roach netting

- Winfield, I. J., James, J. B. & Fletcher, J. M. (2008). Northern pike (Esox lucius) in a warming lake: changes in population size and individual condition in relation to prey abundance. Hydrobiologia 601, 29-40.
- Le Cren, E. D., 2001. The Windermere perch and pike project. Freshwater Forum 15: 3–34.