Data Descriptor

Methodology of the Morphometry Study on Baltic Herring

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Abstract

Acoustic techniques are used in the estimation of the abundance of Baltic herring. Investigations of the relationship between the Baltic herring individual target strength TS and the total fish length L, significant in the acoustic assessment, demonstrated its dependence on the study area location. It motivated the detailed analysis of the relationship between herring from the southern Baltic ICES Subdivisions 24, 25, and 26, in which Poland is responsible for the acoustic herring abundance assessment. The modelling approach, based on the Modal Based Deformed Cylinder Model approximation, was used to study the backscattering. The detailed shape of the body and swim bladder of herring individuals was considered. The article describes the methodology of acquiring data for the model study containing information on the detailed shapes of the bodies and swim bladders of 74 herring individuals obtained in the area of the Polish coastal zone (ICES Subdivision 26).

Keywords: Baltic herring, fish morphometry, X-ray images, numerical modelling of backscattering by fish, target strength, abundance estimation

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Specification table (data records)

Subject area	Fish biomass estimation
More specific subject area	Modelling of acoustic backscattering by southern Baltic herring
Type of data	X-ray images, morphometric measurements and swimbladder countours

How the data was acquired	Fish for research - during the cruise on the fishing vessel X-rays images – taken at the hospital in Hel
Data format	.jpg, .dwg, .txt, .cdr, .xlsx
Experimental factors	Baltic herring
Experimental features	Real-time X-ray living fish analysis
Data source location	MOST Wiedzy Open Research Catalog, Gdańsk University of Technology, Gdańsk, Poland
Data accessibility	CC-BY-NC

Introduction

The published datasets (X-ray images of Baltic herring and X-ray images of Baltic herring. Data analysis) contain detailed information on the shapes of the swim bladders and fish bodies of herring from ICES Subdivision number 26. These data were collected during the author's doctoral dissertation (Idczak, 2015) and were used to model the backscattering characteristics of herring individuals obtained from the Polish coastal zone of the Baltic Sea.

Considering that there is variation in the ontogenesis of herring in various regions of the Baltic Sea (ICES Reports 2004; 2005a, b; 2006), which may have an influence on the geometrical shape of their swim bladders, we can also expect geographic variation in the shape of this organ. An indirect confirmation of this may be the target strength study of herring individuals carried out for various areas of the Baltic Sea (Rudstam, Lindem and Hansson, 1988; Rudstam, 1999; Didrikas and Hansson, 2004; Peltonen and Balk, 2005; Kasatkina, 2009), the value of which largely depends on the morphometric parameters of the fish's swim bladders (Gorska, 2007; Fässler et al., 2008; Fässler and Gorska, 2009; Gorska and Idczak, 2010). These studies revealed a geographic differentiation in the backscattering characteristics of the Baltic herring individuals.

Earlier studies of the shape of the swim bladder of Baltic herring based on X-ray images was performed only for fish individuals obtained from the Baltic Sea area along the Swedish coast (ICES subdivisions 25, 27, 29S) (Håkansson and Arrhenius, 2002; Swedish Museum of Natural History and Danish Institute for Fisheries Research). In order to study the shapes of the swim bladders of fish from other areas of the Baltic Sea, a collection of X-ray images for herring obtained from other areas of the Baltic Sea had to be developed.

Methodology of research on the geometric shape of the swim bladder and the body of herring individuals.

In order to precisely determine the shape of the swim bladder of the South Baltic herring individuals, a research methodology was developed that does not cause significant changes in the shape of this organ in relation to its natural shape (while the fish is in the marine environment) (Idczak, Gorska and Arciszewski, 2011; Idczak and Kniaź-Kubacka, 2012). The biggest challenge in studying the natural shape of the herring's swim blad-

der using X-rays was the necessity to obtain live fish and keep them alive during the research. To achieve this goal, the following actions were undertaken:fish for research were obtained from shallow depths, minimising the risk of distortion of the swim bladder as a result of a sudden change in hydrostatic pressure;a method of storing and transporting the fish (from the moment they are caught until carrying out the X-ray examinations) was developed, assuring the good condition of the fish individuals in order to maintain the natural shape of their swim bladders; the places for collecting, storing fish and taking X-ray images were located in close proximity to each other (to shorten the time of fish transport as much as possible); maximum attention was given when restraining the fish immediately before X-ray examinations (in order not to cause any damage).

Collection of research material

The collection of biological material for X-ray examinations took place in November 2011. The herring was collected from the HEL-125 fishing boat in the Gulf of Gdańsk, south-east of the Hel Peninsula. During the fishing, a pelagic trawl with a mesh side of 11 mm with a horizontal span of about 18 m and a vertical span of about 20 m was used. The trawl was towed at an average speed of approximately 3.5 knots. During transport to the place of X-ray examinations, the collected herring individuals were properly secured using plastic bags with sea water and oxygen.

X-ray studies of herring individuals

Before placing the fish on the X-ray table, it had to be immobilised without being killed. For this purpose, a solution of clove oil and 40% ethanol was used (Hazen and Horne, 2003, 2004) for which the proportions of the individual ingredients are given in Tab.21.1 (Horne and Jech, 2001). The fish were placed in the solution for several seconds. It resulted in their anesthesia, but did not cause a lethal effect. The use of the solution prevented each fish from moving while it was being X-rayed. This allowed for quick X-ray examinations for the desired arrangement of fish on the X-ray table.

Tab. 21.1

Composition and concentration of the solution used for anesthesia of herring individuals (Horne and Jech, 2001)

Concentration (ppm)	Clove oil (ml)	$C_2 H_5 0H$ (40%) (ml)	Water (l)
40	0.4	3.6	10

X-ray studies of 220 specimens of herring were carried out on 03–04.11.2011. In order to study the morphometry of the swim bladder and the body of the fish, two images were taken for each individual: one in the lateral position and one in the dorsal position.

When the image was taken in the dorsal position, the fish was placed on its stomach on the X-ray table and supported on both sides with paper wedges. The X-ray machine parameters were set to low values (applied voltage = 42kV and the product of the current through the X-ray tube (mA) and the X-ray exposure time (s) = 1.2 mAs for fish placed in a lateral position, and 42 kV and 1.6 mAs, respectively, for fish placed in the dorsal position) so that the images of the fish tissue were recorded on the X-ray film.

Before taking the X-rays, in order to identify the fish, an individual metal number was placed next to each fish individual, visible on the X-ray image. The individual fish in the photo had the same number in the lateral and dorsal positions. After the photo was taken, the number was permanently attached to the tail fins of the fish. Then the fish were placed in a container for subsequent geometric measurements of their bodies.

While waiting for the X-ray examinations, the fish were kept in specialised aquariums filled with seawater. For the period of transport for the X-ray examinations, they were re-packed in plastic bags with sea water and oxygen. Only those fish whose form was assessed as good, similar to the form during the stay of the fish in its natural environment, were selected for X-ray tests. All selected fish fled while attempting to be caught with a net in the aquarium and swam naturally in the entire depth of the water. On the first day of the research, X-rays were taken of 136 herring individuals, the next day – the remaining 84 individuals.

Scanning of X-ray films

Next, images were selected for morphometric studies of the fish, and for this purpose a method of converting photos from analog to digital was developed. The task was rather challenging because the photos were available only in the form of X-ray films, which made it impossible to simply scan them. For this purpose, a scanner with a transparency adapter was used, enabling X-ray film scanning.

Measurements of fish morphometric parameters

Shortly after the end of the X-ray examinations, the body lengths of the fish were measured (total length of the fish L – measured with the caudal fin and the standard length of the fish Lb – without the caudal fin, width wb and height hb of the fish bodies). Then, with the help of AutoCAD, the morphometric parameters of the swim bladders of the fish from the digitised X-ray images were measured (length Lsb, width wsb and height hsb).

In this way, the morphometric parameters of 135 herring individuals were measured. It was observed that due to the good condition of these fish individuals, from the moment they were caught from the sea until they were placed on the X-ray table, the swim bladders visible in the X-ray images retained their shapes similar to their natural shape, i.e. the shape of the swim bladders of herring found in their natural environment.

Digitisation of fish body and swim bladder contours

Next, in order to obtain input data for the modelling of acoustic wave backscattering on herring individuals, taking into account the detailed shapes of the fish bodies and swim bladders, the contours of the bodies and swim bladders had to be digitised from the X-ray images. For this purpose, a methodology for reading contours and a method for saving them as digital data that could be used in MATLAB as input data was developed.

For the digitisation of contours, only those X-ray images in which the contours of the fish bodies and swim bladders were clearly visible were selected. Digitisation was carried out using two programs: CorelDRAW and AutoCAD. Using the first program, the contours of the bodies and swim bladders of the fish were read. Using the second program, the contours were saved as digital data. Coordinates (x, y) were read for each contour point (in steps of 1 mm). In this way, from the X-ray images of 220 fish individuals, the contours of the bodies and swim bladders of 74 fish individuals were digitised.

The data prepared in this way can be used as input data in model studies of the backscattering characteristics of herring individuals taking into account the detailed shapes of fish bodies and swim bladders. In addition, the existing collection of X-ray images of herring obtained off the coast of Sweden has been expanded to include X-ray images of fish from the Polish coastal zone.

Data availability

Dataset DOI
10.34808/s4sj-b755
10.34808/80xc-f462

Dataset License
CC-BY-NC

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