Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

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Data collection, electric fishing for eel in Swedish watercourses

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This document describes, in brief, the targeted eel fishing program that is carried out in Sweden. The document contains background and brief history, execution, data collection, end users, and quality assurance.

The European eel (*Anguilla anguilla*) hatches in the Sargasso Sea and as small leptocephalus larvae, they are transported by the ocean currents towards the European continent. During transport, the larvae develop into transparent glass eels. Once on the coasts of Europe, the glass eels begin to develop pigment and when they find their way up into the waterways along the coast, they are called elvers. The migration of elvers to Swedish watercourses takes place mostly along the Swedish west and south coasts. Still, some elvers stay in the coastal band, continue their migration into the Baltic Sea or make their way up into watercourses on the east coast. Data on how many elvers migrate up into Swedish watercourses is collected using several different methods, such as electrofishing and elver traps.

Background and brief history

In Sweden, studies of fish fauna have been conducted using electrofishing since the 1940s. Historically, the method has mainly been focused on catching and counting salmon-like fish (Wolf, 1950). When the Swedish Board of Fisheries started a project in 2010 to develop a recruitment index for eel, electrofishing was one of the methods that was assessed when investigating which method was most suitable for collecting small eels (glass eels, elvers, and smaller yellow eels). The other two methods assessed were portable drop traps and pot traps, but electric fishing proved to be the best (Strömquist & Wickström, in preparation). An electrofishing program was then developed to systematically monitor and estimate the density of small eels in watercourses. Staff from the Swedish Board of Fisheries participated in the work together with experienced consultants who had done a lot of electrofishing on the west coast and thus had good local knowledge.

Implementation

The electrofishing program includes electrofishing sites in a gradient from north to south along the Swedish west coast, from Strömstad in the north to Ystad in the south. Eight sites were included in the electrofishing program at its inception in 2011, since then more sites have been added or replaced, and at most 17 sites were electrofished in the same year (Table 1, Figure 1). Sites in watercourses that discharge into the east coast have also been test-fished in recent years, but none of these sites have yet been added to the electrofishing program (Table 2).

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Table 1. Watercourses and sites included in the electrofishing programme, name of the site in SERS and the years in which they have been electrofished. The sites are sorted from north to south.

Watercourse	Site	Name of the site in SERS	Year
Strömsån	Nedan Hjälpebron	6544553-1233645 Ned Hjälpebron ny	2011-ongoing
Kynne älv	Sundshult	6520990-1255424 Sundshult	2011- ongoing
Örekilsälven	Kröken	6492200-1259350 Kröken	2011- ongoing
Arödsån	Nedre Aröd	6463737-1271667 Nedre Aröd ny	2011- ongoing
Kollerödsbäcken	Utlopp vid fallet	6430280-1261420 Utlopp vid fallet	2017- ongoing
Göta älv	Västerlandaån	6447716-1282917 100 m ned station 1	2012-2013
Knapebäcken	Skolan uppstr bro	6371190-1270560 Skolan uppstr bro	2017- ongoing
Löftaån	Ned utl Kroksjöbäcken	6360870-1283430 Ned utl Kroksjöbäcke	2011- ongoing
Viskan	Kullagård-biotop	6353810-1290580 Kullagård-biotop	2017- ongoing
Kvarnabäcken	Nedstr spången	6301730-1305000 Nedstr spången	2012- ongoing
Rössjöholmsån	Östra kvarn	6242780-1317290 Östra kvarn	2011- ongoing
Pinnån	Stora Mölla	6234830-1327250 Stora Mölla	2011
Rönne å	Sönnarslöv	6226200-1331350 V Sönnarslöv	2011
Kävlingeån	Lilla Harrie	6187340-1336650 L Harrie Kä-4	2017- ongoing
Kävlingeån	Håstadmölla	6186250-1338470 Håstad mölla 59-8	2017- ongoing
Kävlingeån	Silverfors	6187460-1331320 Silverforsen	2024- ongoing
Höje å	Bjällerups kvarn	6172760-1339870 Bjällerups kvarn	2012- ongoing
Dybäcksån	Hörte hamn	6141980-1356940 Hörte hamn	2017- ongoing
Nybroån	Övningsfältet	6147640-1381390 Övningsfältet	2017- ongoing

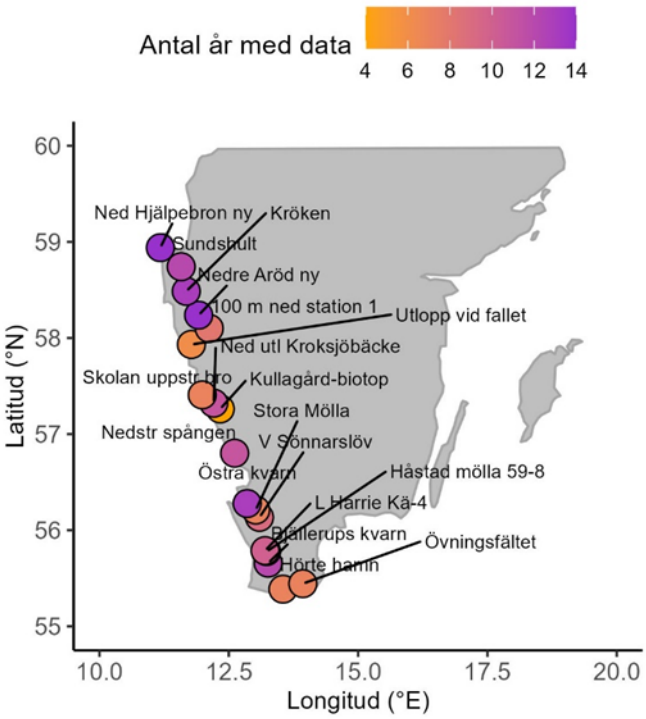

Figure 1: Sites included in the electrofishing programme. Colour scheme over the number of years with data per local.

Table 2. New sites that have been test-fished in watercourses that discharge into the east coast.

Watercourse	Site	Name of the site in SERS	Year
Storån	S:t Laurentikyrkan	6484300-1530000 S-t Laurentikyrkan	2017-2018
Loån			2023
Torshagsån	Ål 2,8 km	6504090-1523940 Ål 2,8 km	2023
Bräkneån	Björstorps kvarn	6230030-1456280 Björstorps kvarn	2023
Marströmmen	Gångbron pensionatet	6378000-1539860 Gångbron pensionatet	2023
Nyköpingsån	Storhuskvarn		2024
Emån			2024
Mörrumsån			2024

In addition to the fact that the number of sites has varied since the start of the electrofishing programme in 2011, the implementation between years for some of the sites has also varied. Among other things, the distance fished, the total area, the number of runs and the time of year when the electrofishing was carried out have varied between fishing occasions. Another factor that has varied is that different practitioners have fished the sites over time. The standardized estimation of the eel density per 100 m^2 considers the length of the site/fished area and the number of runs, but not the time of year or temperature. The fact that the execution has varied slightly between fishing years does not necessarily

have a major impact on the standardized estimation of eel density, but in some cases the sites have varied greatly in size, by a factor of 2-5. Since the time of year when electrofishing has been carried out has varied between July and October, it may have affected the catches of eel and in turn affect the standardized estimation of eel density. This is because water temperature may have varied between fishing occasions, and temperature is strongly correlated to number of eel (Degerman et al., 2019). In some watercourses, such as Viskan, different sites have also been fished between years. All in all, this means that the targeted electrofishing program for eel that has been developed, has been carried out insufficiently and standardized estimation of eel density is difficult to calculate.

Data collection

Electrofishing is mainly carried out by consultants on behalf of the Swedish University of Agricultural Sciences (SLU Aqua) (formerly the Swedish Board of Fisheries). To obtain a measure of eel density as standardized as possible, the instructions for the practitioners for electrofishing in 2024 were changed and clarified (SLU ID: SLU.aqua.2024.5.4-178). The new instructions meant that electrofishing should now be carried out between 1 July and 31 August, with two runs, at a water temperature preferably exceeding 18 C° (in previous years the recommended temperature has been >16 C°), and that only eels need to be documented, no other species (previously all species have been collected and length measured). The consultant fills in protocols for electrofishing according to Swedish standardized electrofishing (SIS 2006; Bergquist et al. 2014; HaV, 2017). Data is collected on the number of eels per fishery, coordinates, dates, length, width, depth, vegetation and water level of the site, etc. After the end of the electrofishing process, the catches and environmental data are registered by the electrofishing consultant in the database SERS managed by SLU Aqua, the electrofishing protocols are also sent to the responsible staff at SLU Aqua. The electrofished site is also photo-documented, from 2024, and photos are sent via email to contact persons at SLU Aqua, as a step in an improved control of the electrofished site.

All eels that are caught must be length-measured by the consultant at each site. In addition to length measurement, some eels are also collected from selected sites for extended individual sampling (dissection) at SLU Aqua, the Freshwater Laboratory, to obtain additional biological data. Until 2022, a maximum of 100 eels (< 300 mm long) were sampled per site per year, but since 2023 this number has been reduced to 30 eels per selected site per eel, with no upper length limit for which eel should be sampled. The eels that are collected are frozen after being caught and then sent to SLU Aqua, the Freshwater Laboratory with frozen transport. Staff at SLU Aqua carry out the individual sampling where weight, length and number of the swim bladder parasite *Anguillicola crassus* are noted. Each individual's otoliths are picked out and stored in marked sample bags in the biological archive at SLU Aqua, the Freshwater Laboratory, to enable future analysis of age and the chemical composition of the otolith. The number of eels dissected has varied from year to year and between sites depending on how many eels have been caught and sampled. Until 2016, individuals were selected to represent the entire length range of the catch. In recent years, individuals have been specifically selected to cover the lengths where data have been missing on the premises where many elvers have been caught. At sites with few captured individuals, all sampled individuals have still been dissected. Individual data is stored in the database, Sötebasen, which is managed by SLU Aqua, the Freshwater Laboratory. Some control of data is done when entering individual data to Sötebasen, as the database has set limit values for some parameters and warns in case of extreme values.

Other manuals concerning the collection of eel with electric fishing are manuals for dissection, age reading, chemical analysis and the biological archive's quality assurance. These can be found on the SLU Quality Assurance website: *https://www.slu.se/qualityassurance*, or on *https://www.slu.se/institutioner/akvatiska-resurser/kontakt/forskningsinfrastuktur/biologiskt-arkiv/*

End user

The annual catches from electrofishing are reported to the public database SERS (link) and the data is delivered by SLU Aqua to the international working group for eel, WGEEL, via annual data requests (so-called data-calls). Data will also be reported in the Fish Barometer from 2024 (www.fiskbarometern.se). The data is also used by other end users such as county administrative boards and researchers.

Quality assurance

Data collection of eel recruits through electrofishing is partly funded by the EU and takes place within the framework of the EU's Data Collection Framework (DCF). Within DCF, three-year work plans are written (Swedish Work Plan 2022–2024) which include quality assurance of the data collected (Annex 1.1 in the Swedish Work Plan 2022–2024). As part of improving the process of quality assurance, all points in Annex 1.1 are listed here with an accompanying comment describing the issue and quality assurance (Table 3).

Table 3: Quality assurance of data from the electrofishing programme targeting eel according to Annex 1.1 of the Swedish national work plan within DCF (Swedish Work Plan 2022–2024).

Category	Question	Comment
Summary	Target species and sampling area	European eel (*Anguilla anguilla).* Individuals from selected watercourses in Sweden.
	Population sampled	Juvenile eels are sampled (juveniles and yellow eels) from watercourses where electrofishing is possible and with the potential to find eels.
	Population unreachable for sampling	For economic and practical reasons, not all watercourses where juvenile eels may be found are sampled. Sites are chosen based on the lack of data on recruitment from other sources and on the potential to host the target population.
	Stratification	Rivers and sites are selected based on where more data is needed on recruitment, and where it is technically possible to perform electrofishing.
Sampling - design and protocol	Sampling design description	Locations are chosen based on the lack of data on recruitment from other sources, on the potential for juvenile eels to be there and the opportunity to electrofish.
	Compliance with the 4S principle	NA
	Regional coordination	No
	Documentation of sampling design	This document.
	Design compliance with international recommendations	The sampling design follows national standards with modification to specifically target eel.
	Documentation of sampling protocols	This document.
	Protocol compliance with international recommendations	The sampling design follows national standards with modification to specifically target eel.

Category	Question	Comment
Sampling - implementation	Recording of refusal rate	NA
	Sampling progress	Electrofishing is conducted during the summer. If a sampling site within a river would be impossible to electrofish, another close-by site can be selected. Data on several site descriptors are collected and can be used to standardize data collected from nearby sites. Otherwise, data for that year is missing and electrofished again the following year.
Data capture	Means of data capture	The method follows national standards with modification to specifically target eel. Streams are electrofished using backpack or generator (differs between sites). All eels are length measured. Stop nets are not used. A sub-sample of eels are kept and later dissected to collect additional data.
	Data capture documentation	This document.
	Documentation of quality checks	This document (and work in progress).
Data storage	National database	Data is stored in the national electrofishing database "SERS".
	International database	Processed data is delivered to ICES via WGEEL Data Calls and stored in the WGEEL database.
	Quality checks and data validation documentation	This document (and work in progress).
Sample storage	Sample storage	A sample is dissected and biological data is collected immediately. Otoliths are saved for later age reading and chemical analyses in the Biological Archive, SLU Aqua, Drottningholm. The samples are archived fireproof in accordance with SLU's procedures for quality assurance.
	Sample analysis	Manuals for dissection, age reading and chemical analysis can be found on SLU Aqua's webpage for quality assurance.
Data processing	Evaluation of data accuracy (bias and precision)	Data processing is documented on the SERS webpage: https://www.slu.se/en/departments/aquatic-resources1/databases/database-for-testfishing-in-streams/
	Editing and imputation methods	Data processing is documented on the SERS website https://www.slu.se/en/departments/aquatic-resources1/databases/database-for-testfishing-in-streams/
	Quality documents associated to a dataset	No DOI but an article from the Swedish Institute for Standards, Article no: STD-34647. https://www.sis.se/en/produkter/environment-health-protection-safety/water-quality/examination-of-biological-properties-of-water/ssen14011/
	Validation of the final dataset	Processed data is validated within Data Calls and the annual ICES WGEEL working group meetings.

References

ANNEX 1.1 - Quality report for biological data sampling scheme. Del av: Swedish Work Plan 2022–2024. Swedish Work Plan for data collection in the fisheries and aquaculture sectors. Regulation (EU) 2017/1004 of the European Parliament and of the Council of 17 May 2017 on the establishment of a Union framework for the collection, management and use of data in the fisheries sector and support for scientific advice regarding the common fisheries policy and repealing Council Regulation (EC) No 199/2008 (recast). https://dcf.ec.europa.eu/wps-and-ars/work-plans_en

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