KRAFTTAG ÅL

MEASURES AND KNOWLEDGE TO PROTECT THE EUROPEAN EEL

KRAFT TAG ÅL

Energiforsk

Krafttag ål – measures and knowledge to protect the European Eel

FACTS ABOUT EELS

The natural habitat of the European eel in Sweden spans almost the entire country, with the exception of the northern and southern highlands. Today, eel stocks inland and in the north are very sparse except areas where eel have been reintroduced.

Spawning and migration
During spring the European eel spawns at a depth of a few hundred meters in the Sargasso Sea. Elver (young eels) are transported by streams to Europe's coasts. It's roughly estimated that they take between one and three years to reach the coast of Sweden. When eel's mature they embark on a six month migration back to the Sargasso Sea, where they die after spawning.

Source: The Swedish Agency for Marine and Water Management

The European Eel stock is critically endangered. The 2007 EU Eel Regulation created a National Eel Management Plan, including measures on reduced fishery, reduced turbine mortality and increased restocking of imported glass eel. The Krafttag ål[1] programme was initiated in 2011 as a result of a memorandum of understanding signed by a number of hydropower companies and the Swedish Board of Fisheries. When the Swedish Board of Fisheries was decommissioned, the Swedish Agency for Marine and Water Management assumed the role The program consisted of two parts; protective measures and research and development (R&D).

The first phase of Krafttag ål (2011-2014) comprised eight R&D projects. These projects increased knowledge concerning eel survival when passing hydro power plants. Possibilities and limitations of technical solutions for downstream migration were analysed, resulting in the development of a modelling tool, which can be used to estimate survival rates for downstream migration past any specific hydro power plant. Several projects included field studies.

The three main goals of the program during 2015-2017 were:
- To increase knowledge of hydroelectric power and eels
- To reduce the impact of hydroelectric power on eel stocks
- To increase migration of the silver eel from Swedish waters


Restocking of glass eel.
Photo: 8Fjordar

Protective measures taken during 2015-2017 resulted in:
- Restocking of 1.2 million imported quarantined glass eel on the Swedish west coast (North Sea).
- Trap and transport of about 47 000 migrating eels past hydropower stations in four rivers: Göta älv, Lagan, Ätran och Motala.

A short report in English, summarising the work from the Krafttag ål programme will be published in 2018 on Energiforsk's website. The full-text research reports are in Swedish, with English summaries.

[1.] Kraft=power, ål= eel and krafttag is similar to effort or vigorous

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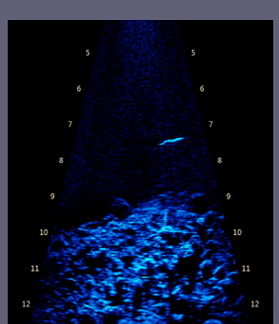
Results from R&D projects

Eel migration complete – from start to power plant passage

Project managers: Olle Calles, Karlstad University, Kjell Leonardsson, Henrik Jeuthe, Arne Fjälling and Johan Östergren, Swedish University of Agricultural Sciences

Improved knowledge on what can act as triggers for eel migration has been made possible in the project by the development of a new statistical method for analysis of behaviours triggered by changes in the environment. Applying the method on autumn river data showed that flow contributed most to the initiation of migration, but moon phase and day length also entered as significant variables. Water temperature improved the model slightly. The use of high resolution acoustic telemetry allowed for studies of eels' swimming behaviour close to the hydropower inlet. The telemetry study also showed that direct and delayed mortality for eels that passed through the turbines was comparable in magnitude. Difficulties in separating live eels from dead eels after turbine passage contributes to uncertainties in survival estimates from these types of studies. The project included an evaluation of imaging sonars as potential technology for detecting downstream migrating silver eels. This technology is thought to provide an early warning on migrating eels in real time, which could be used to adapt the management at hydropower stations. Results show that the resolution of the system tested in the Göta älv river was insufficient for indisputable identification of eels at any distance. Hence, it cannot be considered suitable as a warning system in rivers the size of Göta älv. However, sonars could be used to monitor eel migration in smaller rivers. Within the project, there were also experiments on e-DNA, environmental DNA. However, the results are not yet finalised.



Downstream passage facilities for collecting silver eel: technical challenges and improved economic efficiency

Project manager: Olle Calles, Karlstad University

The most common way of improving downstream passage conditions at hydropower plants is to use low-sloping racks to guide fish to and through bypasses. There are examples in the literature of such downstream passage facilities with a documented high passage survival for silver eels, but the examples have until now been limited to plants with an intake capacity of < 88 m3/s. It is not known to what extent the technique can be upscaled to plants with an intake capacity exceeding this. Experience from plants with low-sloping racks in Sweden was mostly positive and there was no obvious connection between the size of the plant and the experiences of maintenance and generation at plants with low-sloping racks. Nevertheless, this project showed that site-specific challenges have a significant effect on the feasibility of implementing low-sloping racks at the plants that were analysed. Still, the technique was considered applicable at one power plant in the river Motala ström, whereas the high costs and uncertainties identified for a plant in the river Göta älv revealed an important knowledge gap. Before implementing a low-sloping rack at any plant with a high dam safety rating, there is a need for improved knowledge to avoid problems resulting in unexpected costs and failures.

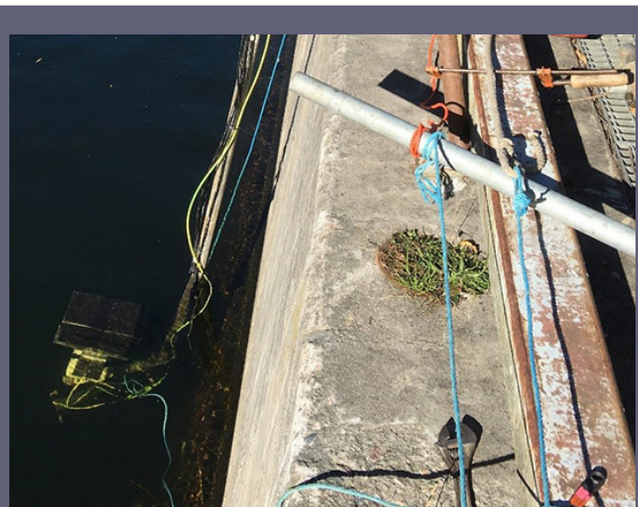
Hydro power plant in Göta älv. Photo: Norconsult

Adaptive hydropower management

Project manager: Henrik Jeuthe, Swedish University of Agricultural Sciences

Adaptive hydropower management has been proposed as a way to increase the survival rate for silver eel that pass hydropower plants on their way to the sea. A study about adaptive hydropower management and different measures and warning systems used around the world is an important part of the project.

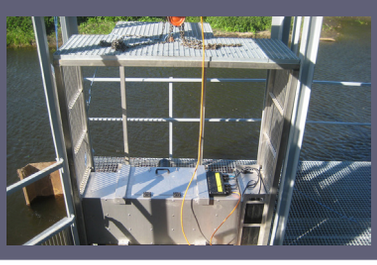
Furthermore, there has been a study on which of these proposed measures could be possible at the power plants in Göta älv and Motala ström. The study indicates that Göta älv would primarily be useful to direct the flow between different plants and to optimise the operation of the turbines in order to maximise the survival of the eels. In Motala ström, the conditions are better for stopping production entirely during migration and to let the eel pass by using spillways.



Studying eel populations and eel migration by use of fish counters

Project manager: Mats Hebrand, Fiskevårdsteknik AB

Data from seven different data collection points with fish counters, in six waterways has been analysed in order to gain knowledge on how present fish counters can be used to register the migration of eel. The analysis shows that it is possible to register mature eels in an adequate way using camera fish counters. The prerequisites are there to monitor eel populations by creating control stations that are adapted to downstream migrating eel where a majority of mature eels pass and can be counted by fish counters. The results can give valuable information about the size of the eel population in a catchment area and how this population changes during an extended period of time.



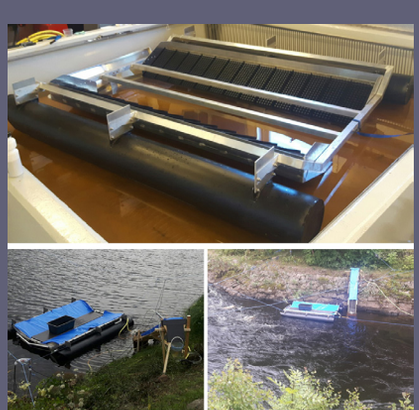
The project shows that adult eels can be successfully registered in fish counters with a camera. Photo: Fiskevårdsteknik

An alternative method for trapping juvenile eel

Project manager: Jonas Christiansson, Elghagen Fiskevård

A newly constructed floating trap for catching juvenile eel has been tested in the Ätran and Lagan rivers. The new construction has also been compared to conventional stationary traps. In every trial, the floating trap caught more juvenile eel than the conventional trap, and this is thought to make a more efficient collection of juvenile eel possible.

Trials were also conducted, where pumping trapped juvenile eel with an ejector jet was tested. The eels were pumped to a tank on land, and this method was compared to the conventional use of a ramp to collect juvenile eels. Both methods seemed to be equally gentle on the eel, as no signs of damage had appeared within 48 hours after the eels were transported.

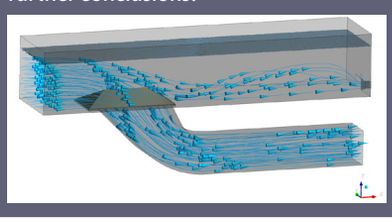


The floating trap is a gentle way to manage juvenile eel. Photo: Jonas Elghagen

Adaption of small hydropower plants to eel migration

Project manager: Anders Andersson, Luleå University of Technology

In this project, a numerical fluid-dynamics model was used to simulate a new design of a sloping intake rack, as well as how the water flow is impacted if eel passages are placed at the bottom of the spillway gate instead of at surface level. The purpose being to make downstream passages past power plants easier for eel. A number of different constructions have been simulated and the results show that spillways with a contraction, a gradually smaller intake, gives the lowest velocity gradients to the cost of a somewhat higher spillage. The velocity gradient is likely to be the limiting factor, as a large gradient might deter eels from trying to pass the power plant at all. There is a need for better knowledge concerning eel behaviour at different flow conditions and at different velocity gradients to be able to draw further conclusions.



Proposed design for downstream passage facilities.

The importance of bar spacing in low-sloping racks

Project manager: Olle Calles, Karlstad University

The purpose of this project was to study how the bar spacing in low-sloping racks impacts the guidance of eel. The hydraulic properties and problems regarding floating debris were also to be investigated. The theory was that low-sloping racks divert eels both by physical and behavioural means, which means that eels that physically could pass through the rack would not always do so..

Due to delays in construction and to reasons of animal welfare, it was decided to postpone the experiment. The plan is to conduct trials with three different bar spacings during 2018, outside Krafttag ål.

Knowledge about downstream passage solutions is limited, as a result there are uncertainties about how to design solutions that provides both good conditions for generation and safe downstream passage conditions for fish. Today there are a number of downstream passage facilities at small and mid-sized power plants, which have shown to efficiently pass eel, trout and salmon without any negative consequences for operation and safety.

The new test facility, a flume at Vattenfall laboratory. Photo: David Aldvén

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