Eel passage projects

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Photo: Jörgen Wiklund
Dekker et al. 2003

Index of juvenile eel stocks (% of 1960s-1970s)

Year


European eel
Japanese eel
American eel

Dekker et al. 2003
European eel conservation strategy (Council Regulation (EC) No 1100/2007)

National eel management plans:

- To allow with high probability that the escapement of silver eel to the sea is at least 40% of the best estimate of escapement biomass that would have existed if no anthropogenic influences had impacted the stock.

Actions of the Swedish eel management plan (2008):

1) reduction of the fishery
2) increased control measures
3) reduced turbine mortality
4) increase juvenile eel recruitment

Knowledge gaps!

- Downstream passage solutions
- Upstream passage solutions
Swedish eel projects

European eel life-cycle

- Silver eel downstream passage solutions
- Yellow eel foraging, growth & habitat use
- Elver upstream passage & habitat use
Sweden → Karlstad → Study area
Win-win solutions for hydropower and nature
- Resolving recruitment bottlenecks for the critically endangered European eel
1. Coastal river connectivity

*Do the existing upstream fish passage solutions work for juvenile eels?*
Standardized coefficient estimates (t statistics; coefficient estimates divided by the standard deviation of the estimate) received from the initial (light grey) and final (dark grey) generalized linear mixed models. The bars describe the direction and the weight of the effect from each variable on the probability of encountering an eel of ≤300 mm.

The probability of encountering an eel of $\leq 300$ mm upstream an obstacle.

1. Nature-like fishways
2. Eel ramps
3. Technical fishways
4. Dams without fishway

Nature-like  Eel ramp  Technical

2. Eel ramps
Water wetting the ramps

Attraction water

Climbing substrate

Migration barrier
Climbing substrate types

- Studded
- Open weave
- Bristle
- Substrate selection experiment
- 6 cages with triple ramps
- Over-night trials
- IR-cameras

Studded substrate
Which substrate did the eels use?

ANOVA: $F_{2,134} = 81.0$, $P < 0.001$

Why was the studded substrate the most successful one?
Field validation!
Field validation

- 6 positions
- 5 nights
- 21:45 – 00:15

Field validation

GLM: Substratum

\[ F_{2, 82} = 15, p < 0.001 \]
Field validation

GLM: North vs. South

\[(F_{1,82} = 23.5, \ p < 0.001)\]

The performance of a two-way passage facility for diadromous fish species
River Ätran Connectivity
Herting
Before 2013

© Fiskevårdsteknik AB
Herting
Before 2013
Vessigebro elver counts 2010-2012

Total catch per year (#)
Herting
After 2013

\[ Q \geq 11 \text{ m}^3/\text{s} \]

Electricity production down by 35%
**Downstream passage solution**
- Conventional rack → Low-sloping rack

**Old conventional bar rack**
1. Vertical steel bars - 90 mm
2. $\alpha = 60^\circ$
3. Surface bypass (2.0 cms)

**New angled bar rack**
1. Horizontal composite bars - 15 mm
2. $\beta = 30^\circ$
3. Full-depth bypass (0.3-3.0 cms)
The project goals

• Strengthen diadromous fish populations:
  – Atlantic salmon
  – European eel
  – Sea lamprey
The project goals

• Strengthen diadromous fish populations:
  – Atlantic salmon
  – European eel
  – Sea lamprey
  ...with contrasting life-cycles and behavior

• Evaluation of Fish Passage Solutions, before and after modifications, by quantifying:
  – Passage efficiency (rate)
  – Fish Guidance Efficiency (FGE)
  – Passage time (delay)
Methods
Silver eel results
Silver eels
Passage = 70%
Time = 0.16 h
Silver eels

Passage = 95%
Time = 24 h
**Herting survival (IPE)**

- **Salmon kelts**
  - Before: 33-80%
  - After: 96%

- **Salmon smolts**
  - Before: 90%
  - After: 91%

- **European silver eels**
  - Before: 70%
  - After: 95-100%

**Info Herting**

- Falkenberg Energi
- 40 m³/s
- 15 mm
- $\beta_H = 30^\circ$
- 1 entrance (FD)
- 0.3-2 m³/s (1-5%)
- Passage facility

Herting – Salmonid spawner count
2000-2019
Unwanted guests
Racks & the importance of bar spacing & phenotypic diversity for fish passage

Photo: Jörgen Wiklund
Specifications
- Recirculatory with jet-pumps
- Two 30 m long test arenas
  - Cross-section: 2 x 4 m
- Max velocity = 2 m/s (16 m³/s)
- Controlled light and temperature
- River water: filtered/unfiltered
Eel experiments – Inclined rack (α = 30°)

Bypass 1

Bypass 2

Bar spacing 15/30 mm

Approach velocity ≈ 0.7 m/s
Eel projects take home message

1. Elver upstream passage & habitat use
   1. Nature-like fishways most efficient FPS
   2. Eel ramps hold potential: optimize design and placement

2. Silver eel downstream passage solutions
   1. Inclined & angled racks offer efficient & timely passage + maintained electricity generation
   2. Individual variation poorly understood: mechanisms & population effects
15 PhD students on fish and hydropower

River flow regulation, fish behaviour & status

- WP1 – Fish stress & behaviour
- WP2 – Fish hydrodynamics
- WP3 – Tools & technologies
- WP4 – Fish management solutions

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Thanks for your attention!


