Designing Upstream Eel Passage at Hydroelectric Plants

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Basic Design Considerations

Locate the entrance in areas where eels congregate and have access, while considering river and eelway flows, the ability to maintain the structure, and its capability to survive in the river in this location.

- Locate where eels congregate
  - Portable traps - ramp, submerged basket trap
  - Night personnel observation
- Consider predation
- Attraction and transport flows (relatively small for eels)
- How eels move or you move them above the obstruction (dam)
- Location of discharge should be where they will not be swept back downstream
- Monitoring – live car, video
**Ramp channel** (plywood, plastic, aluminum) ~4-6” high by 8-18” wide, with movable cover; length, width dependent on site characteristics; turns and resting pools acceptable

**Trap tank & cover; polyethylene or custom-built, size depends on required capacity**

**Valve to control ramp flow**

**Padlocks if required**

**Flexible supply hose; size dependent on attraction flow volume**

**Flexible attraction water hose**

**Flexible gravity drain hose**

**Tank drain; through bottom of tank**

**Outlet strainer, commercial or construct similar; maximum 1.5 mm mesh or slit width; clean regularly**

**“Generic” Temporary Eel Ramp Pass Trap**

Design by Alex Haro, Research Ecologist (aharo@usgs.gov)

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Entrance generally located in areas of low flow and at highest elevation

Portable Ramp Trap

Useful for locating eels prior to building permanent eel passage
Substrate/Slope

• Surface tension will allow smaller eels to climb vertical surfaces.
• Generally accepted max slope is 40 degrees (83%) but eel ramps have worked at greater slopes.
• Steeper slope and large eels require substrate with greater projections.
• If there is a great size variation of eels at the same site different substrate sizes may be required.
• Some typical types of substrate:
  - Pegs - Milieu, Akwadrain, Pipes, Studliner
  - Mesh - Enkamat
  - Brush
  - Gravels, sand, sticks and stones
Milieu Peg
Multiple Substrates

Enkamat

Studliner
Brush
Predation

- Have seen predation from birds, mink, muskrat, pelicans, fish
- Cover eelway to limit predation
- Covers have benefit of giving a longer period of movement (not just night)
- Exclusion mesh
Water

- More water is required in the immediate area to attract eels to an entrance area (50 gpm)
- Takes little water to wet transport substrate (1-2 gpm)
- Eels have been seen going through damp grass around a dam
Eel Ramp with Ram Pump
Transport Water From Below Eelway Crest
Types of Upstream Eel Ramps

• Gravity Flow
• Gravity Flow with Trap
• Pumped Flow with Trap and/or Sluice to Headpond
• Lifts
Gravity Flow Ramp to Exit in Headpond

• Requires control of headpond or means to compensate for headwater variation

• Types
  - V shaped for headwater changes. If there is a 45 degree lateral slope the effective head range is approximately 2’.
  - Brush on wall
  - Substrate on dam
Examples of installation of the prototype bristle board eel pass.

Example 1: Frog Mill on the River Hamble (Southern region). NGR SU 5222 1491

4.12 Downstream view of pass installation at Frog Mill, River Hamble (NGR: 5222 1491). Note the area of slack water on left for elver and eel to enter pass.

Figure 4.13: Installed pass, showing brackets and fixings
Gravity Flow Trap Eelway

• Gravity flow provides attraction and transport
• Can’t provide unattended passage above dam
• Requires a holding trap. Periodically, eels must be removed from the trap and released above the dam or in a preferred location.
Combined Eelway / Trap

Gravity (or Pumped) Attraction / Transport Water

Ramp with Two Substrates

Trap
Trap & Eel Ramp Raised
Pumped Water – Trap/Sluice

- Allows eels egress over the dam
- May go into a trap, then sluice into headpond
- Use of trap facilitates enumeration
Sample Eel Ramps
Sample Eel Ramp
Useful where site geometry prohibits a straight ramp.
Eel Lifts

- Become cost effective at over 20’ of head or when there are special conditions
- Requires power
Site Downstream of Spill Gate
Schematic of Eel Lift

Guide Wires
Hoist
Hopper Dumping
Holding Tank

Hoist Cable

Hopper with Integral Ramp
65’ Lift – No Guide Rails

Hopper Discharge

Fishing Location

Access Ramps

Pumped Water Supply

Sluice To Headpond
Raising Hopper
Rail Type Skip Hoist 45’ Lift

- Discharge Point
- Hopper Traveling Up Rails
- Access Ramps
Summary Design of Typical Eelway

- Pole shows general slope of eel ramp
- Eel entrance at high area out of main flow
3D CAD Model Development

- Matches eel ramp to site geometry
- Ensures eel ramp can meet specifications
- Ensures all parties are in agreement with design
Eel Ramp Overview
Maintain Submerged Ramp Entrance

- Entrance Pool
- Attraction Water
Turnpool
Spraybar at Turnpool

Spraybar Ensures Even Flow Downstream of Turn Pool

Valve for Attraction Water
Eel Collection Tank

- Attraction Water Hose
- Valve For Flushing
- Discharge To Headpond
- Hose From Pump
- Eel Collection Tank
Exit Area with Spraybar

Valved Spraybar

Overshot Style Spraybar
Tank Overflow To Scent Line

Valve to Scent Line

Tank Level Control

Scent Line To Ramp
Drain To Headpond In Collection Tank
Resources:
The following papers offer detailed upstream eel passage designs. These papers are available on the internet.

Manual for provision of upstream migration facilities for Eel and Elver
Science Report SC020075/SR2

Elver and eel passes
A guide to the design and implementation of passage solutions at weirs, tidal gates and sluices
The Eel Manual— GEH0021/BTMIV-E-E