Jun 19th, 3:30 PM - 3:50 PM

**SNIFFER with ICE: a taster of barrier assessment issues**

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SNIFFER with ICE:
a taster of barrier assessment issues

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Inland Fisheries Ireland

Inland Fisheries Ireland is the statutory agency responsible for inland fisheries in Ireland.

Mission Statement: “To ensure that the valuable natural resources of inland fisheries and sea angling are conserved, managed, developed and promoted in their own right to generate positive return for the community and the environment.”
Barriers & Fish

A physical, permanent structure that hinders or prevents fish migration up- or downstream

• Habitat fragmentation
• Habitat degradation
DRIVERS for change – European Directives

- **Habitats Directive (Species protection in SAC)**
  - Salmon (smolts, adults)
  - Shad (Twaite & Allis)
  - Lamprey (River, Sea, Brook)

- **Water Framework Directive** - River connectivity a central theme

- **EU Eel Regulations** - Eel (glass eel, yellow eel, silver eel)
Atlantic salmon
Sea lamprey
Irish Barriers: the usual man-made collection.....
Bridge Floors & Aprons
Weirs
Culverts
Fords
Hydroschemes.....
Sluices
Irish Barriers: The extent of the problem - contributing to European Atlas of Barriers in AMBER project
Mean barrier height **1.05m** (n=703, **barriers <10metres**)

(Excluded: 9 structures >10m)
IFI 2-stage barriers strategy

• Level I surveys – putting spots on maps (desk and field protocol to generate GIS layer of barriers in Irish rivers

• Level 2 surveys – use SNIFFER at barriers where modifications are proposed – enables comparison of pre- and post-works passability
IFI Barrier recording Level 1: IFI Tablet

• On-site Data collection via ruggedized laptops loaded with Geofield™ software.

• GPS recording

• Built-in camera

• Drop-down menus for data capture
### Roughness of structure
- Smooth
- Rough
- Very Rough

### Slope through structure
- Vertical
- Steep ~45°
- Moderate ~30°
- Gentle ~15°

### Size information (Bridge or culvert)
- Width (m) - C/BW:
- Length (m) - C/BL:
- U/S Apron Length (m) (if present) - UAL:
- D/S Apron Length (m) (if present) - DAL:
- Drop Height (m) - DH:
- D/S Depth (m) - DD:
- Plunge Pool Depth (m) - PPD:
- Depth (m) (water through structure) - D:
- Channel Width (m):

### Size information (Weirs, waterfalls etc.)
- Barrier Length (m) - BL:
- Barrier Depth (m) - BD:
- D/S Apron Length (m) (if present) - DAX:
- D/S Apron Height (m) - DX:
- Drop Height (m) - DH:
- D/S Depth (m) - DD:
- Plunge Pool Depth (m) - PPD:
- Sill Length (m) (measured on the horizontal) - SL:
- Channel Width (m):
## Risk Posed by Structure to Particular Fish Species

<table>
<thead>
<tr>
<th>Species</th>
<th>Impassable</th>
<th>High</th>
<th>Moderate</th>
<th>Low</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmon (adult)</td>
<td>Impassable</td>
<td>High</td>
<td>Moderate</td>
<td>Low</td>
<td>None</td>
</tr>
<tr>
<td>Salmon (smolt-downstream)</td>
<td>Impassable</td>
<td>High</td>
<td>Moderate</td>
<td>Low</td>
<td>None</td>
</tr>
<tr>
<td>Eel (adult downstream)</td>
<td>Impassable</td>
<td>High</td>
<td>Moderate</td>
<td>Low</td>
<td>None</td>
</tr>
<tr>
<td>Eel (elver)</td>
<td>Impassable</td>
<td>High</td>
<td>Moderate</td>
<td>Low</td>
<td>None</td>
</tr>
<tr>
<td>Shad</td>
<td>Impassable</td>
<td>High</td>
<td>Moderate</td>
<td>Low</td>
<td>None</td>
</tr>
<tr>
<td>Sea Lamprey</td>
<td>Impassable</td>
<td>High</td>
<td>Moderate</td>
<td>Low</td>
<td>None</td>
</tr>
<tr>
<td>River Lamprey</td>
<td>Impassable</td>
<td>High</td>
<td>Moderate</td>
<td>Low</td>
<td>None</td>
</tr>
<tr>
<td>Brown Trout</td>
<td>Impassable</td>
<td>High</td>
<td>Moderate</td>
<td>Low</td>
<td>None</td>
</tr>
<tr>
<td>Pike</td>
<td>Impassable</td>
<td>High</td>
<td>Moderate</td>
<td>Low</td>
<td>None</td>
</tr>
<tr>
<td>Cyprinids</td>
<td>Impassable</td>
<td>High</td>
<td>Moderate</td>
<td>Low</td>
<td>None</td>
</tr>
</tbody>
</table>
IFI Case study: Barrow catchment (3,100 km²)

Barriers recorded to date
N=233
- 126 bridges
- 42 weirs
- 22 locks
- 21 (sluice/mill/structure
- 11 culverts
- 11 fords
River Barrow Barriers....
IFI Barrier surveys Level 2:– SNIFFER (UK)

Field survey
• Examine each ‘transversal’ or possible crossing point
• Discrete set of measurements
• Detailed D and V measurements
• Qualitative observations

Desk wrap-up
✓ Reference to Tables
✓ Final score
Clondulane Weir: Hydraulic Head 2.6 m
SNIFFER barrier passability survey September 2014

Complete Barrier

Partial Barrier High Impact

Partial Barrier High Impact

Complete Barrier
IFI Barrier surveys Level 2: ICE (Fr)

Field survey
• Examine each ‘transversal’
• Discrete set of measurements
• Detailed D and V measurements....NON
• Qualitative observations...NON

Desk wrap-up
ī Reference to Protocol
ī Final score
Barrier Scoring System (SNIFTER & ICE)

\[
\begin{align*}
\ddot{y} &= 0 = \text{Total barrier} \\
\ddot{y} &= 0.3 = \text{High impact partial barrier} \\
\ddot{y} &= 0.6 = \text{Medium impact partial barrier} \\
\ddot{y} &= 1 = \text{Low impact passable barrier}
\end{align*}
\]
SNIFFER V ICE
Measurements required

<table>
<thead>
<tr>
<th>Measurement</th>
<th>SNIFFER</th>
<th>ICE</th>
<th>IFI Level I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drop height</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Slope</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Depth through structure</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Plunge pool depth</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Velocity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turbulence (OPINION)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standing wave (OPINION)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Turbulence and Standing wave are based on opinion.

[Diagram of measurement setup]

Hydraulic head (H) / effective length (L) in Slope. Express as percentage (%) e.g., 0.5m hydraulic head (height gain) over a 10 m effective length would be (0.5/10)*100 = 5% slope.

[Diagram of water velocities: bed and 0.5 depth]
SNIFFER: Measure D and V at inlet, mid-point and outlet. Drop height. Plunge pool, turbulence, lip, standing wave.

ICE: Drop height, Depth through structure, Slope, Plunge pool
Intercalibration of SNIFFER and ICE: % Score Agreements between protocols

<table>
<thead>
<tr>
<th>Species</th>
<th>Agree</th>
<th>Don’t</th>
<th>Total Transversals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult salmon (55-100cm)</td>
<td>53.3</td>
<td>46.7</td>
<td>60</td>
</tr>
<tr>
<td>Adult Lamprey</td>
<td>60.3</td>
<td>39.7</td>
<td>58</td>
</tr>
</tbody>
</table>
Adult salmon score differences between protocols

Salmon (SNIFFER 0)

Salmon (SNIFFER 0.3)

Salmon (SNIFFER 0.6)

Salmon (SNIFFER 1)
Sea Lamprey score differences between protocols

Sea Lamprey (SNIFFER 0.3)

Sea Lamprey (SNIFFER 0.6)

Sea Lamprey (SNIFFER 1)
## Threshold depths for swimming

<table>
<thead>
<tr>
<th>Species</th>
<th>ICE_min_depth m</th>
<th>SNIFFER_min_depth m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult Salmon (55-100cm)</td>
<td>0.2</td>
<td>≤ 0.07</td>
</tr>
<tr>
<td>Salmon Trout (25-55cm)</td>
<td>0.2</td>
<td>≤ 0.05</td>
</tr>
<tr>
<td>Juvenile salmonids (&lt;25cm)</td>
<td>0.1</td>
<td>≤ 0.03m</td>
</tr>
<tr>
<td>Adult Lamprey</td>
<td>0.05</td>
<td>≤ 0.03m</td>
</tr>
</tbody>
</table>

Reasons for differences...

Weir slope
water depth
0.10 m...

Adult salmon:
SNIFFER= 0.3
ICE = 0
Reasons for differences...

**Velocity**

- SNIFTER assessment requires velocity readings

  ![velocity diagram](image)

- ICE does not. Velocity outcome is based on modelled flow over slope in conjunction with swimming capabilities of fish

- Sometimes ICE can miss funnelling effect (velocities too high for fish to actively swim through)
 Reasons for differences...

**SNIFTER:** Subjective element can significantly affect passability scores

- **Turbulence:** Entrained air and chaotic flows associated with high water velocities and plunging flows at riverine obstacles.
- **Standing wave:** Problems for fish passage by causing them to become disoriented and water velocities can exceed swimming capacity.
So now.....added value

• Level 1 data – option to generate ICE scores
  .....leads to **OBJECTIVE** assessment of fish
  passage, complementing ‘expert opinion’

• Linking with University of Southampton -
  AMBER project partner - on this one