The effect of restocking Danish waters with a focus on Roskilde Fjord.

Michael Ingemann Pedersen
Section of Freshwater Fish and Ecology
DTU Aqua
Outline

1) Status of the eel stock in Denmark
2) History of stocking
3) Main conclusions from stocking studies
4) The effect of stocking Roskilde Fjord
Status of the Danish eel stock

Harte Hydropower

Yellow eel (kg)

Tange Hydropower

Yellow eel (kg)

Vester Vedsted Brook

Yellow eel density

Fisheries catch 1920-2011

Monitoring sites

Catch (ton)

Historic catches of glass and yellow eel for restocking.
Present stocking

- Import of glass eel ongrown to 3-5 gram before stocking.

- Funded by the recreational fisherman licence fee and from 2010 the European Fisheries Fund by 50%.

- What is the effect of stocking?
Main conclusions from restocking experiments

Streams


Spreading the eels at time of stocking increased survival.


Growth was the same for both types of eel but mortality was much higher for the cultured eel.


No growth and high mortality/migration.
Main conclusions from restocking experiments

Lake


Good growth and high survival (stocking large eel, 30 g) – good eel habitat!

Marine


Growth and sex were comparable to the wild eel population but recapture rates were small except in a semiclosed fjord (salinity =0).

Pedersen M.I. 2010. **Effect of eel stocking in Roskilde Fjord**. (In Danish) DTU Aqua-repport nr. 230-2010
Effect of restocking a marine area with on grown glass eel

Material and method

• The seed stock used was glass eels imported from France on grown in heated culture to a size of 3 and 9 gram before stocked in a marine fjord (12-18 ppt).

• A total of 100,000 eels were Coded Wire Tagged and released in the year 1998 and 1999 (Figures 1,2).

• In collaboration with recreational- and professional fishermen on the fjord catches were examined for tagged eel during the years 2000-2006 (Figures 3,4).

Figure 1: Study site, Roskilde Fjord, Denmark

Figure 2: The coded wire tag was inserted in the flesh. Tag retention rate was minimum 97 %.

Figure 3. Fisherman weighing the catch before examination for tags.

Figure 4. Professional and recreational landings were checked for CW tagged eel, using a tunnel CWT detector (North West Marine Technology).
Results

**Growth, sex and size**

During 2000 - 2006 a total of 1834 tagged eel size (35 – 55 cm) were recaptured.

Growth increment was 3 - 7 cm annually.

Sex ratio was 63 % females.

Fishing intensity on the fjord was high (F > 1) and therefore most eels were captured before they reached the size of 40-45 cm and in consequence female silver eels were rare.
Yellow eel migrations

The stocked eel stayed in the vicinity of the stocking area, but with time dispersed into other parts of the fjord. (Figures 5, 6)

Sr/ca analyses of otoliths from 28 specimen indicated that the stocked eels spend the entire feeding stage in the marine area. (Figures 7, 8)

**Figure 5:** Stocking site (green area) in the bottom of Roskilde Fjord

**Figure 6:** Frequency of tagged eel in any sample was higher in the stocked area (green) than any other area of the fjord.

**Figure 7:** Sr/Ca analyses. Example of one eel stocked in 1998 at size 19 cm recaptured at size 50.5 cm in 2005.

**Figure 8:** Sr/Ca analyse. Freshwater Lake Rugård. Eel stocked at size ca. 13 cm released in 1999 recaptured at size 35 cm in 2005.
**Silver eel migration**

- Silver eels of wild and stocked origin were Carlin-tagged and released in the bottom of the fjord. The fishermen were given a reward for returning Carlin-tags with information on recapture site and date.

- **Results**
  - The recapture rate of wild eels was higher compared to the stocked eels.
  - The wild eels were captured faster than the stocked eel.
  - Independent of eel origin (wild or stocked), both eel types were caught in the southern part of the fjord and in the northern part of the fjord.

<table>
<thead>
<tr>
<th>Year</th>
<th>Batch</th>
<th>Carlin tagged</th>
<th>Total recapture</th>
<th>Days until recapture</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>N</td>
<td>n</td>
<td>n</td>
</tr>
<tr>
<td>2004+5</td>
<td>Stocked</td>
<td>143</td>
<td>27 (19%)</td>
<td>22,9 (9-23)</td>
</tr>
<tr>
<td>2004+5</td>
<td>Wild</td>
<td>450</td>
<td>122 (28%)</td>
<td>19,0 (2-51)</td>
</tr>
</tbody>
</table>

- Table 1. Carlin tagged eel recaptured in Roskilde fjord.

**Figure 8.** Map of Roskilde fjord, showing release and recapture sites of Carlin tagged silver eel.

**Figure 9.** Eel with Carlin tag
Fisheries yield

• During the years 2002-2006 we examined 19 % (7.2 ton) of the commercial reported eel catch on the fjord.

• Extrapolation to the total reported catch suggested that 10.3 % of the cohort of 3 g eel were recaptured by the professional fishery.

• Three % percent was estimated captured by the recreational fishery (# recreational gear)

• A cohort analyses suggested that 5 % left the fjord as silver eels.

<table>
<thead>
<tr>
<th>Year</th>
<th>Landing</th>
<th>Examined</th>
<th>Recapture s tagged</th>
<th>Professional landings (number)</th>
<th>Large (9 gram)</th>
<th>Small (3 gram)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(kg)</td>
<td>(kg)</td>
<td>%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>12052</td>
<td>25</td>
<td>2.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td>9331</td>
<td>220</td>
<td>1.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td>9844</td>
<td>928</td>
<td>3</td>
<td>1389</td>
<td>1587</td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td>7659</td>
<td>1231</td>
<td>2.8</td>
<td>836</td>
<td>1304</td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>5524</td>
<td>2216</td>
<td>2.6</td>
<td>546</td>
<td>931</td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td>7663</td>
<td>1260</td>
<td>1.9</td>
<td>444</td>
<td>1075</td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>7613</td>
<td>1523</td>
<td>0.4</td>
<td>99</td>
<td>158</td>
<td></td>
</tr>
<tr>
<td>I alt</td>
<td>59686</td>
<td>7157</td>
<td>3313</td>
<td>5055</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| % recaptures | 6.8 | 10.3 |

I Tabel : Landing statistics of professional fishermen (http://webfd.fd.dk/) and recaptures of tagged “large” og “small” stocked eel.
Conclusion

- Stocked cultured eels seem not different from wild eels with respect to growth rate and sex ratio.

- The overall effect of stocking Roskilde Fjord with a cohort of 3 gram eel is a minimum survival of 18% (capture and escapement) the remaining 82% is the accumulated natural mortality in the fjord.

- The stocked eel migrate toward the opening of the fjord, as do the wild eels. No tagged silver eel were reported captured outside Roskilde Fjord.
Thank you for your attention!