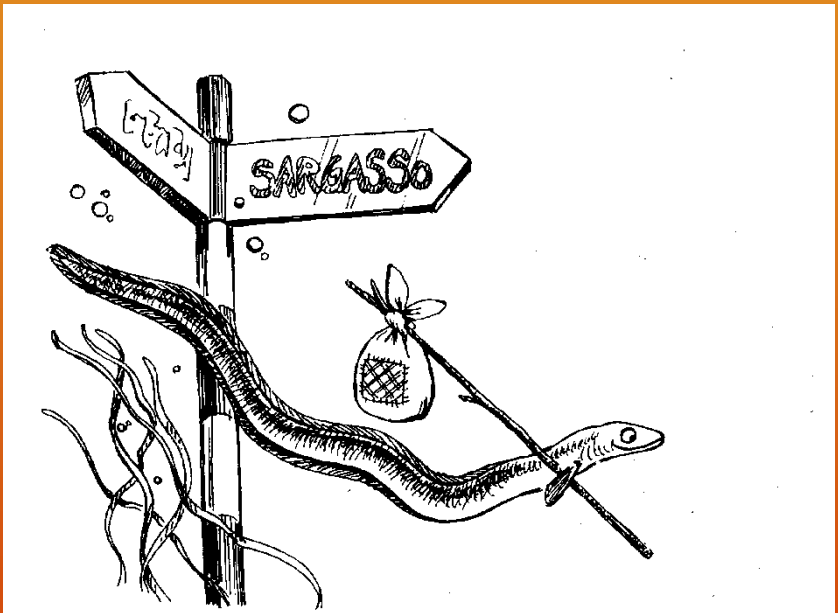
The effect of restocking Danish waters with a focus on Roskilde Fjord.



Michael Ingemann Pedersen
Section of Freshwater Fish and Ecology
DTU Aqua

Outline

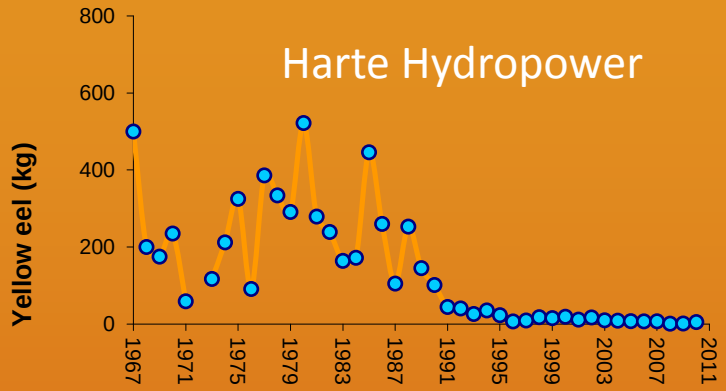
1) Status of the eel stock in Denmark

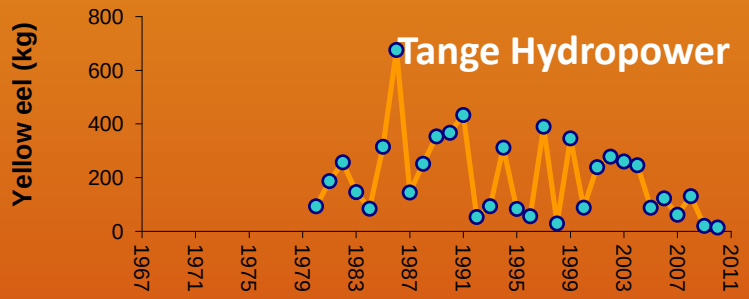
2) History of stocking

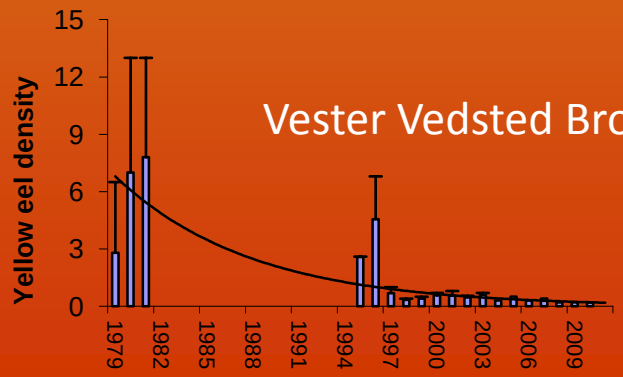
3) Main conclusions from stocking studies

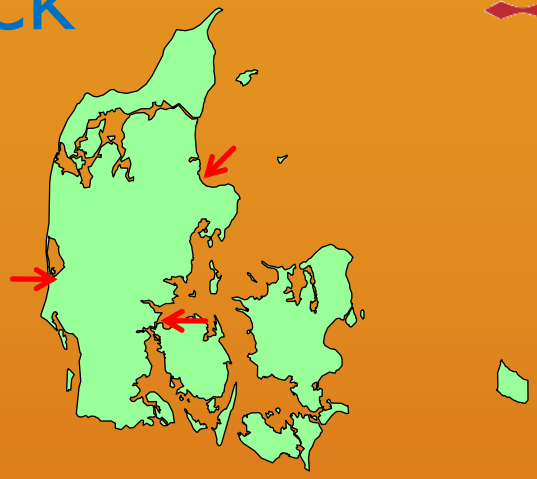
4) The effect of stocking Roskilde Fjord

Status of the Danish eel stock



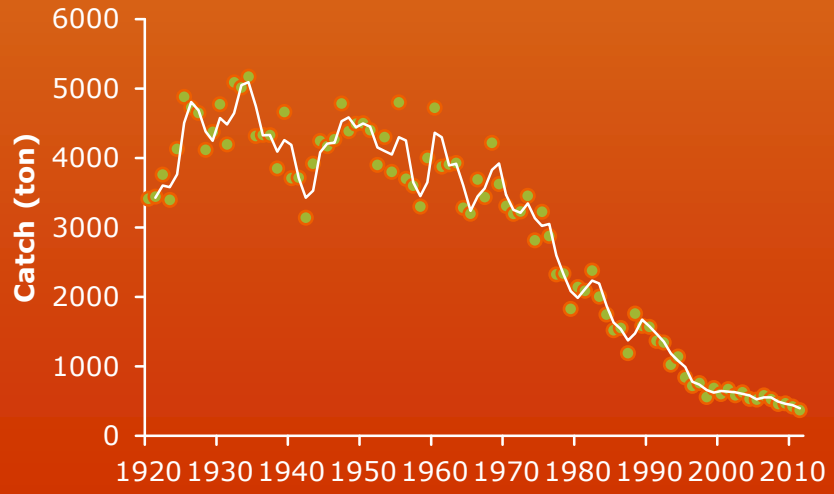






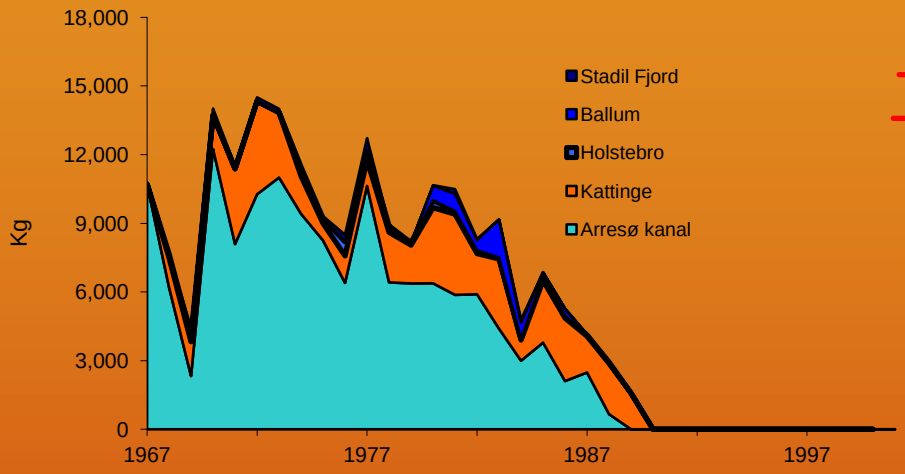
Monitoring sites

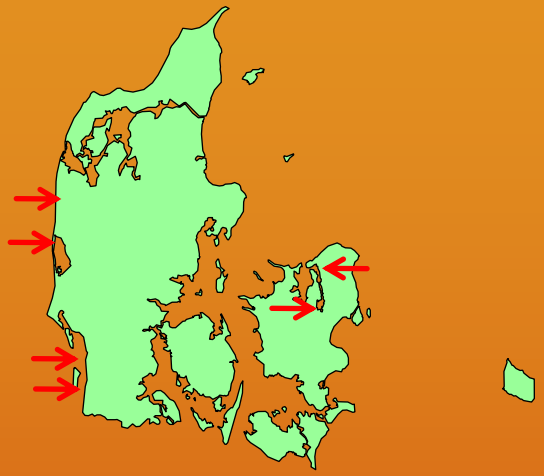
Fisheries catch 1920-2011



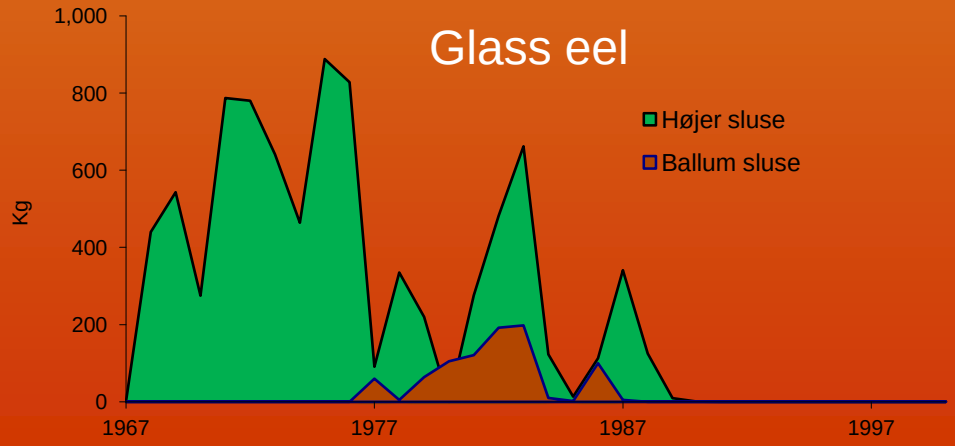
Historic catches of glass and yellow eel for restocking.

Yellow eel



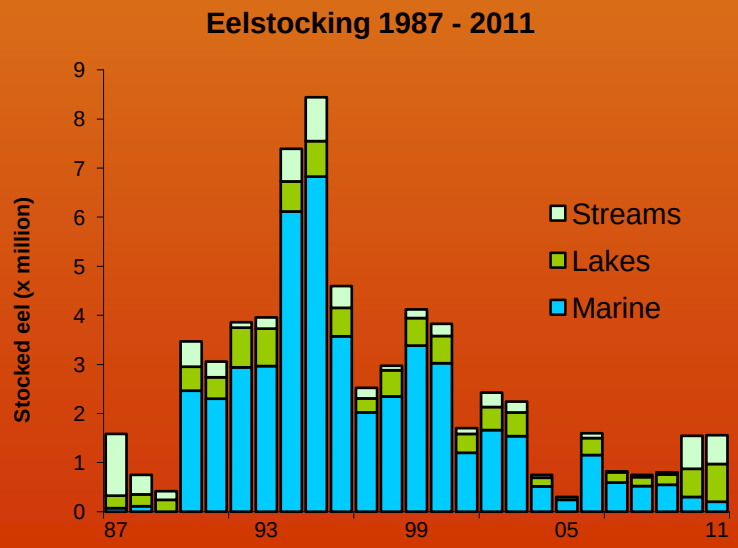


Glass eel



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

Berg S. & J. Jørgensen, 1994: Stocking experiments with O+ eels (Anguilla anguilla L.) in danish streams: **post stocking movements, densities and mortality**: In Rehabilitation of Freshwater Fisheries. Ed. by I.G Cowx. Fishing News Books. University of Hull, U.K. ISBN 0-85238-195-6.

Spreading the eels at time of stocking increased survival.

Bisgaard J. & M.I Pedersen, 1991: **Mortality and growth** of **wild** and **introduced cultured eels** (Anguilla anguilla (L)) in a Danish stream, with special reference to a **new tagging technique**, DANA, vol 9, pp. 57-69.

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

Pedersen M.I. 2009. **Does Stocking of Danish Lowland Streams with Elvers Increase European Eel Populations**? Amrican Fisheries Society Symposium 58: 149 -156, 2009.

No growth and high mortality/migration.

Main conclusions from restocking experiments

Lake

Pedersen M. I. 2000. Long-term estimate of **survival and growth of stocked eels** Anguilla anguilla (L.) in a small eutrophic Danish Lake. DANA Vol.12 pp. 71-76.

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

Marine

Pedersen M. I. 1998. **Recapture rate, growth and sex** of stocked cultured eels *Anguilla anguilla (L.)*.
Bull. Fr. Peche. Piscic. 349: 153 – 162.

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).

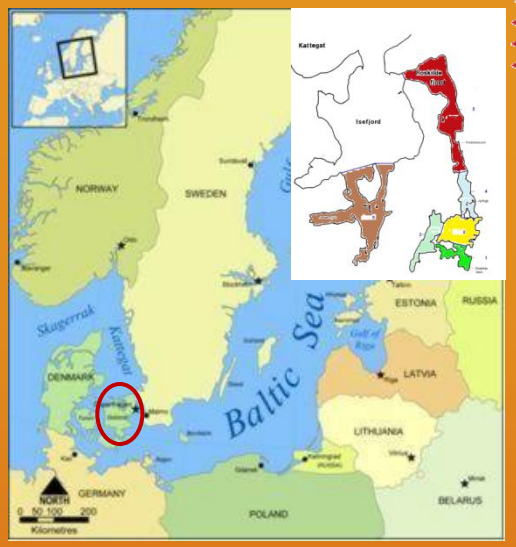


Figure 1: Study site, Roskilde Fjord, Denmark

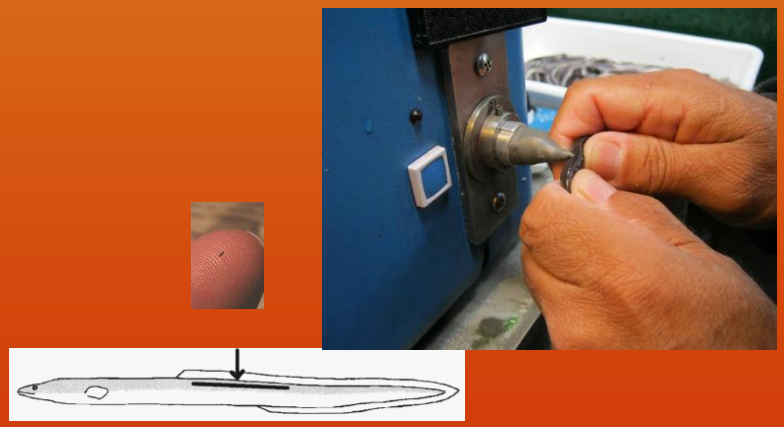


Figure 2: The coded wire tag was inserted in the flesh. Tag retention rate was minimum 97 %.

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

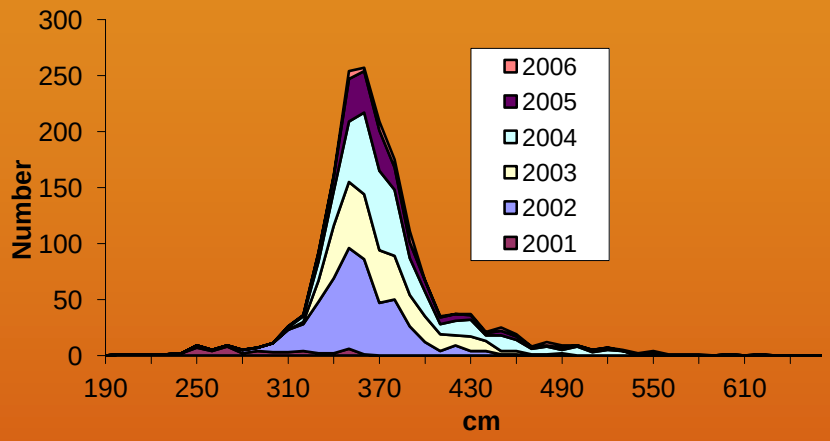
During 2000 - 2006 a total of 1834 tagged eel size (35 – 55 cm) were recaptured.

Growth increment was 3 - 7 cm annually.

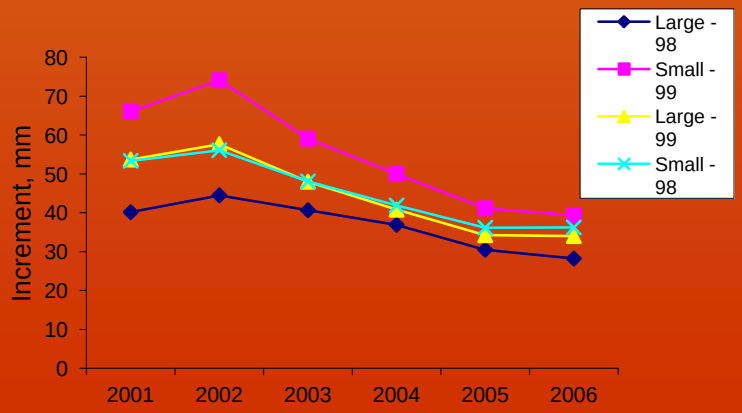
Sex ratio was 63 % females.

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.

Size distribution



Annual growth increment



Sex ratio

	Males (%)	Females (%)	Sex not identified # (%)	Total
Yellow	301(33 %)	519(63 %)	90 (11 %)	910
Silver	751(98 %)	12 (2 %)	0	753
Total	1042	531	90	1663

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)

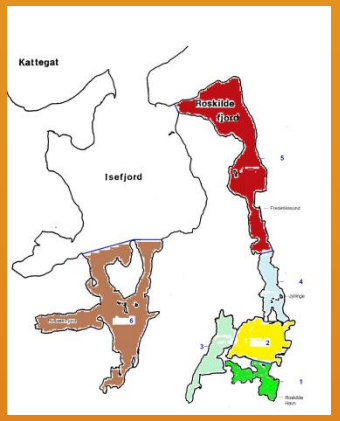


Figure 5: Stocking site (green area) in the bottom of Roskilde Fjord

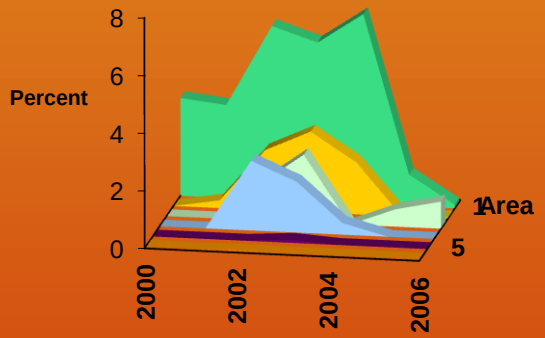


Figure 6: Frequency of tagged eel in any sample was higher in the stocked area (green) than any other area of the fjord.

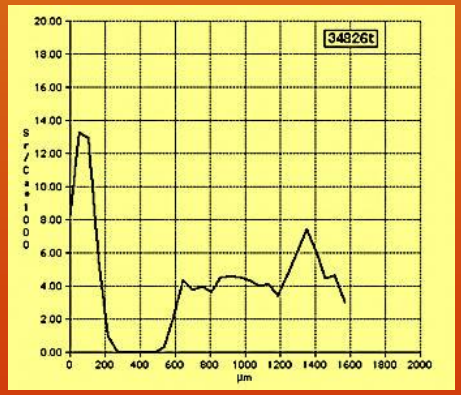
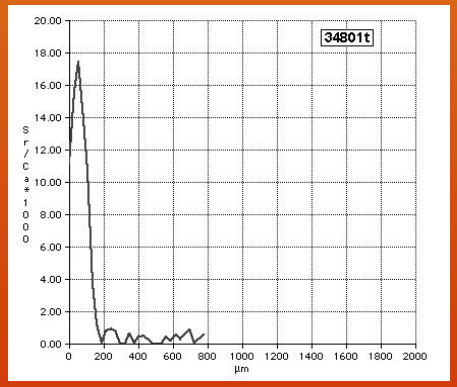


Figure 7: Sr/Ca analyses. Example of one eel stocked in 1998 at size 19 cm recaptured at size 50.5 cm in 2005.



Figur 8: Sr/Ca analyse. Freshawater 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 was 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 were 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.

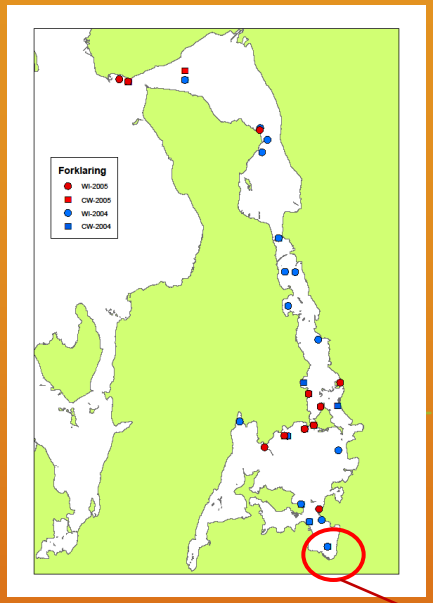


Figure 8. Map of Roskilde fjord, showing release and recapture sites of Carlin tagged silver eel.

Year	Batch	Carlin tagged	Total recapture	Days until recapture
		N	**n**	n
2004+5	Stocked	143	27 (19%)	22,9 (9-23)
2004+5	Wild	450	122 (28%)	19,0 (2-51)

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

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.

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