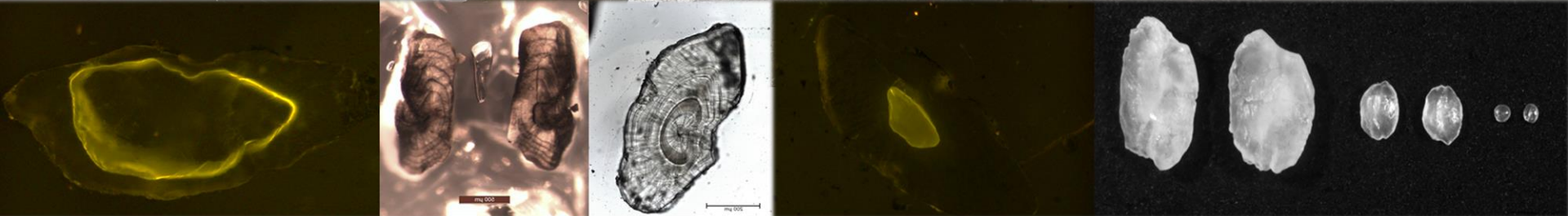




Well-intentioned, but ... Lessons learned from European eel stocking measures

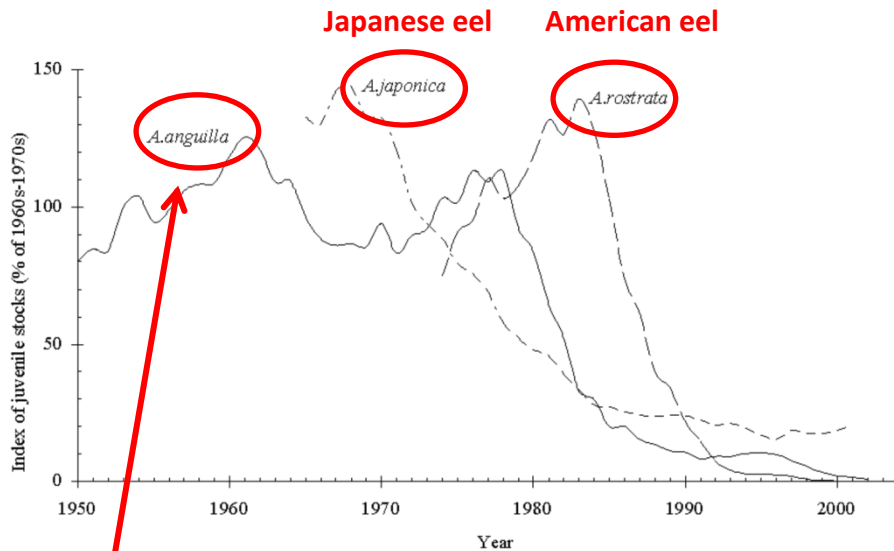
by

Björn Kullmann & Ralf Thiel



Worldwide recruitment decline

Glass eels recruitment decline



Québec Declaration of Concern. (2003). *Fisheries*, 28(12), 28-30.

European eel

- Conservation status is critical (IUCN Red List „Critically endangered“)
- Strict trade regulation (CITES Annex II listing in 2010)

EU-wide management since 2007* „Eel regulation“

Recovery



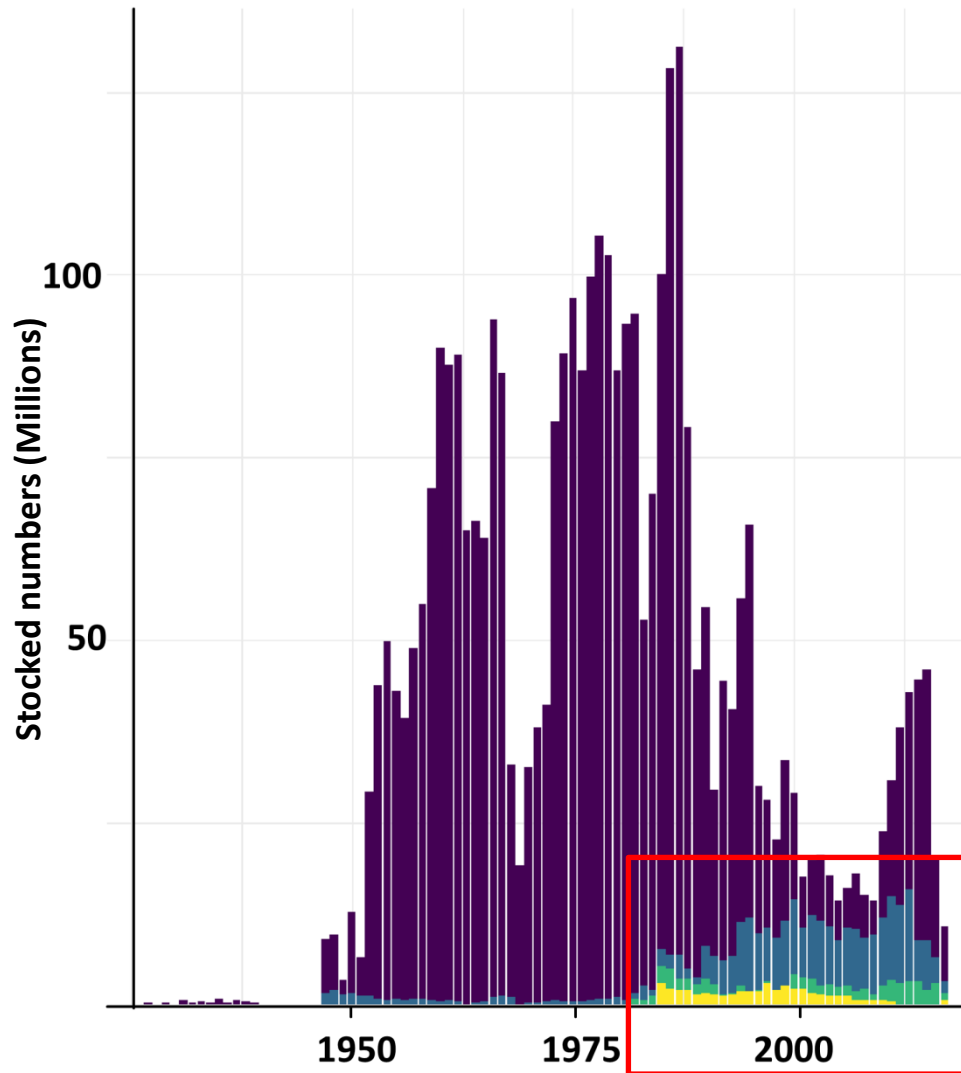
Sustainable use

Stocking measures



*EC NO 1100/ 2007; <http://eur-lex.europa.eu/LexUriServ/LexUr iServ.do?uri=OJ:L:2007:248:0017:0023:EN:PDF>

That's not a new concept ...



A high stocking effort ...

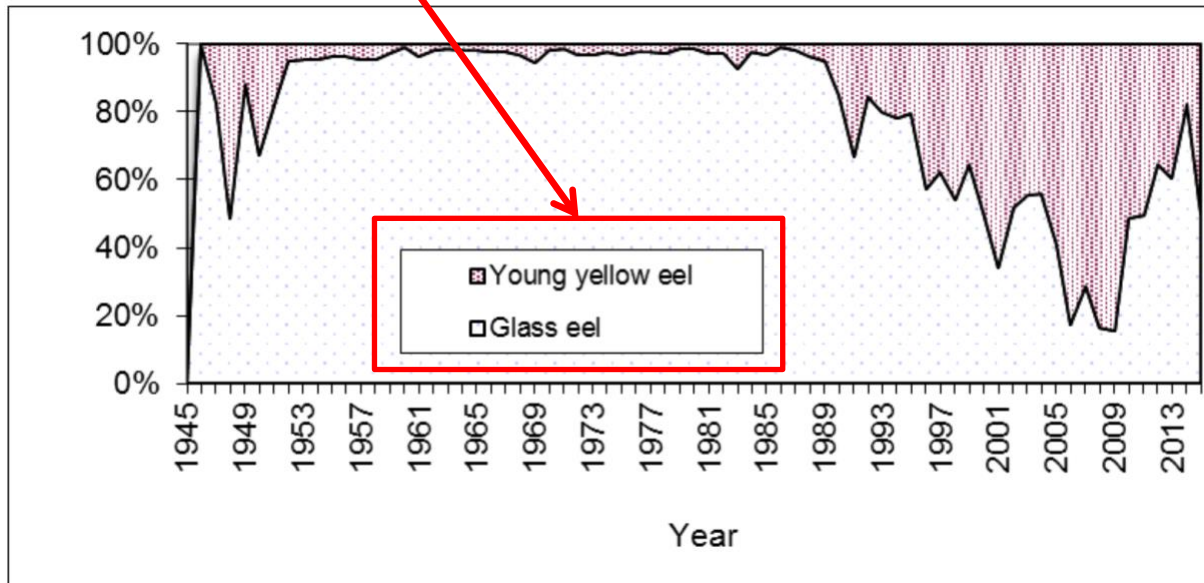
Still a lack of recovery



How to increase the outcome of eel stocking measures?

Diversification

Glass vs farmed eels



ICES WGEEL (2016) ICES CM 2015/ACOM:18, 130 pp.

→ Growth performance

→ Benefit cost ratio

Is bigger better in eel stocking measures?

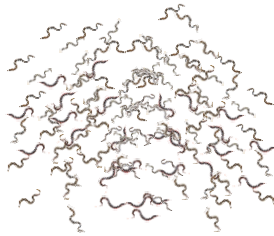


50/50

Glass eels

6-7 cm

117 kg



approx. 351 000 individuals

vs

Farmed eels

15-20 cm

1040 kg

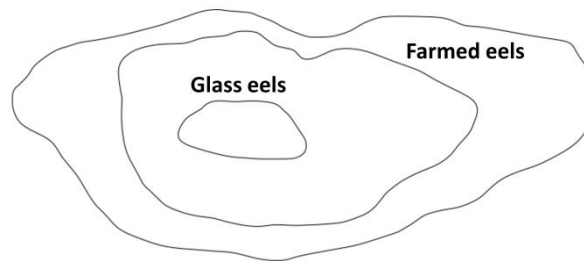
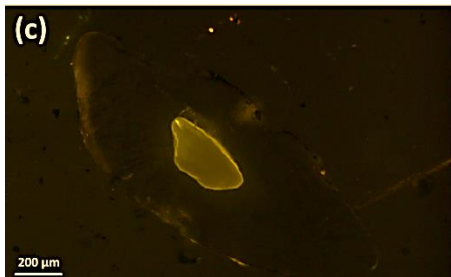


approx. 156 000 individuals

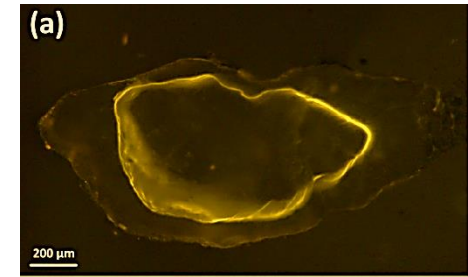
Numerical proportion

2.3 : 1

Alizarin red S



Alizarin red S



Kullmann, B., Hempel, M., & Thiel, R. (2018). *Journal of Fish Biology*, 92(1), 203–213.

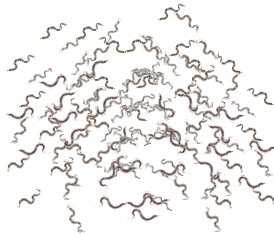
Kullmann, B., Neukamm, R., & Thiel, R. (2017). *Journal of Applied Ichthyology*, 33(5), 914–917.



Glass eels

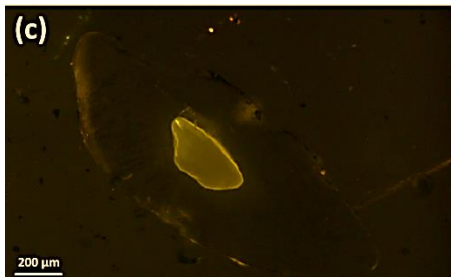
6-7 cm

117 kg



approx. 351 000 individuals

Alizarin red S



50/50

vs

Numerical proportion

2.3 : 1



Farmed eels

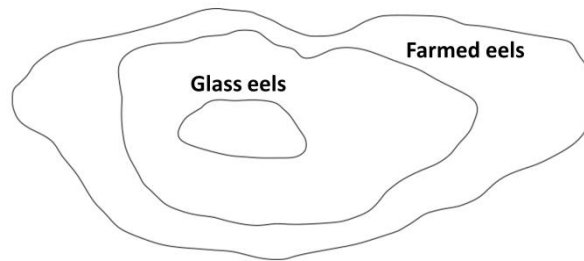
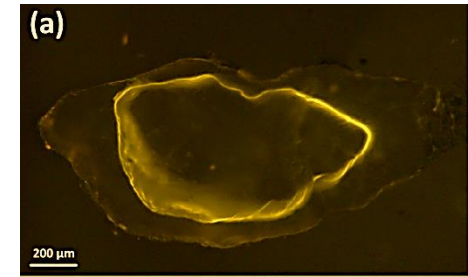
15-20 cm

1040 kg



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Alizarin red S



Kullmann, B., Hempel, M., & Thiel, R. (2018). *Journal of Fish Biology*, 92(1), 203–213.

Kullmann, B., Neukamm, R., & Thiel, R. (2017). *Journal of Applied Ichthyology*, 33(5), 914–917.

Mass-marking



Up to 1100 kg of farmed eels at once is a challenging task



Recommendations:

- concentration of 0.15 g ARS L⁻¹
- 3 h for glass eels 9 h for farmed eels
- **Use fully drainable tanks!**



More details can be found here:

Kullmann, B., Neukamm, R., & Thiel, R. (2017). *Journal of Applied Ichthyology*, 33(5), 914–917.

Kullmann, B., Hempel, M., & Thiel, R. (2018). *Journal of Fish Biology*, 92(1), 203–213.

Kullmann, B. & Thiel, R. (unpublished) The chemical marking of eels – state of the art and application perspectives. Eels 'Science into Management' 5m Publishing.

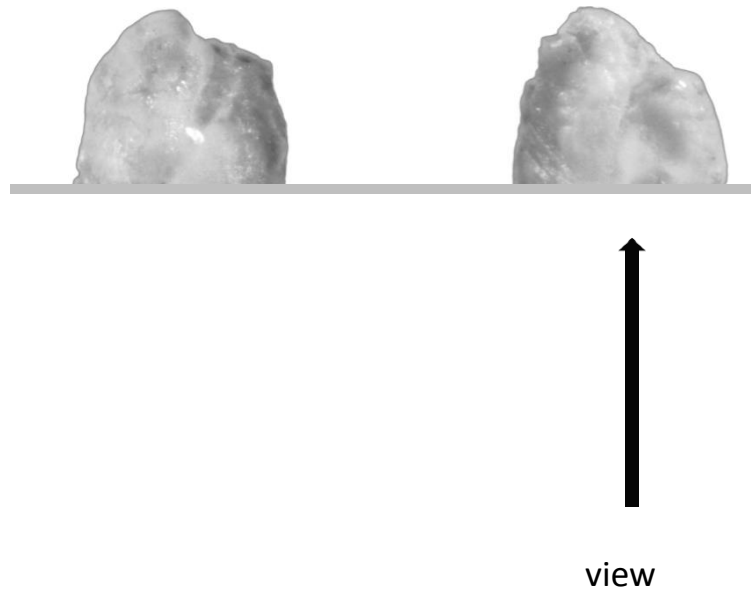
Mark detection



view

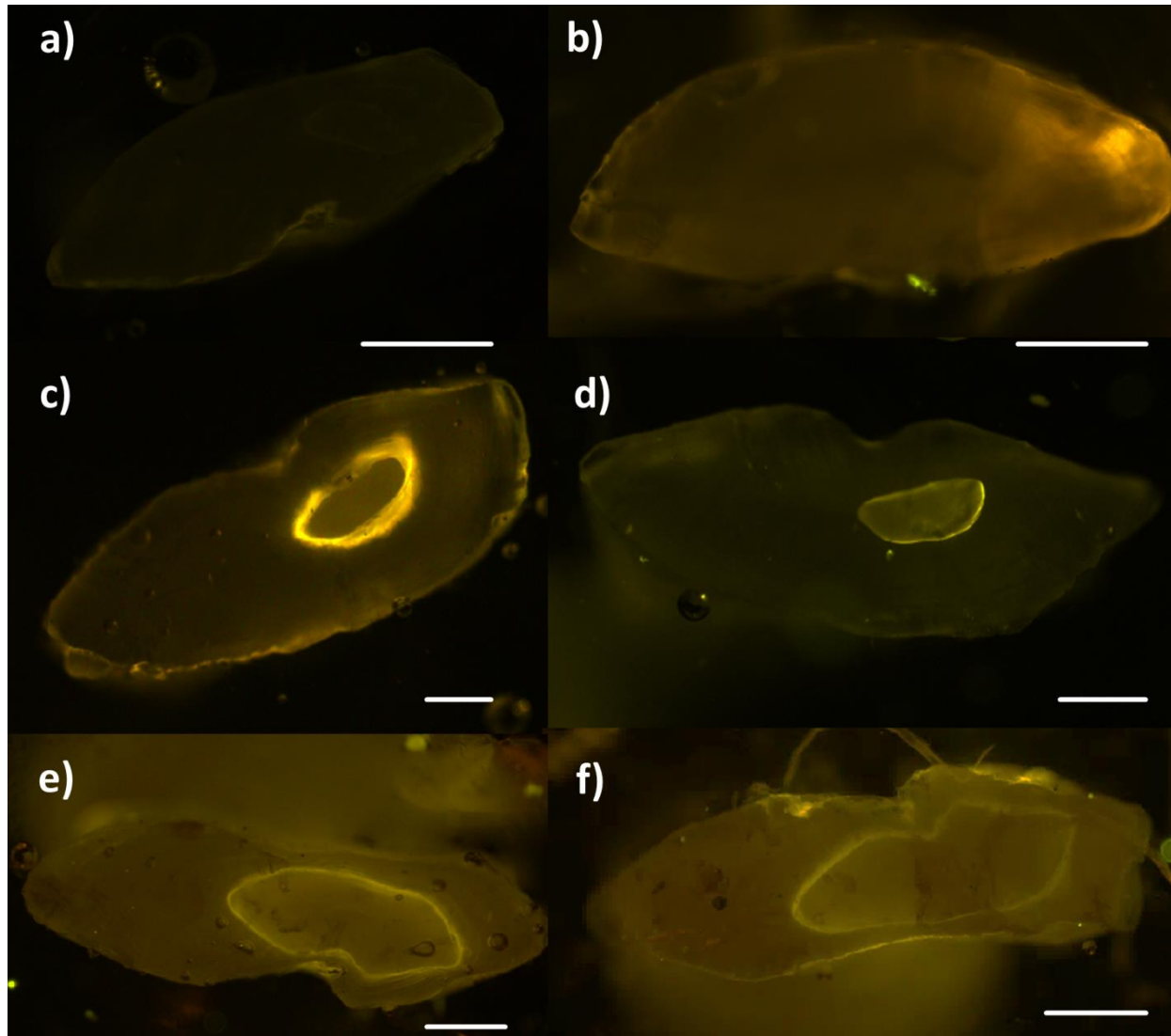
Kullmann, B. & Thiel, R. (unpublished) The chemical marking of eels – state of the art and application perspectives. Eels 'Science into Management' 5m Publishing. (expected to be available in November 2018)

Mark detection



Kullmann, B. & Thiel, R. (unpublished) The chemical marking of eels – state of the art and application perspectives. Eels 'Science into Management' 5m Publishing. (expected to be available in November 2018)

Mark detection – a matter of seconds



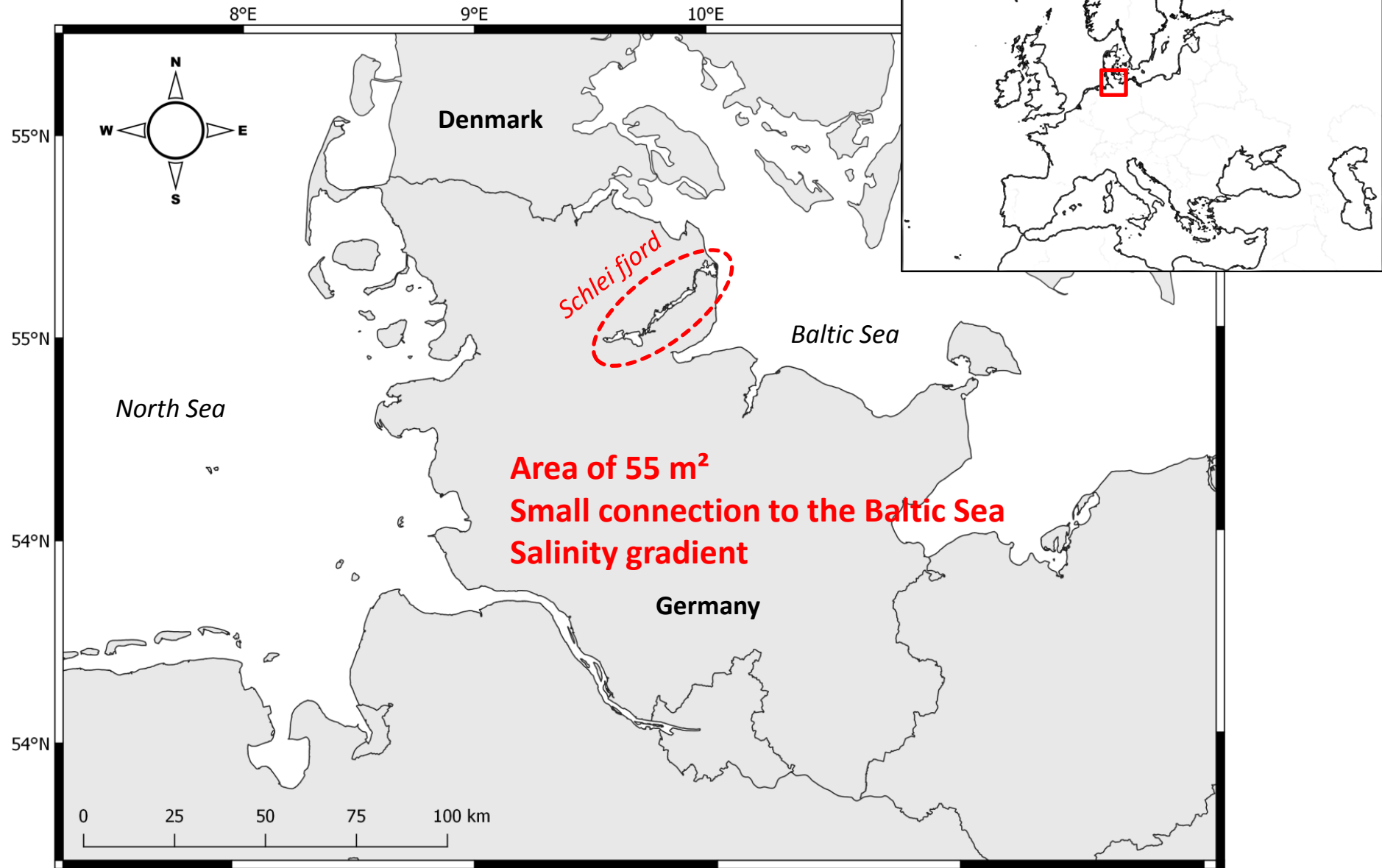
Not marked

Marked as glass eel

Marked as farmed eel

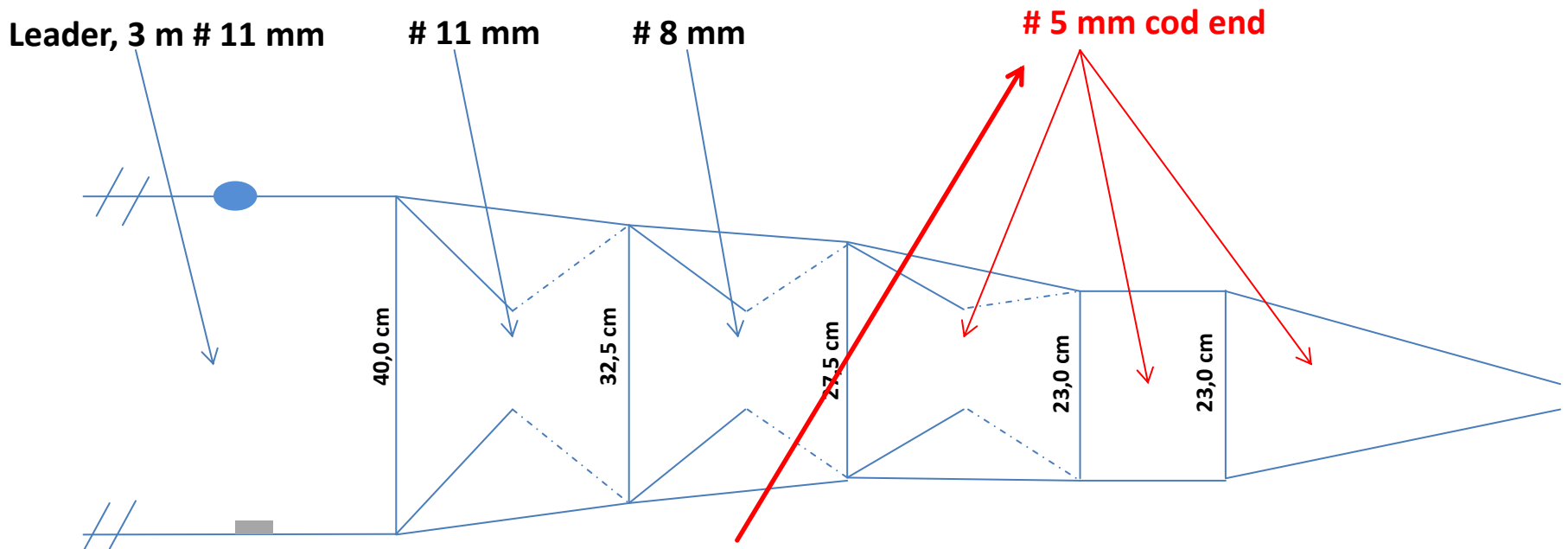
Kullmann, B. & Thiel, R. (unpublished) The chemical marking of eels – state of the art and application perspectives. Eels 'Science into Management' 5m Publishing. (expected to be available in November 2018)

The study site



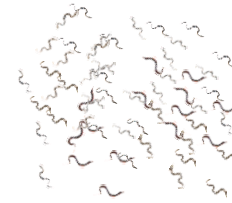
The recapture

- Cooperation with commercial eel fishermen
- Fyke nets and longline
- and **custom-made fyke nets** ...

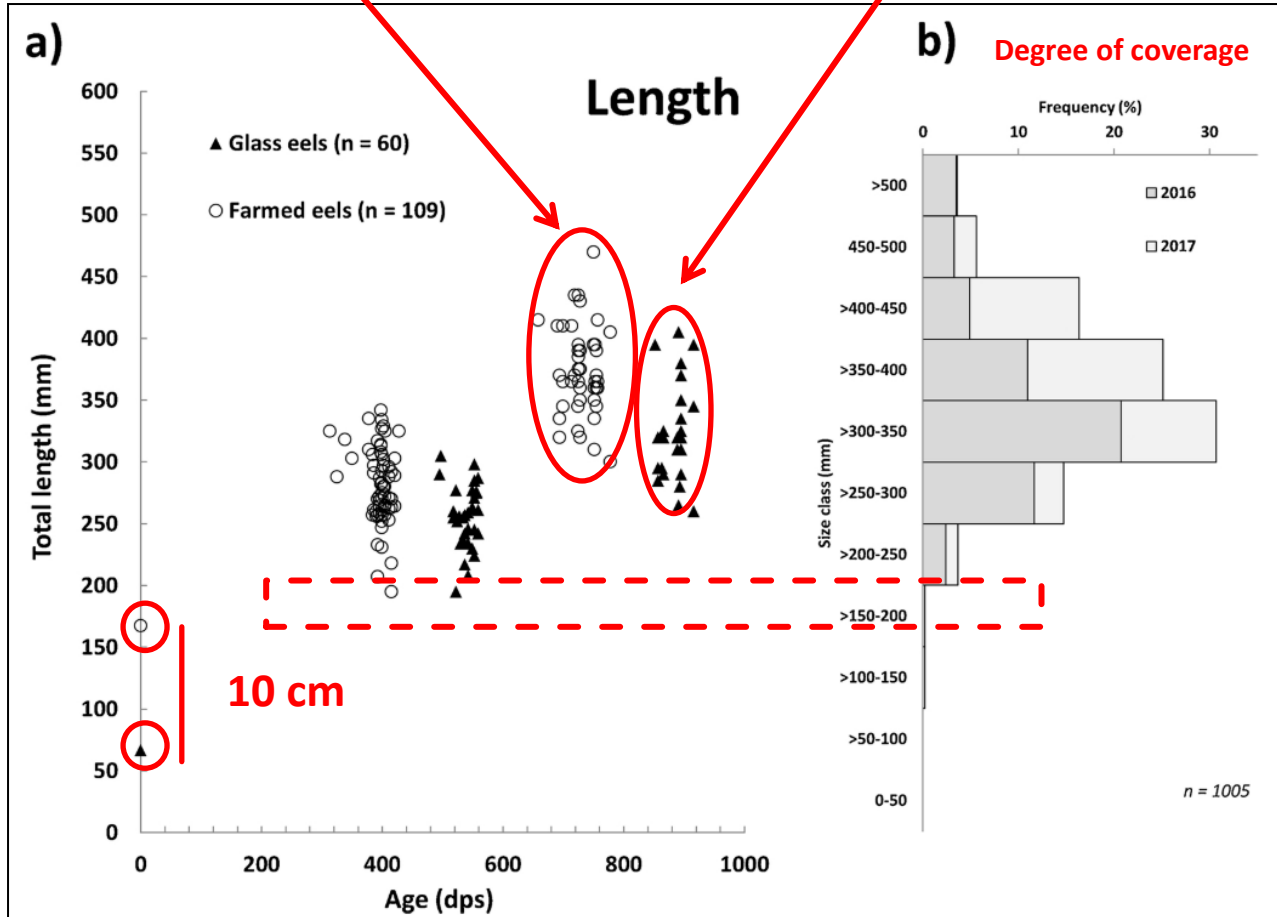


accounting for the low catchability of stocked glass eels

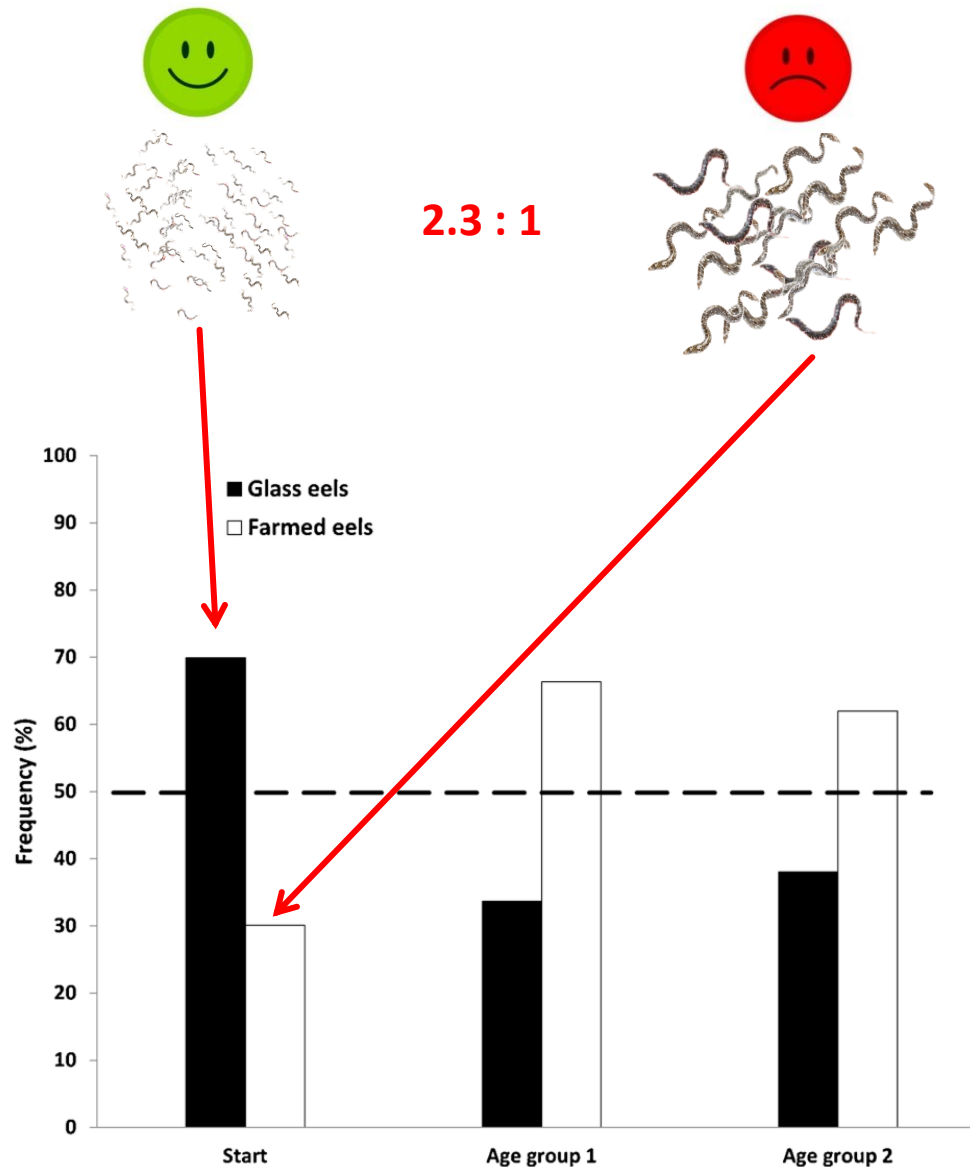
Bevacqua, D., Leo, G. A. de, Gatto, M., & Melià, P. (2009). *Journal of Fish Biology*, 74(9), 2178–2186.



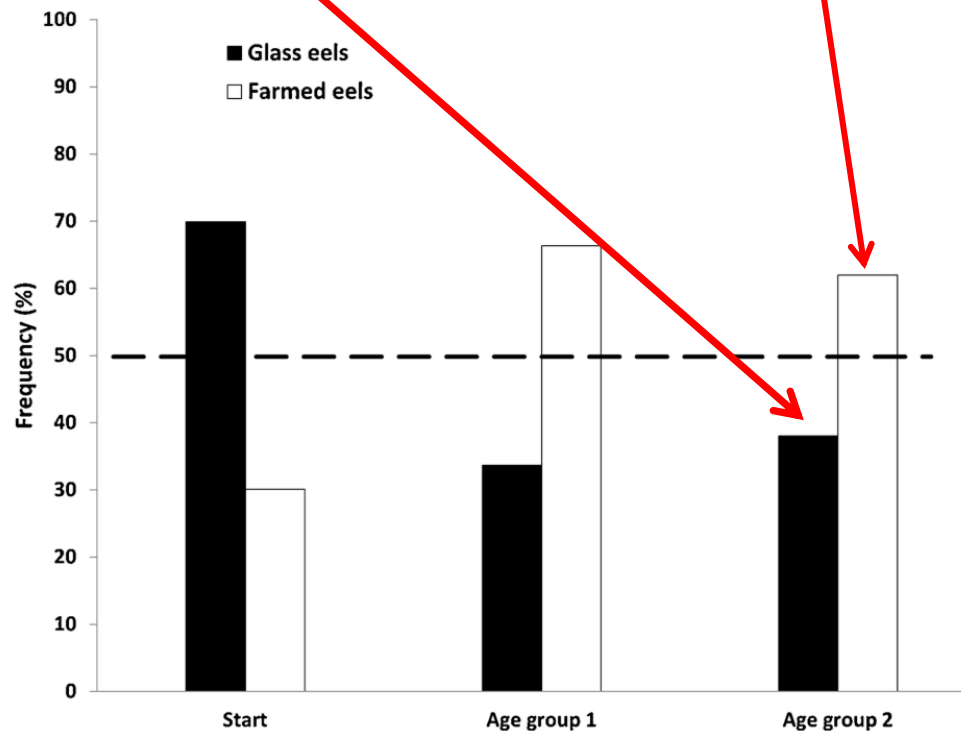
Length
5 cm
 $p < 0.05$



Kullmann, B. & Thiel, R. (2018). *Fisheries Research*, 205, 132–140.



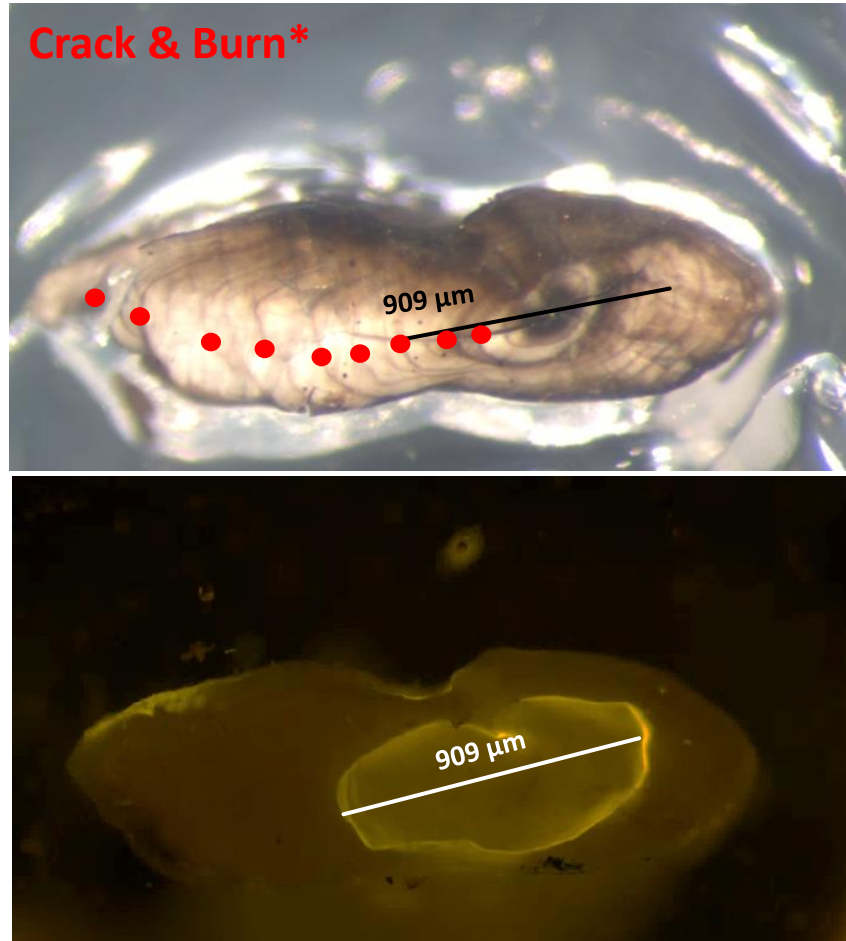
Kullmann, B. & Thiel, R. (2018). *Fisheries Research*, 205, 132–140.



Growth performance + benefit-cost-ratio → Yes, bigger is indeed better!

Kullmann, B. & Thiel, R. (2018). *Fisheries Research*, 205, 132–140.

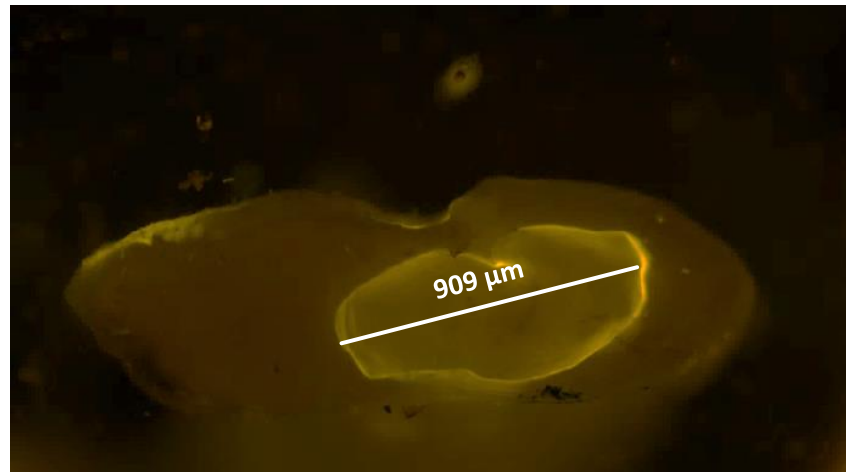
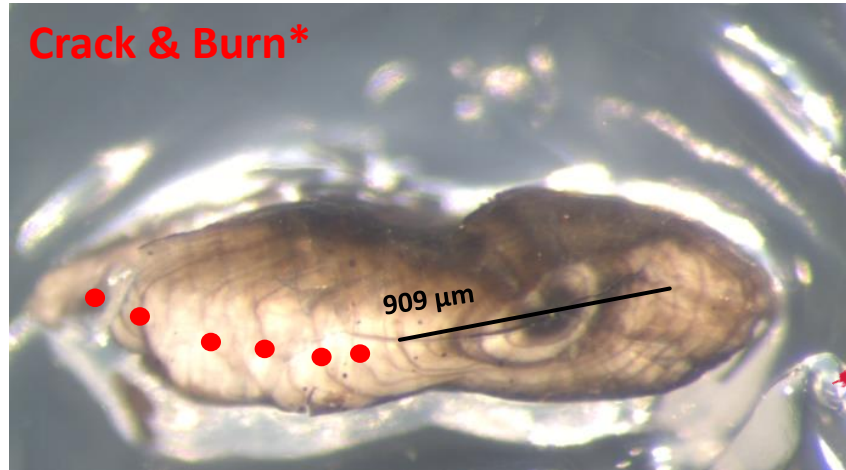
Lesson learned #1 ... The ageing issue



- 100 otoliths, 2 readers
- Read and annotate independently
- Recaptured farmed eels
- The ARS for age correction

Farming related stress rings

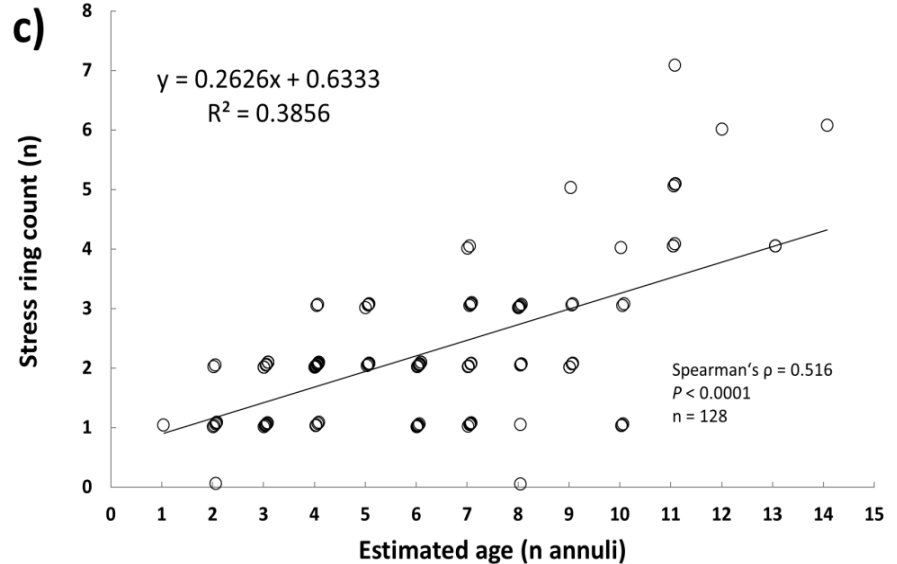
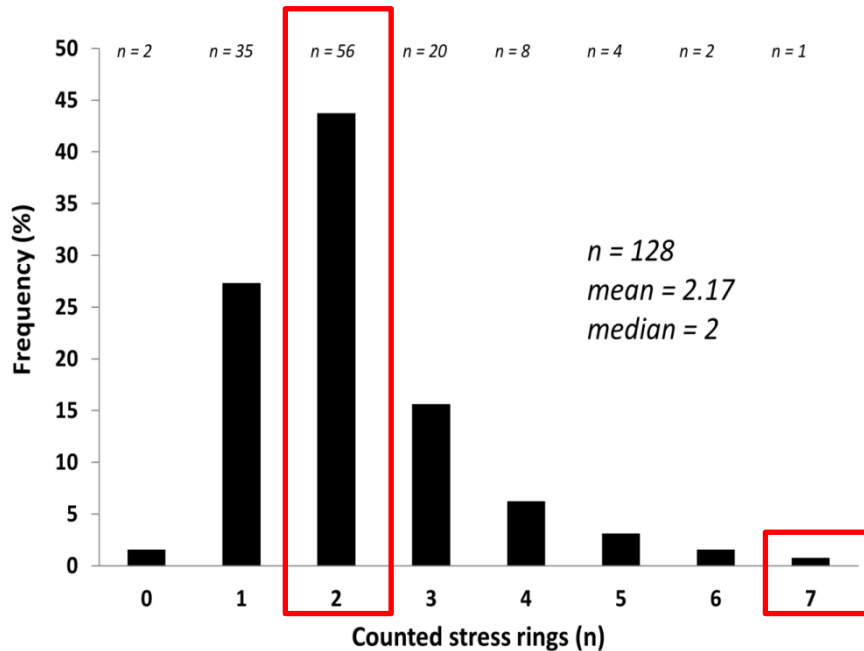
Lesson learned #1 ... The ageing issue



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Farming related stress rings

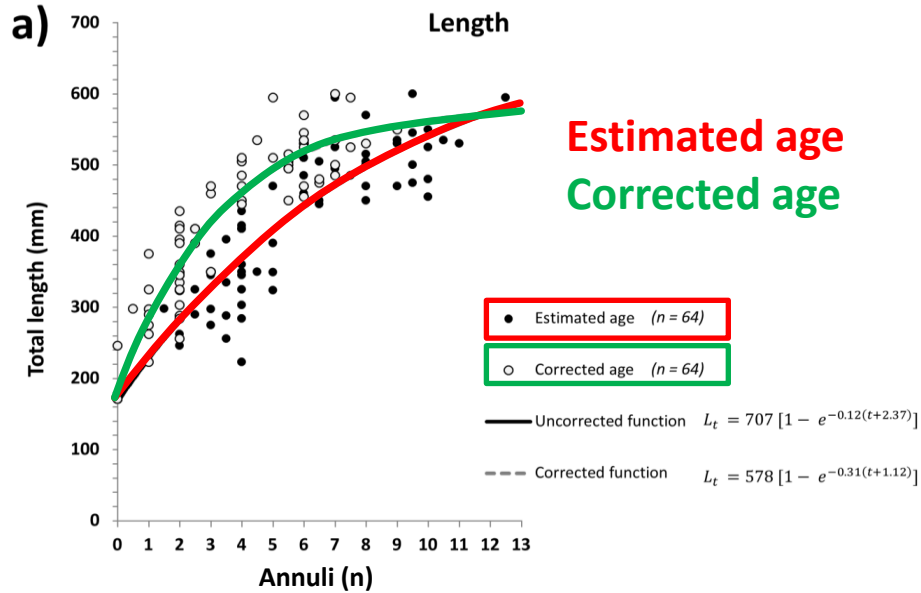
Lesson learned #1 ... The ageing issue



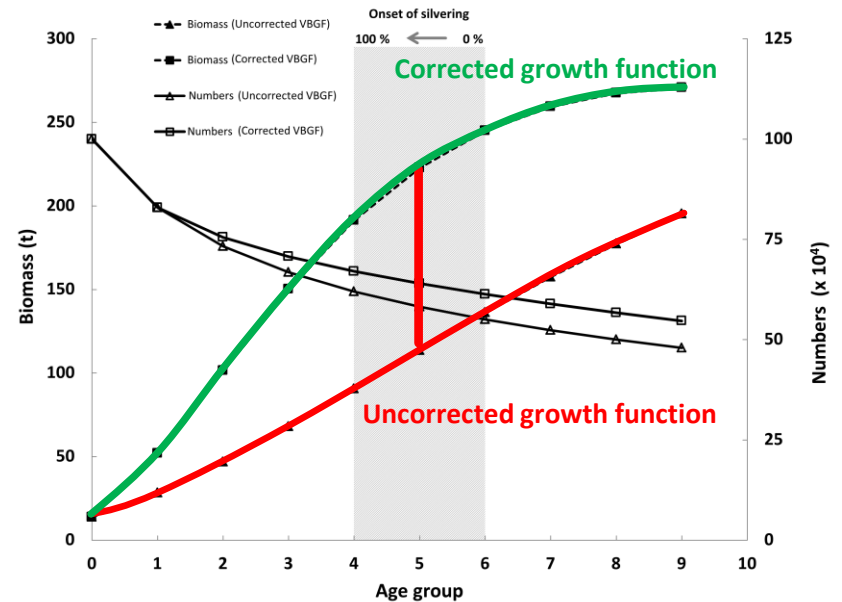
Overestimation up to 7 years

Ageing error is non invariant

Lesson learned #1 ... The ageing issue



Eel VPA*



~ 100 % underestimation

Estimated age **Corrected age**

L_∞ : **707 mm** → **578 mm**

k : **0.12** → **0.33**

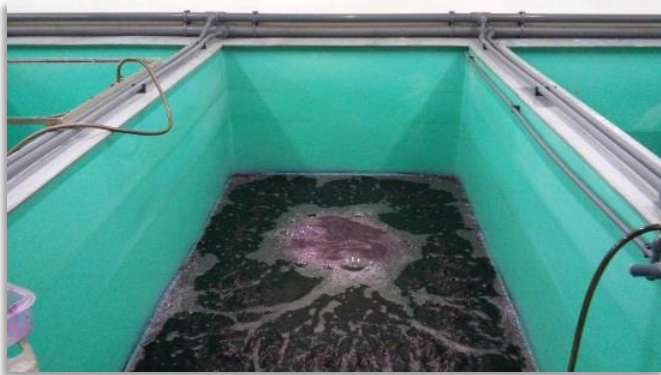
Age + Length → Biomass



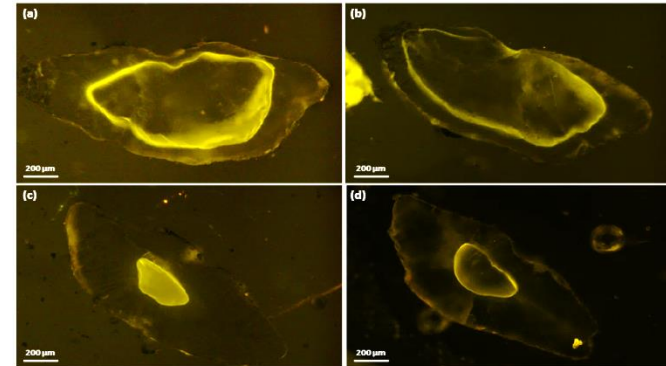
Kullmann, B.; Pohlmann, J.D.; Freese, M.; Keth, A.; Wichmann, L.; Neukamm, R.; Thiel, R. (under review) Age-based stock assessment of the European eel is heavily biased by stocking of unmarked farmed eels. *Fish Res*
* Pohlmann et al. (2016) *ICES Journal of Marine Science: Journal du Conseil*, 73(10), 2509–2517

Lesson learned #2 ... The biosecurity issue

Alizarin red S immersion bath



After recapture



High mortality of farmed eels during the marking process in 2015

- Lethargy
- Yellow liver
- Red head and fins



qPCR revealed eel herpesvirus infection

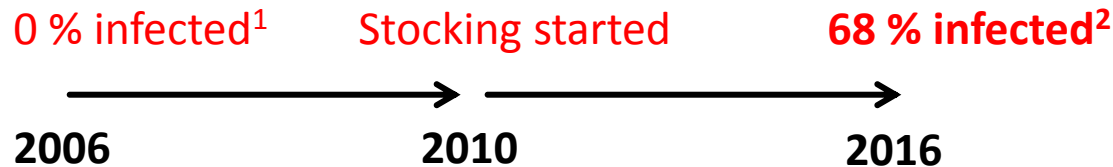
Lesson learned #2 ... The biosecurity issue

1. Eel farmers **deliberately infect** eels with AngHV-1 („vaccination“)
2. **No disease containment strategy** (lack of legal obligation, complicity, and sanctions)

→ **AngHV-1 infection of all 3.5 t farmed recruits since 2010?**

Follow-up study revealed ...

→ Virus prevalence increased from 0 % (2006)¹ to 68 % (2016)²



¹Jakob *et al.* (2009) *Journal of fish diseases* 32(6), 557-561

²Kullmann, B., Adamek, M., Steinhagen, D., & Thiel, R. (2017) *Journal of fish diseases*, 40(11), 1695–1706.

The *eel herpesvirus* – a serious problem

- Persistent virus occasionally without clinical signs¹
- Transferable by bath immersion²
- Outbreak triggered by stress³
- Silver eels are particularly vulnerable⁴
- „Vaccination“ of farmed eels is common practice⁵



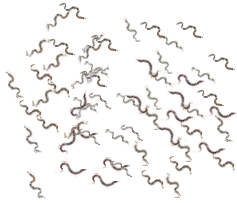
¹Nieuwstadt, van A. P. et al. (2001) Diseases of Aquatic Organisms, 45: 103–107.

²Hangalapura, B. N. et al. (2007) Diseases of Aquatic Organisms, 78: 13–22.

³Haenen, O. L. M. et al. (2002) Bulletin of the European Association of Fish Pathologists, 22: 247–257.

⁴Kullmann, B. et al. (2017) Journal of fish diseases, 40: 1695–1706.

⁵EFSA (2008) The EFSA Journal, 809: 1–18.



vs



Get To the Point



Lessons learned ...

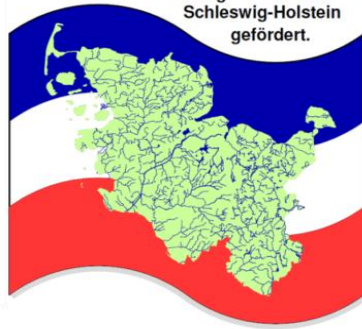
- (i) Q: Is bigger better in eel stocking measures?
A: In contrast to previous studies, **possibly YES**, but **beware** of ...
- (ii) The **ageing error** in farmed eels and **use marked** eels
- (iii) The **health status** and particularly of the ***eel herpesvirus***

Colleges and coauthors:

Rüdiger Neukamm
 Mattias Hempel
 Mikolaj Adamek
 Dieter Steinhagen
 Marko Freese
 Jan-Dag Pohlmann
 Alexander Keth
 Laura Wichmann
 Vicky Magath
 Elena Hauten
 Lisa Matthiesen

Thanks for your attention

Dieses Vorhaben wurde aus Mitteln der
 Fischereiabgabe des Landes
 Schleswig-Holstein
 gefördert.



The fishermen:

Armin Laß
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 Günter und Christel Luick
 Horst-Dieter Petersen
 Joachim Otto
 Jörn Ross und Söhne
 Julius Piel
 Matthias Nanz
 Michael Grünhoff
 Olaf Jensen



Fischzucht  **Kemnitz**

