Supplementary stocking selects for domesticated genotypes

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Supplementary stocking

- Release of hatchery produced juveniles
  - Conservation or increase harvest
- ~180 anadromous and marine species (Kitada 2018)
- Concern: Unintentional domestication selection (Christie et al. 2012; 2016; Le Luyer et al. 2017)


Photo: Espen Holte

Atlantic salmon (*Salmo salar*)

- ~50 populations are being stocked in Norway
- Large numbers of escaped farmed salmon
- Widespread genetic introgression (Karlsson et al. 2016)
- Farmed salmon is selected for rapid growth and high survival in captivity
- Hybrids and farmed salmon outgrow wild salmon under hatchery conditons (Solberg et al. 2013)

Atlantic salmon (*Salmo salar*)

- Individuals escaped as young are difficult to tell apart from hatchery-produced fish using scale analysis
- Hybrids cannot be distinguished using scales

Escapees and hybrids have been used as broodstock in Norway

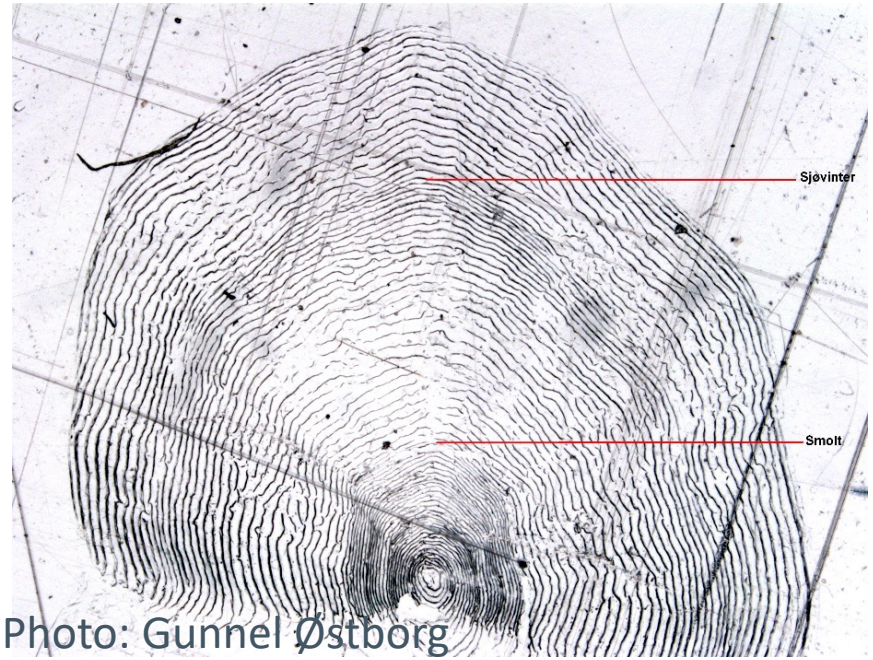


Photo: Gunnel Østborg

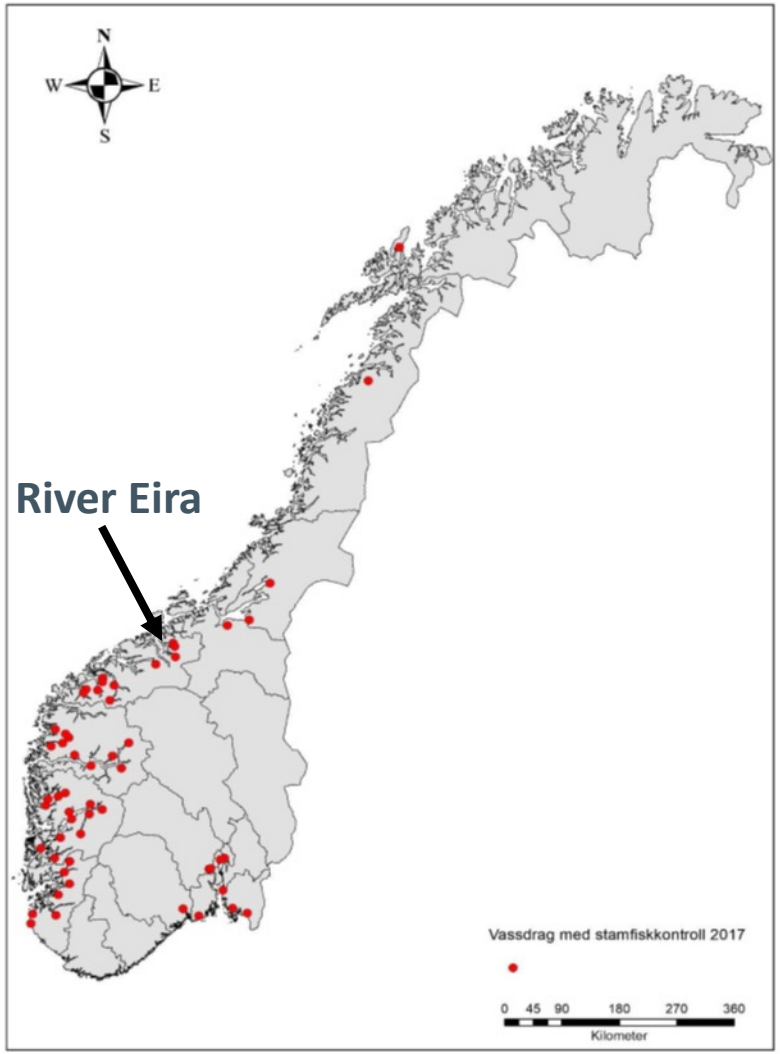
In systems where stocking and introgression co-occurs:

Farmed/hybrid salmon is expected to do well in hatchery conditions but poorly in nature:

1. Do introgressed broodstock produce more offspring under hatchery conditions than wild broodstock?
2. How does stocking affect introgression in a recipient population?

The study system: the River Eira

- High degree of genetic introgression from farmed salmon (Karlsson et al. 2016)
- ~ 50 000 smolts released annually
- ~ 17 000 smolts produced naturally
- Individuals of hatchery origin make up 30 – 50 % of the population



Datasets from the River Eira

1a) Broodstock introgression - 7 brood years
1b) Number of returning adult offspring

- 85 family groups
- 887 offspring

Parentage assignment

Photo: Washington Dept. of Fish and Wildlife

2) Introgression in returning adults from 20 run years (1987 – 2016)

- 1347 wild
- 1567 hatchery-reared

Parentage assignment

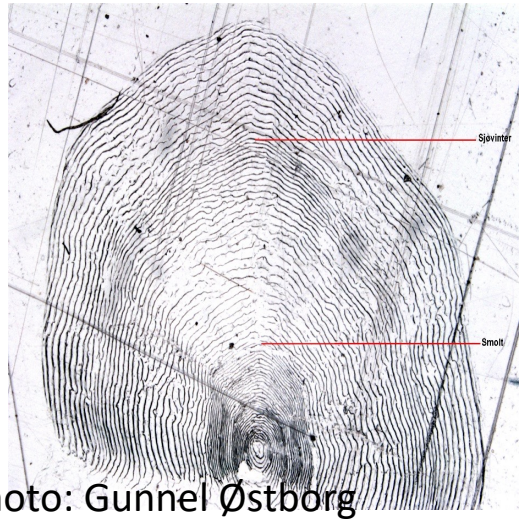
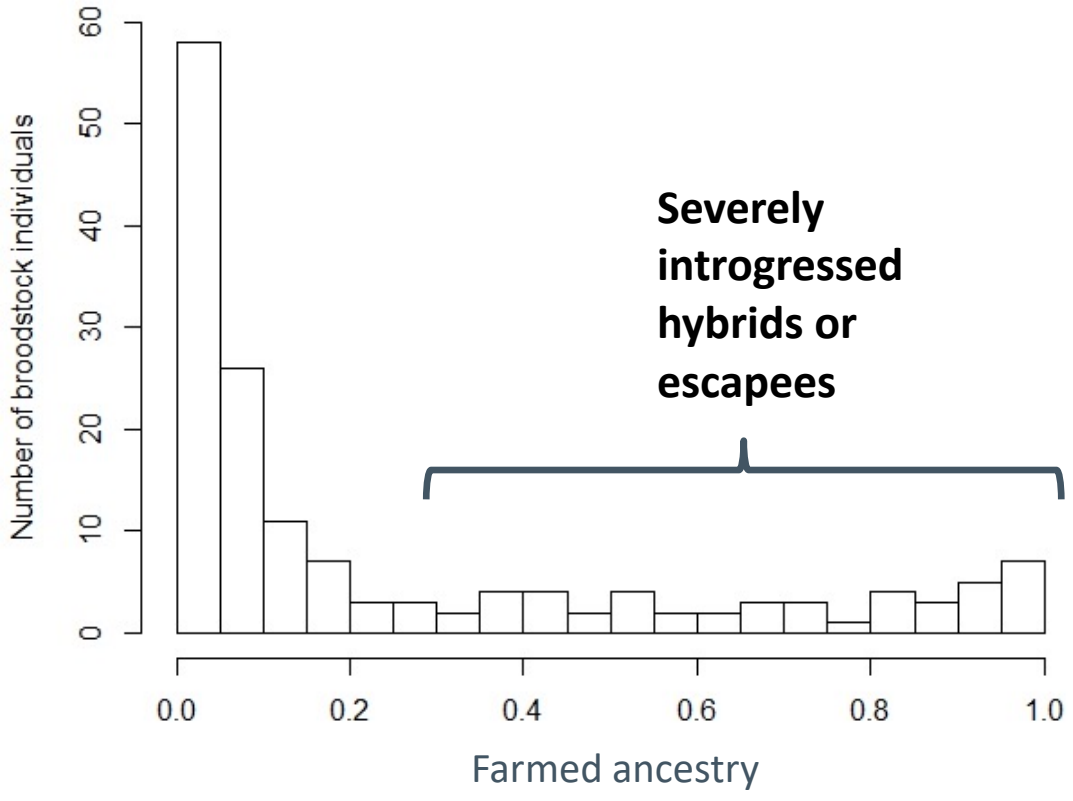


Photo: Gunnel Østborg

Results: Introgression in broodstock

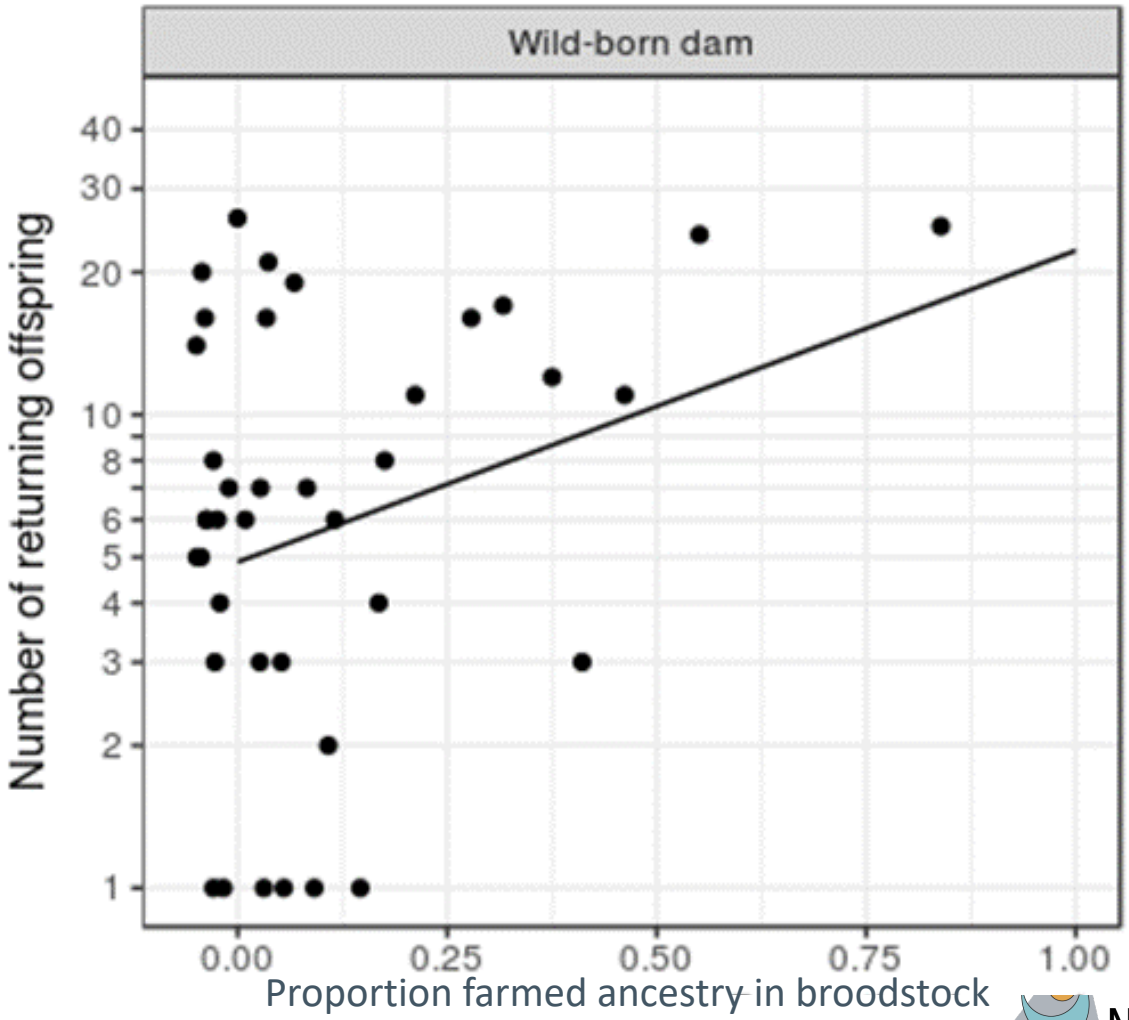


Severely introgressed broodstock have been used in the Eira stocking programme

Results: Do introgressed broodstock produce more offspring?

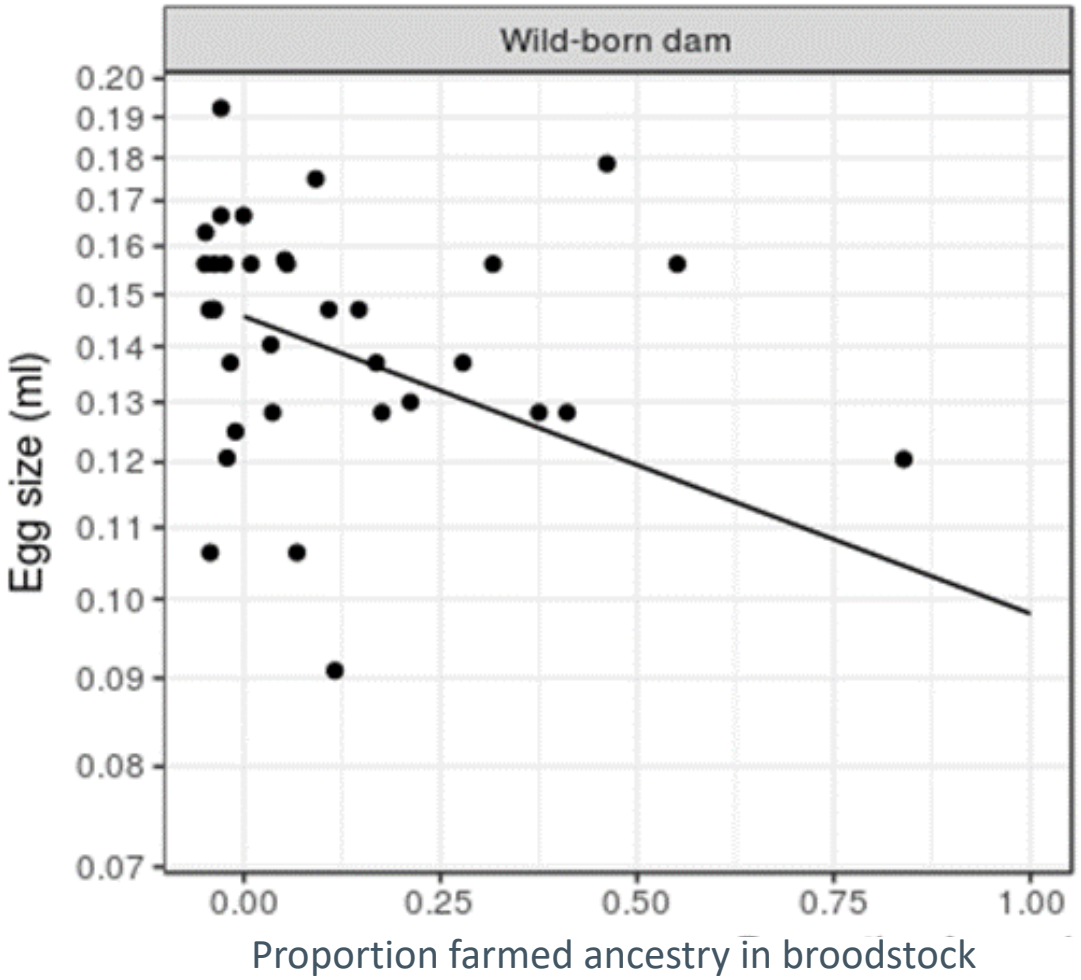
Yes

- Severely introgressed broodstock produce **4x** more offspring (*P* = 0.025)



Introgressed broodstock also produce smaller eggs

- Severely introgressed broodstock produce eggs that are 0.67x smaller (95% CI: 0.51 – 0.89)



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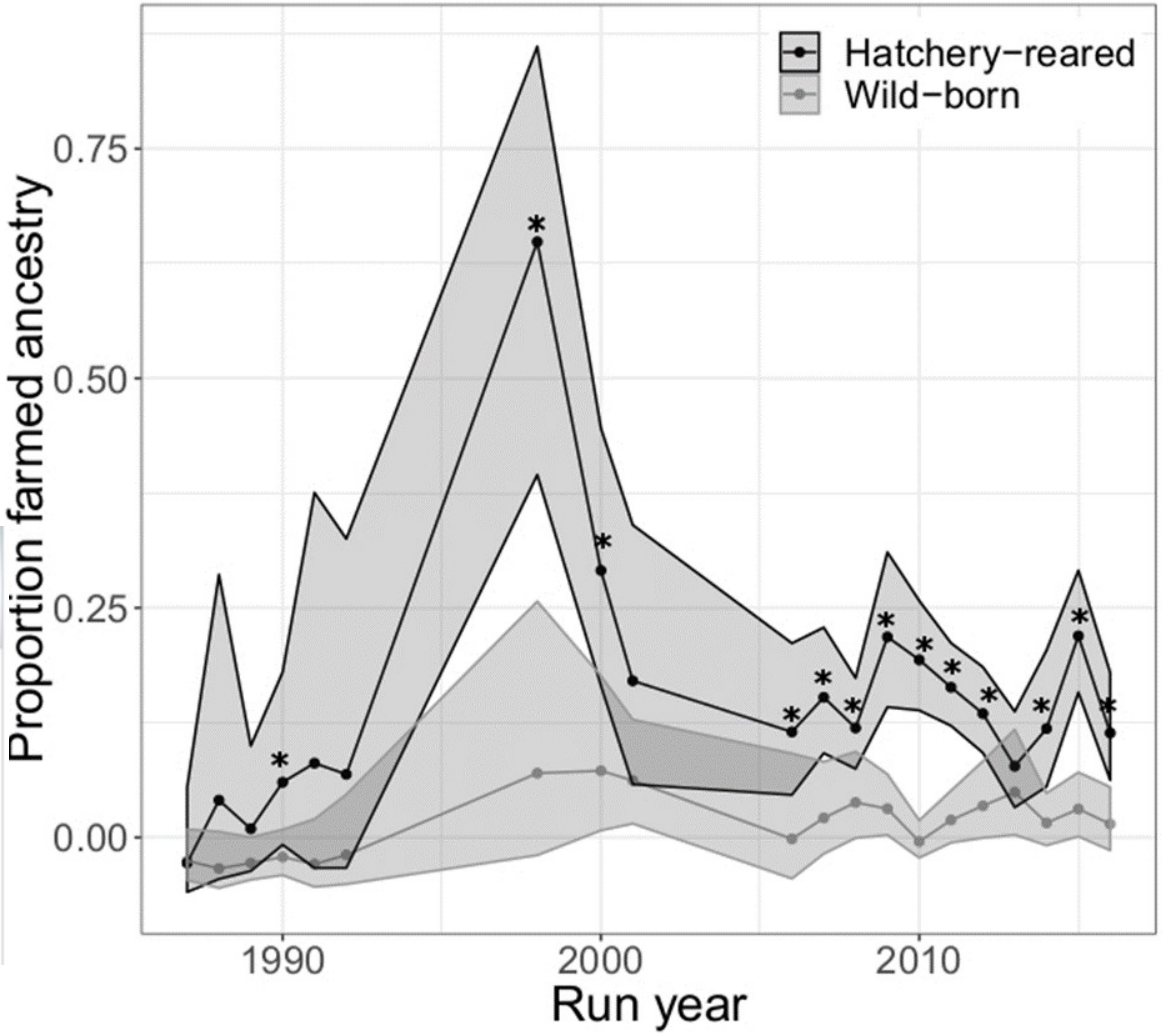
Results: Has this affected the level of introgression in the recipient population?

Yes

- Introgression is higher among hatchery fish compared to wild spawed fish
- Very significant for 13 out of 20 run years



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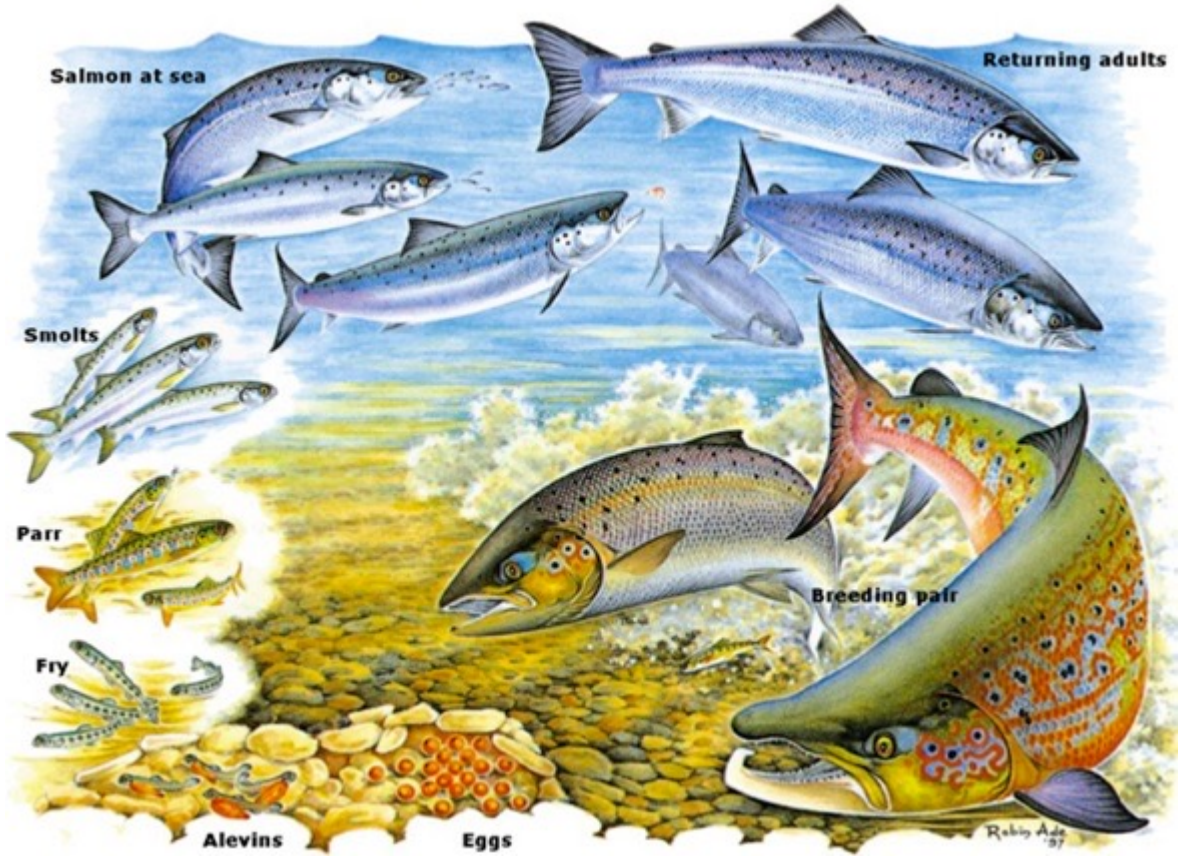
Effect not fully counteracted by natural selection

- Effect measured on individuals after 1-4 years at sea
- Domestication selection and natural selection after release → the latter probably moderates the response
- **> 4-fold return rate** for fish having parents with fully domesticated ancestry



Conclusion

- Depending on the conditions in the hatchery:
  - Stocking can amplify genotypes associated with domestication

Admixture between wild and domesticated conspecifics will accentuate the harmful domestication effects of stocking

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