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THE ARCTIC  
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# 0186: Biology and economics in ecosystem services valuation

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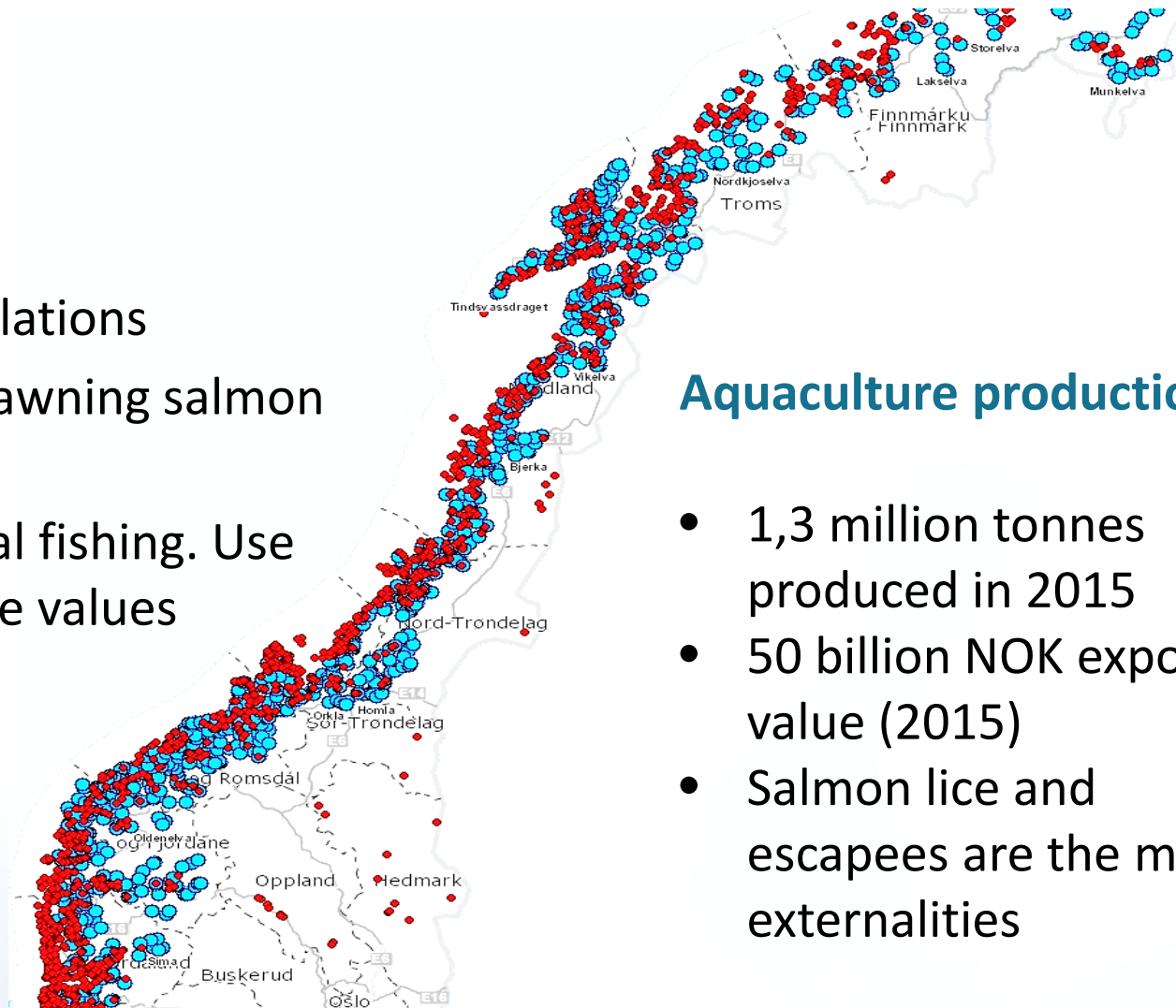
# The tradeoff between wild and farmed salmon

## Wild salmon

- $\approx 440$  populations
- 522 000 spawning salmon in 2015
- Recreational fishing. Use and non-use values

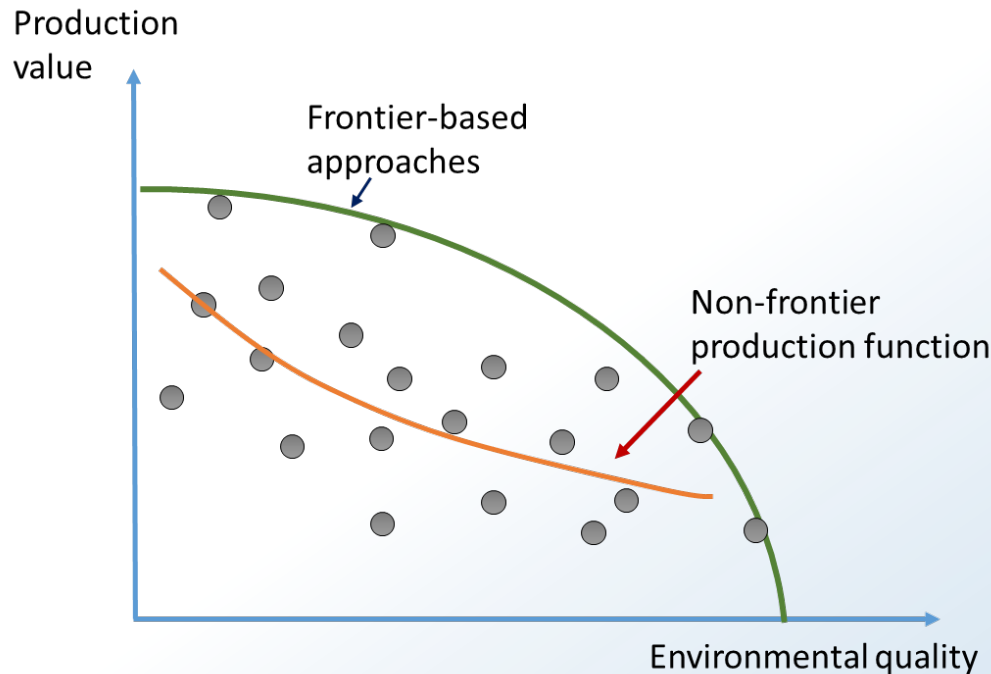
## Aquaculture production

- 1,3 million tonnes produced in 2015
- 50 billion NOK export value (2015)
- Salmon lice and escapees are the main externalities



# Approaches to shadow price estimation

- Models that take into account ecological relationships are preferable. However, they require transdisciplinary (interdisciplinary) approach.



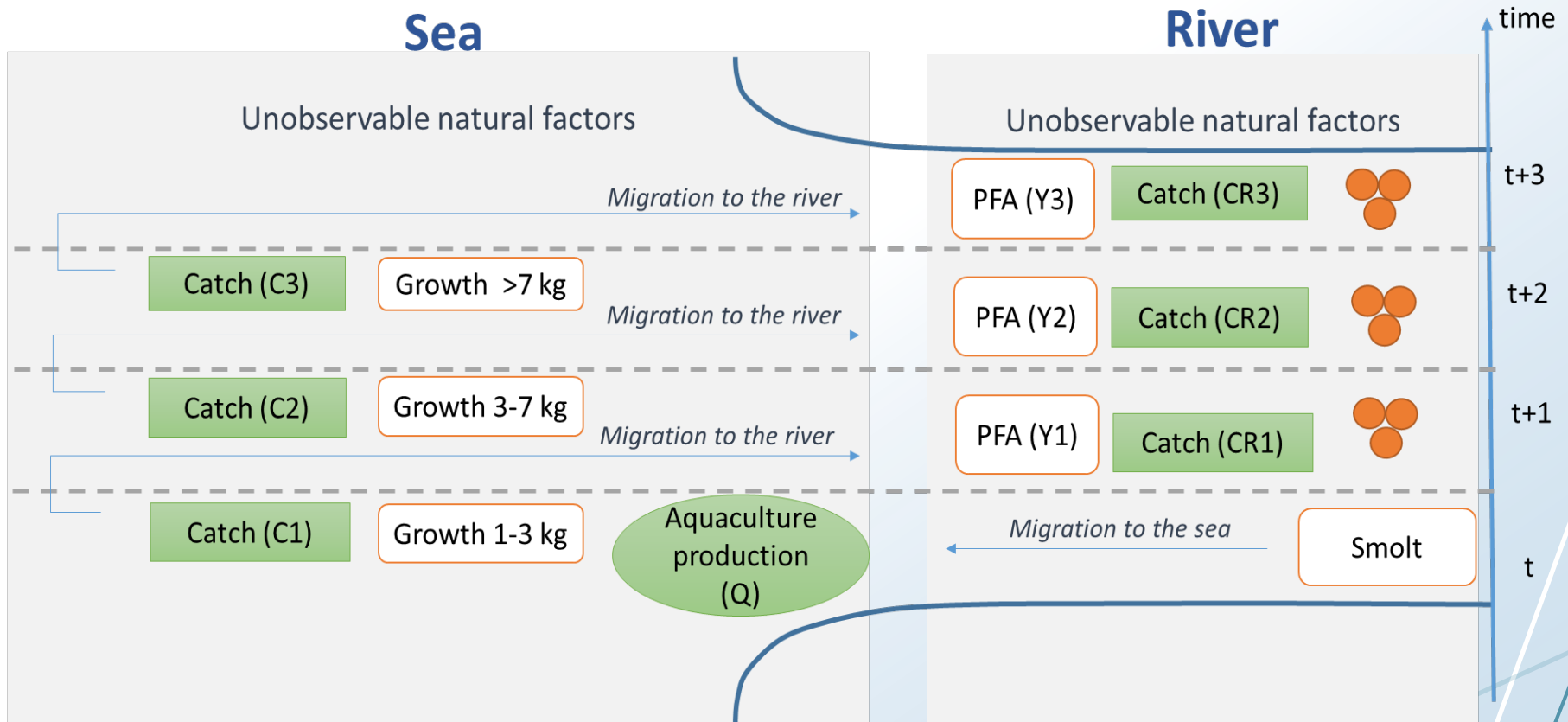
$$Y = f(Q), f'(Q) < 0$$

$$V = p * Q$$

$$\frac{\partial V}{\partial Y} = \frac{p}{f'(Q)}$$

# Data and model

- 94 rivers, 7 years, aquaculture production within 30 km



# Econometric approach

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$$\ln(YT_{it}) = \alpha_i + \beta_1 \ln(B_{it}) + \beta_2 \ln(lice_{it}) + \beta_3 \ln(C_{it}) + \beta_4 \ln(CR_{it}) + \varepsilon_{it}$$

Fixed effects panel model, within estimator, individual and time effects

$YT_{it}$  - pre-fishery abundance (PFA) of the cohort t in the i-th river

$B_{it}$  - standing biomass at salmon farms at the year of smolt migration

$lice_{it}$  - average sea lice level in at the time of smolt migration

$C_{it}$  - sea catch of the fish from the cohort t at the regional level

$CR_{it}$  - river catch of the cohort t-2

$\alpha_i$  - intercept terms which vary over the individual units,  $\varepsilon_{it} \sim \text{IID}(0, \sigma_\varepsilon^2)$

# Results

	Estimate	Std. Error	t-value	Pr(>  t )
log(B)	-0,015133	0,006883	-2,1986	0,028354 *
log(lice)	0,012554	0,010171	1,2343	0,217664
log(C)	-0,123825	0,057619	-2,1490	0,032103 *
log(CR)	-0,075224	0,024198	-3,1087	0,001984 **

**R-Squared: 0.038429**  
**Adj. R-Squared: 0.032024**

The shadow price calculated for the means of YT and B :

$$\frac{\partial V}{\partial Y} = \frac{p}{f'(Q)} = \frac{5000 * 1,7}{(-0,015 * \frac{1238}{3882})} = -1.76 \text{ million NOK}$$

*per 1 wild salmon ≈*

*– 350 tonnes farmed salmon*

# Conclusion

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- Interdisciplinary approach was required to estimate the shadow price of an environmental good.
- A model that reveals causal relationship provides an interpretation of the shadow price in terms of forgone benefit.
- This is an essential information for policy.
- Uncertainty is a major challenge. If the real coefficient is zero, the shadow price is irrelevant (no tradeoff).

Thank you for your attention!

