"Nascent Developments in Arctic Fisheries: Managing the Red King Crab in the Barents Sea"

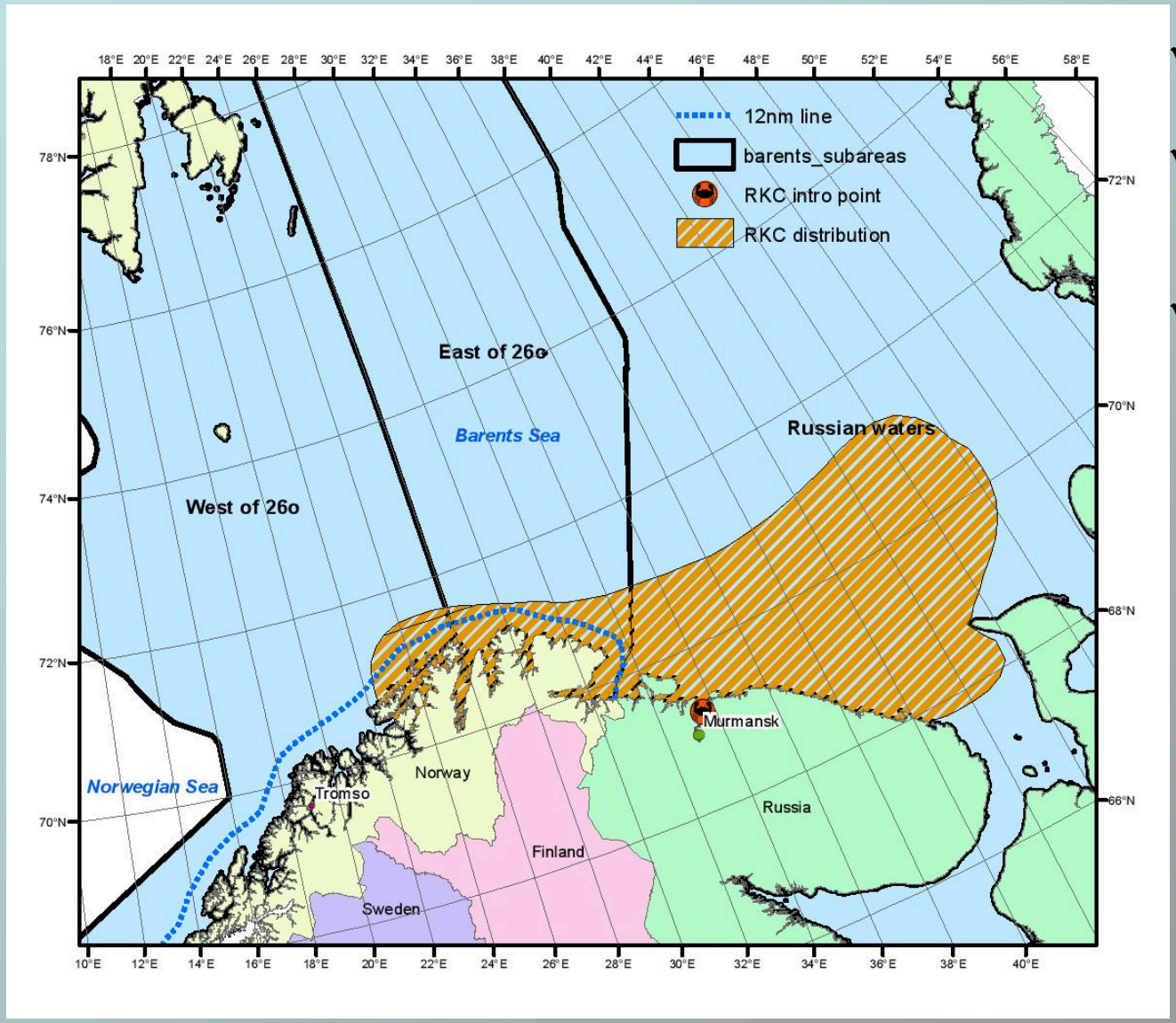
Present and emerging Arctic fisheries

Brooks Kaiser[1], Melina Kourantidou[1], Linda Fernandez[2]

IIFET 2016
Wednesday 13/07/2016, Aberdeen

1 University of Southern Denmark
2 Commonwealth Virginia University

Distribution & Management Overview



- ✓ East Finnmark coast
- ✓ Purposeful Introduction at Kola, from N.Pacific
- ✓ 12% Barents coverage

History of Invasive Red King Crab

1960's | 1977-78 | -1994 | DM-bycatches | -2001 | 2002 | 2004-07 | 2007 | 2008-09

Scientific | Commercial | split management

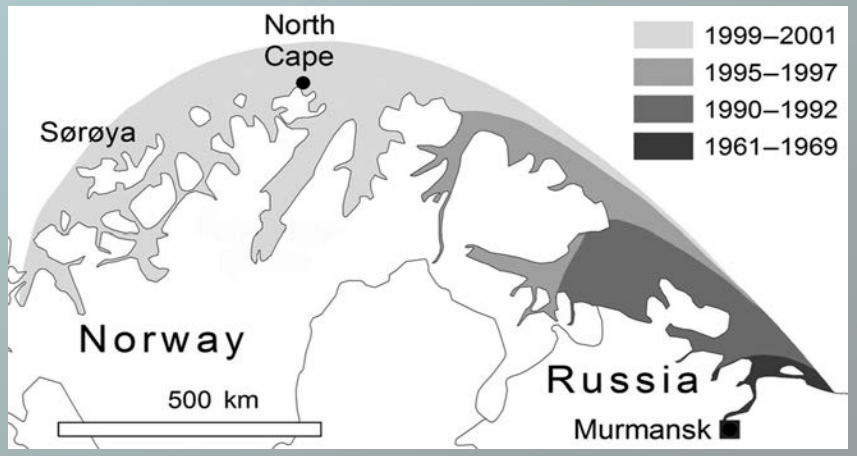
RU had established unilateral quotas E26° REZ

- ✓ Introduction (No consent)

~2000 female,
~1000 male,
~10,000+ juvenile,
~1.5 mil larvae E. Russia

- ✓ Agreement for joint management

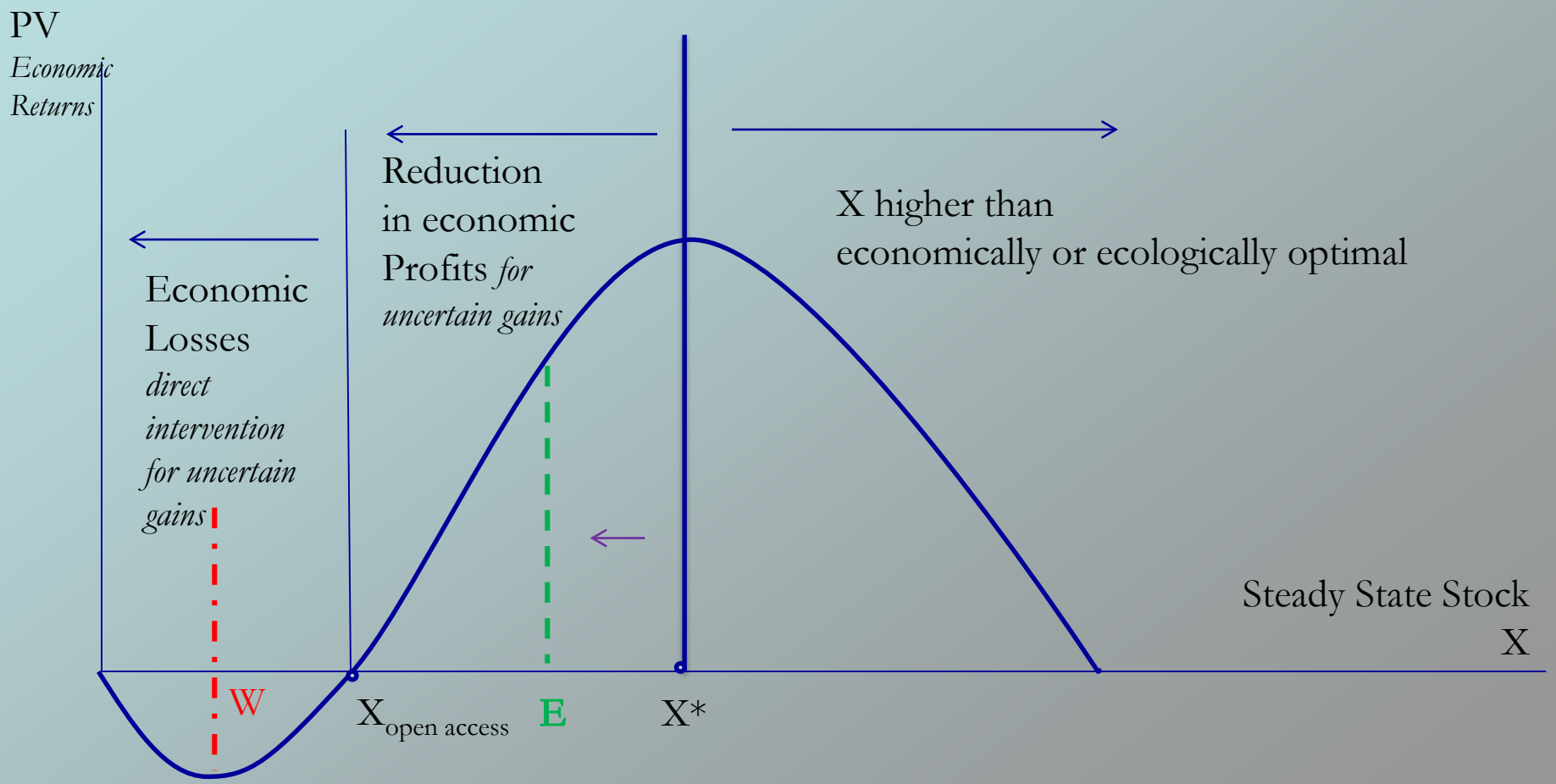
- ✓ Migration noted
- ✓ Discussion NO-RU



- ✓ Joint management as 'protected species' to grow stock (Asset? Liability?)
- ✓ Experimental quota fishery

- ✓ NO high quotas to push down migration

Tradeoffs of a profitable invader



Scarce Empirical Observations

- Inevitable Uncertainties
  - Stock (X)
  - Growth F(X)
  - Damages DM(X)
  - Control Costs
- Trade off-Sign of λ
  - X or h source of future benefits ?
  - Value from investing in this asset or divesting in this liability

$$MaxV = \int_0^{\infty} e^{-\delta t}\left[Ph_t - C(X_t)h_t - DM(X_t)\right]dt$$

$$F'(X_t) - \left(\frac{DM'(X_t) + C'(X_t)F(X_t)}{P - C(X_t)}\right) = \delta$$

s.t.

$$\dot{X} = F(X_t) - h_t$$

$$0 \le h_t \le X_t$$

$$X_0 \le X(0)$$

$$\lambda = \frac{\dot{\lambda} - DM'(X) - C'(X)h}{\delta - F'(X)}$$

Cost Function

- 2016 NO Registry & 2002-2007 dataset
- Individual effects: Variation in costs across vessels
- Regression Analysis: explanatory variables: annual X, Vessel Length (VL), harvest (monthly)
- **Overview of how output and X affect variable unit costs**

$$CPUEmales = 0.0085X^{0.4482}$$

- Annual Operational Costs sorted by VL (S:8-9.9m, M: 10-14.9m, L: 15-20.9m)
- Fixed Weighted Averaged Cost for every year

$$\bar{C}_t = AC_t^S / \sum_S T_t + AC_t^M / \sum_M T_t + AC_t^L / \sum_L T_t$$

$$C(X) = \frac{\bar{C}_t * CQ_i / \sum_i PD}{0.0085X^{0.4482}}$$

$$C_{2005}(X) = \frac{32}{X^{0.4482}}$$

$$C_{2002}(X) = \frac{178}{X^{0.4482}}$$

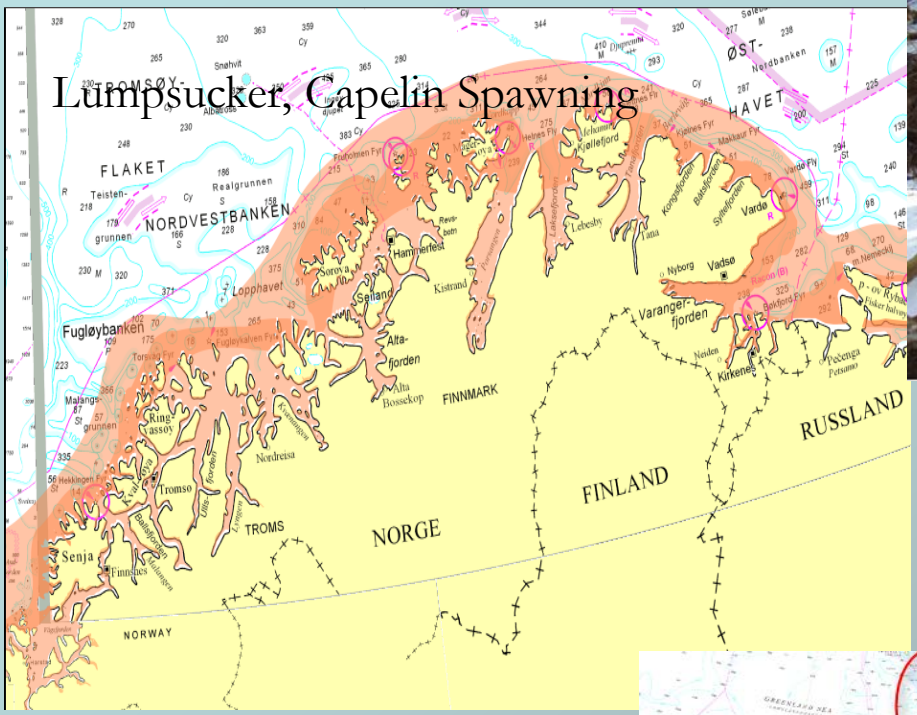
- *%CQi fraction of crab quotas when compared to overall other quotas*
- *AC annual cost; weighted average of annual VL classes*
- *ΣPD is the sum of Pot days (for every individual trip) of every vessel i.*

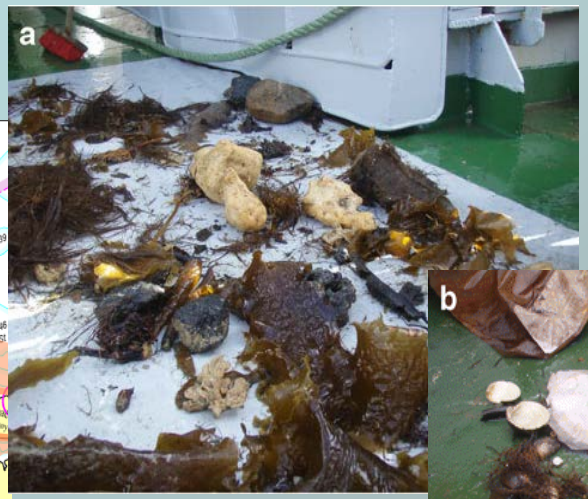
Broadening the Perspective

Multiple Fisheries managers (RU/NO) goals incomplete

Full Ecological Economic Story includes Damages and Externalities, and Unknowns

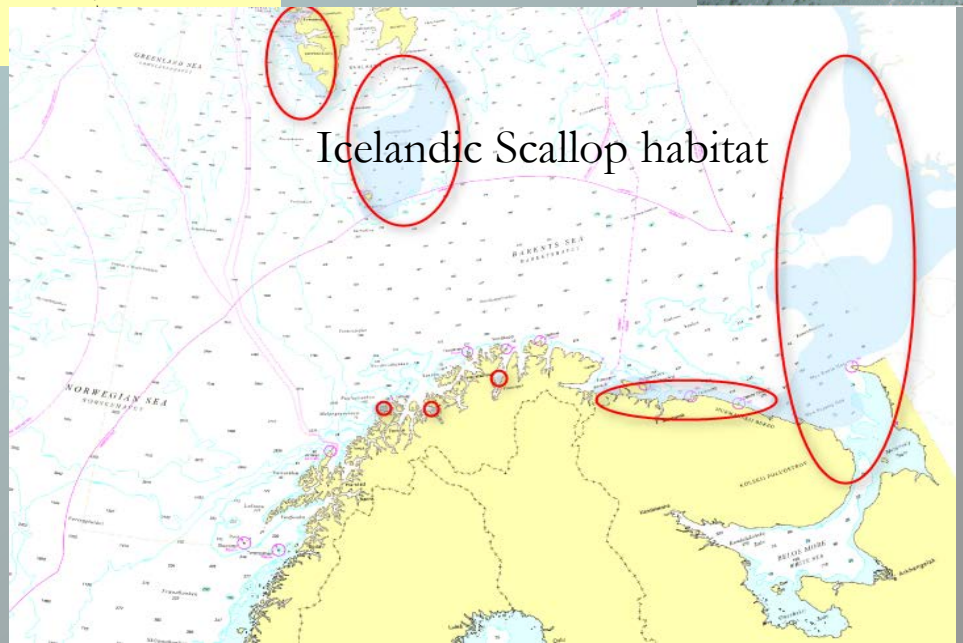
- Different Costs, Incentives
  - Bycatches
    - removing baits, losing target species, entagling & destroying nets
  - Predation upon commercial species
    - Capelin *(Mallotus villosus)*
    - Arctic lumpsucker (*Cyclopteropsis macalpini*)
    - Icelandic Scallop *(Chlamys islandica)*
  - Ecosystem Damages
    - Benthos
    - Competition with native species
    - Parasites & Commensal





epifaunal communities are impoverished

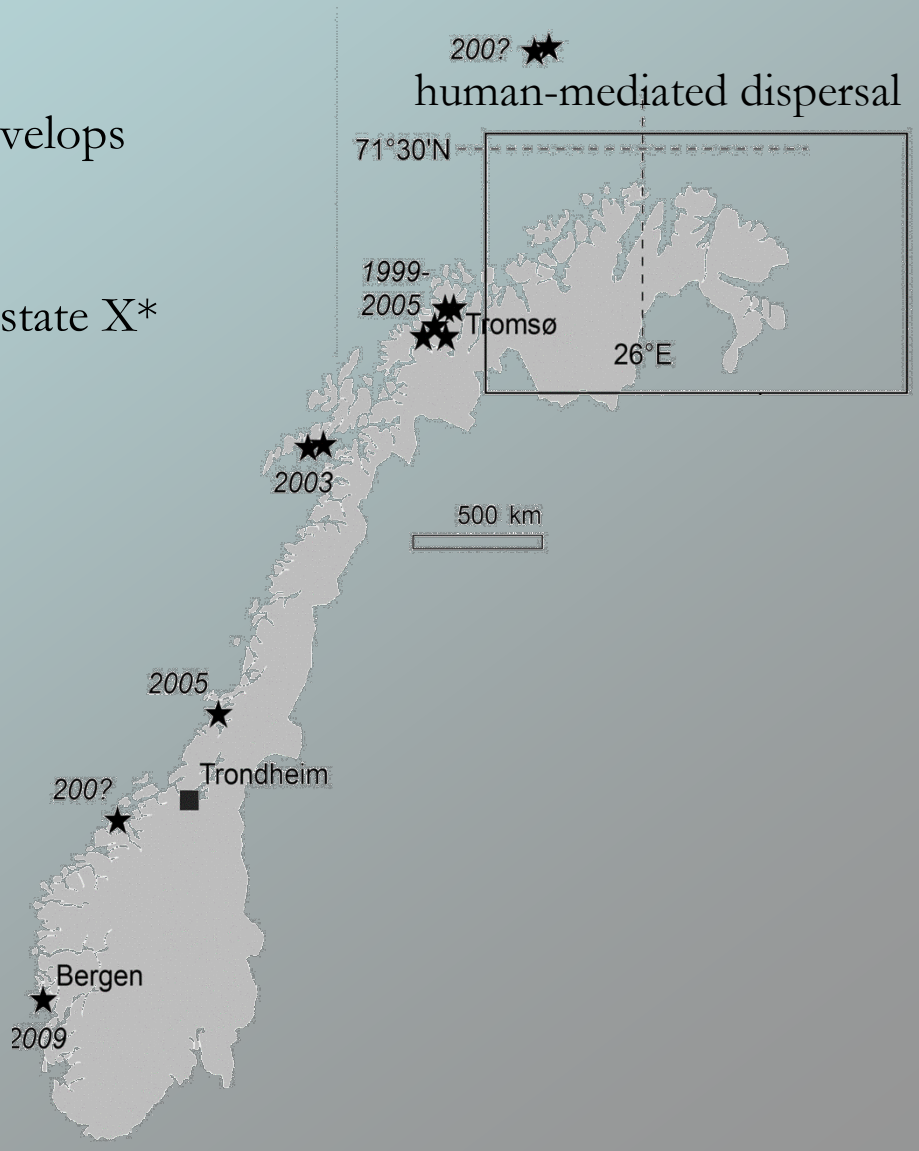
trawl catch at 110 m depth in non invaded nearby fjord



Pro's and Cons of Commercial harvesting as a means of control for ecological goals

- ✓ Quotas: Compensation for Damages
- ✓ Market Benefits grow larger as invasion develops
- ✓ Increasing economic dependence
- ✓ Additional pressure on Social Planner
- ✓ Myopic strategies may justify larger steady state X*

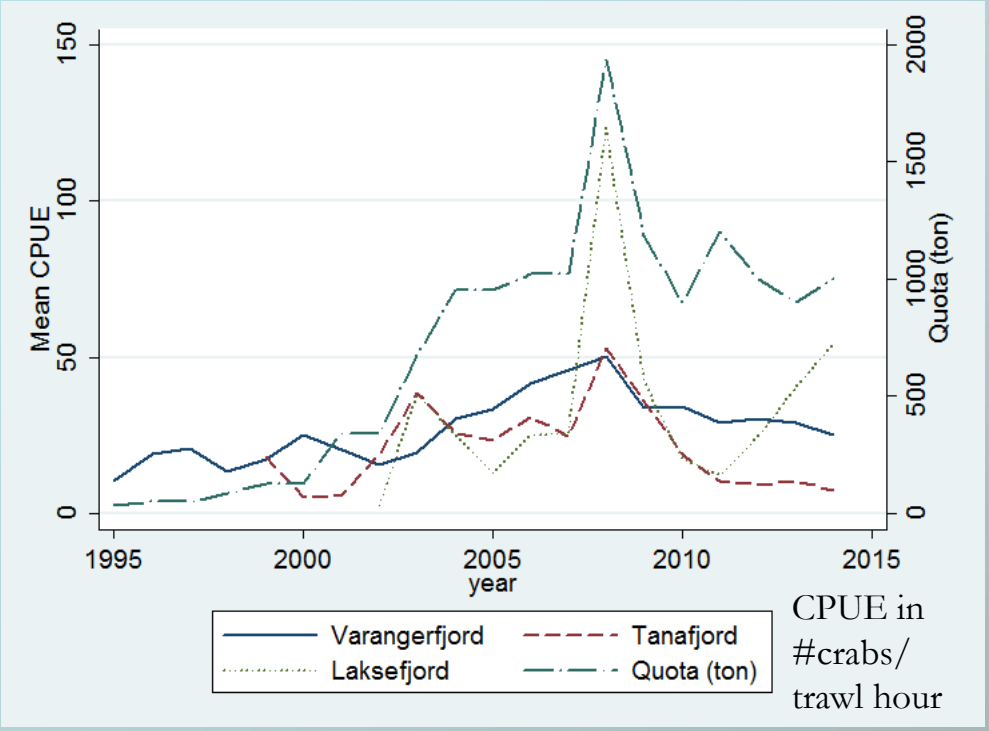
- ✓ RKC < 0.8kg not commercial
- ✓ Måsøy: Expand the border to give access to Quota Regulation!
- ✓ E/W Discard policy differs too
- ✓ Norwegian violations of international policy on invasive species?



Thank you very much for your attention

mkour@sdu.dk, baka@sdu.dk, lmfernandez@vcu.edu

Blunt management tools: Need for refinement?



CPUE in #crabs/ trawl hour

- ✓ RKC expanding spatially & in density
- ✓ Management pushing down X
- ✓ Laksefjord (close to 26°): unstable. Increased harvest maybe ?
- ✓ Posangerfjord & other fjørds ?!

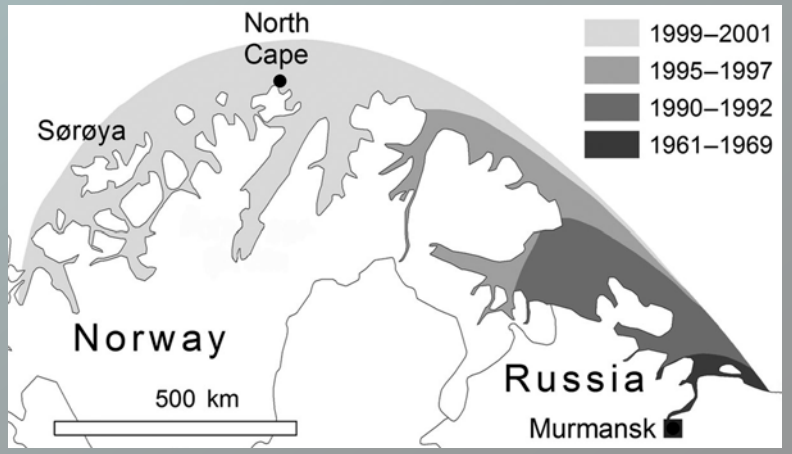
Spatially explicit concerns

✓ **West**

Reduce X (With Investment beyond OA outcome):

- own damages
- International Spatial spread/Mitigation?

✓ **East**

Reduce X (With Quota?) for

- own damages *(if any)*
- Within Norway Spatial spread/Mitigation?