MANAGEMENT AND ECONOMICS OF RESOURCES AND THE ENVIRONMENT
UNIVERSITY OF SOUTHERN DENMARK
Department of Sociology, Environmental and Business Economics

SDU

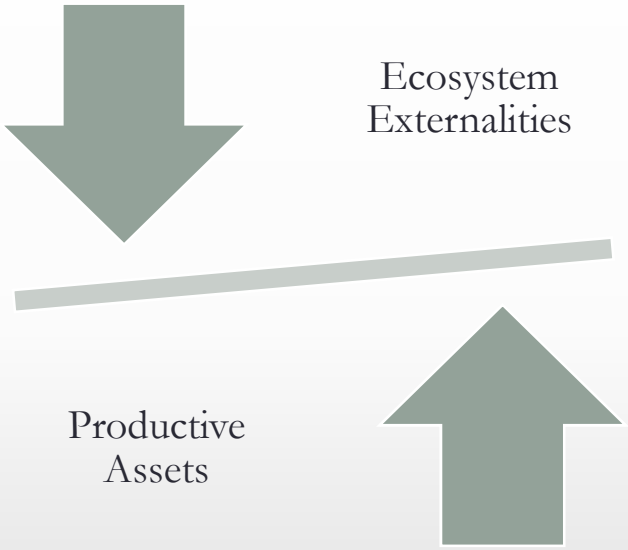
Allocation of research resources for invasive species with a commercial value: The case of the red king crab

Melina Kourantidou, Brooks Kaiser

CAFF 2018
9/10/2018, Rovaniemi

Invasive Species Management: The Red King Crab

- Why do we need to care about allocation of research resources for invasions?



- **Literature**: Optimal allocation of resources to **Prevention** versus **Control**
- **Gap**: **Information costs** of research at **Pre-** and **Post-** invasion stages

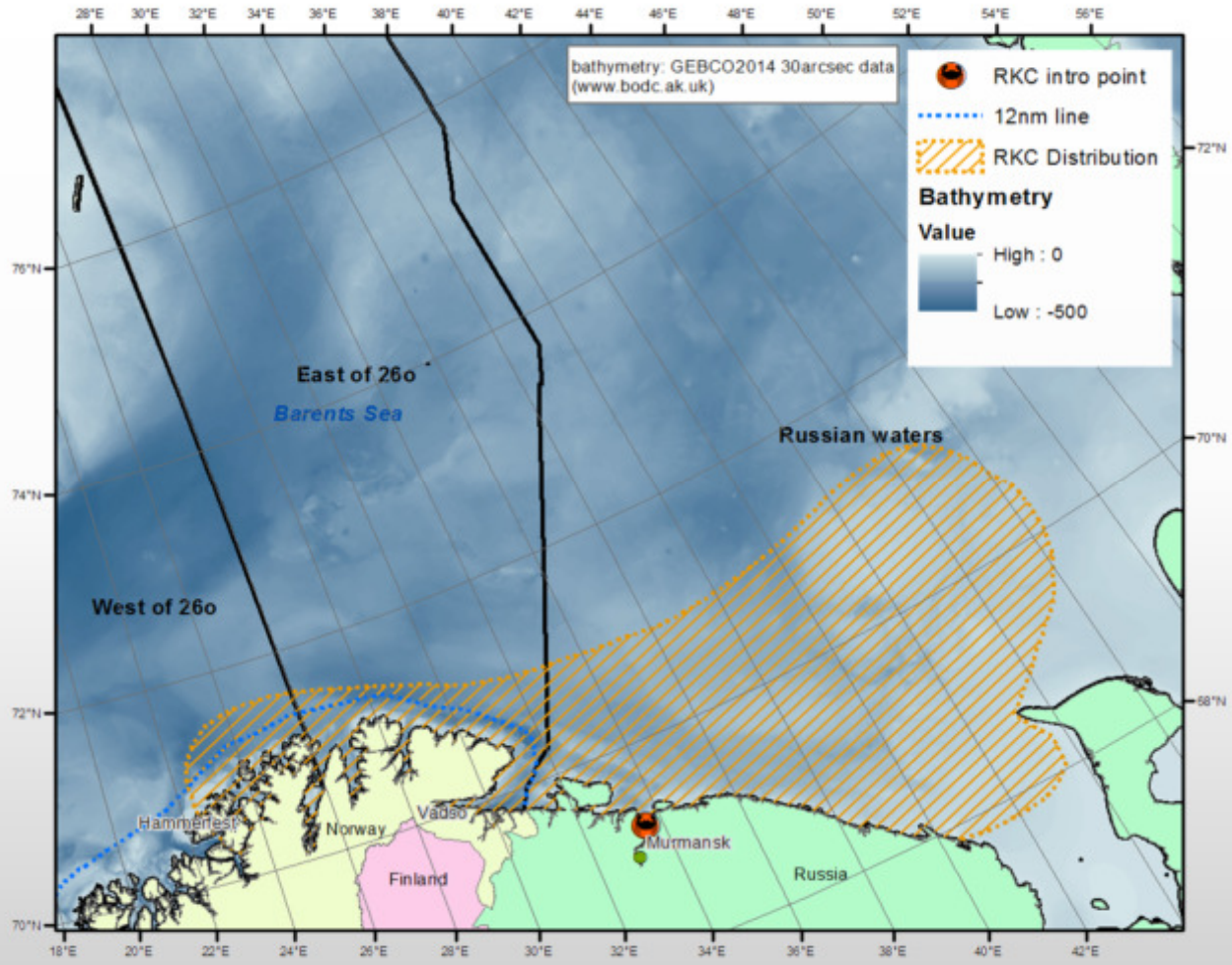
Red King Crab (RKC), *Paralithodes camtschaticus*

- Representative (Spreading nuisance & Valuable Economic Resource)
- Question of Precision of Economic Profit Vs Environmental Costs

A hard to measure trade-off

Paralithodes camtschaticus

- Reconcile: long-term fishery vs. minimum spread
- High fishing mortality limits the spread but reduces stock
- Nærings- og fiskeridepartementet unclear on how to balance the **risk of spread** with **fisheries' stability**
- Socio-economic welfare in Finnmark's local communities



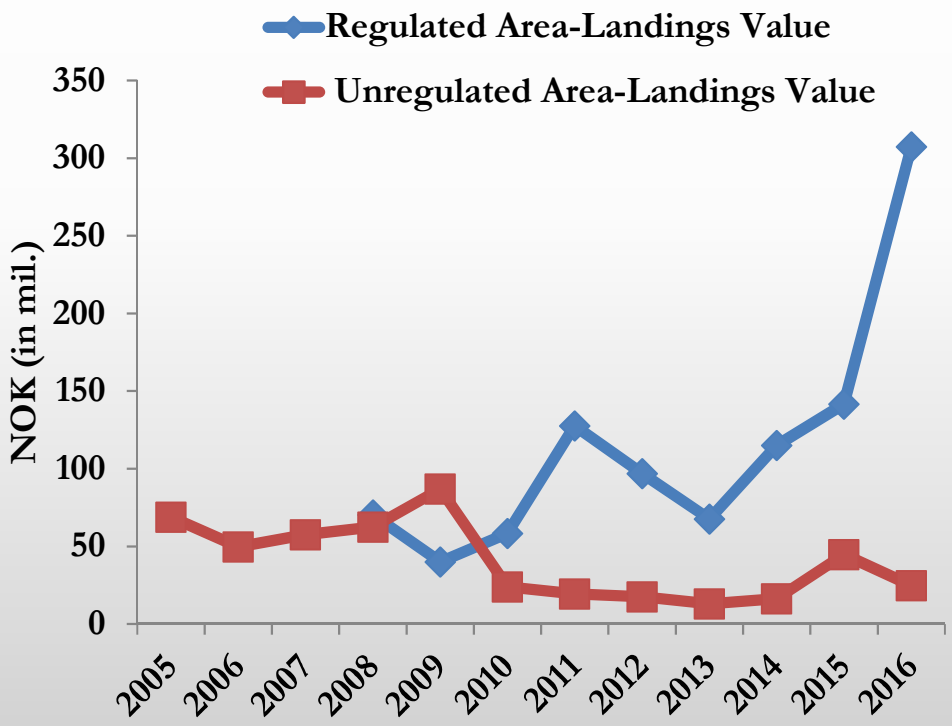
Russian waters
142,048.9 km^2

Norwegian waters
East of 26°E
(Quota-regulated)
11,280.86 km^2

West of 26°E
(Open-access)
12,253.32 km^2

A threat or a fishing goldmine?

The goldmine



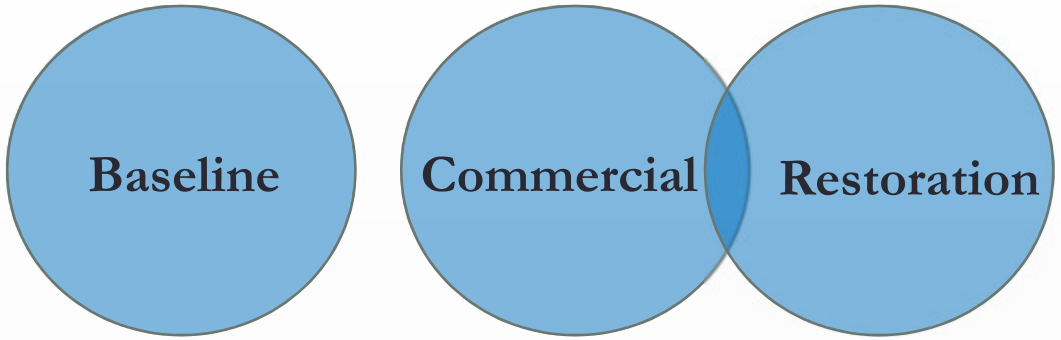
The threat

- Bycatches
  - Fuel: 7.4 mil NOK
  - Maintenance & Gear: 1.9 mil NOK
- Commercial Species
  - Capelin: 8.8 - 657 mil. NOK
  - Lumpsucker : 1.4 - 4.3 mil NOK
- Benthos: 7.3 mil - 2.7 bil NOK
- 6.3 - 948 NOK/crab or
  2 - 296 NOK/Kg

The threefold management of the Red King Crab

- What costs more to society ?
  - **Poor management of the commercial stock ?**
    MEY/MSY (Stock assessments, Harvesting costs, Optimal Stock)
  - **Poor knowledge of ecosystem values lost?**
    Costs of invasion externalities – ecosystem losses (Monitoring)
  - **Poor knowledge of natural resources at stake?**
    Baseline ecosystem assets at risk (EDRR -Early Detection and Rapid Response)

Allocating Research Resources



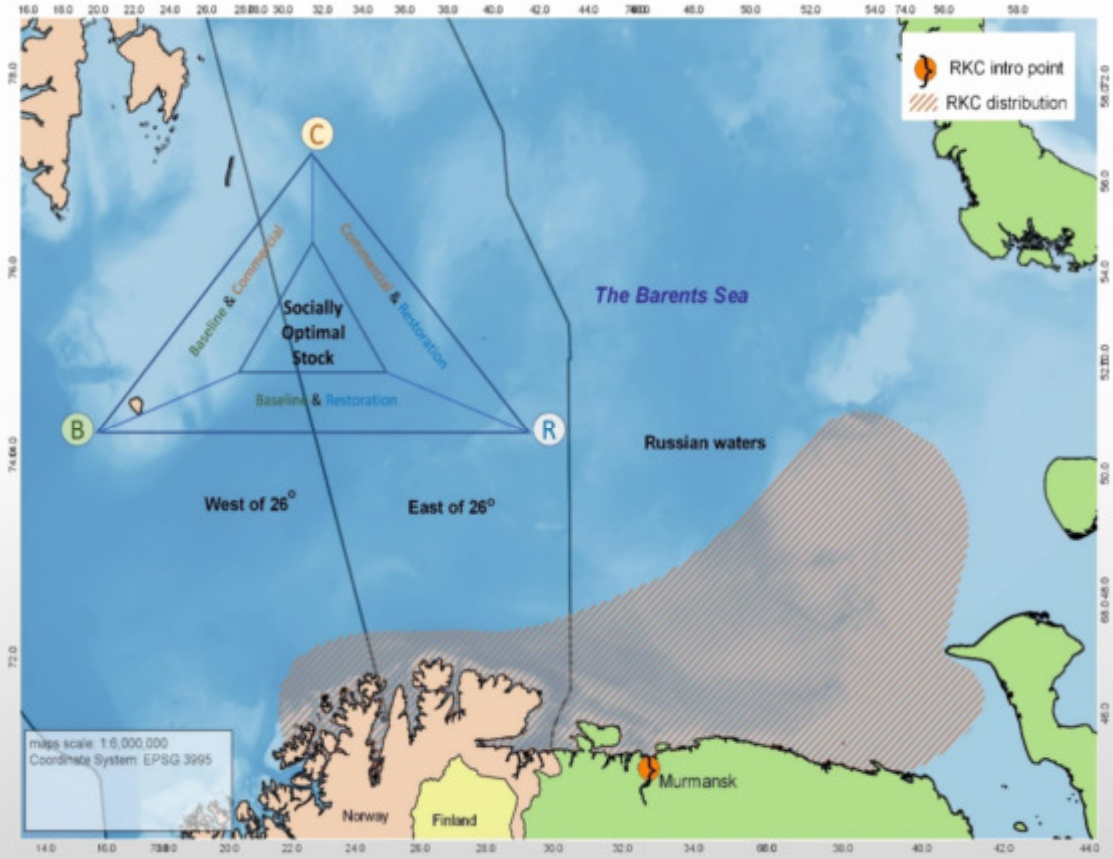
Benefits accrue from

- Research on **Commercial** stocks
- Research on external damages & risks

External Damages can be studied

- Ex-ante (**B**aseline) (ahead of invasion frontier)
- Ex-post (**R**estoration) (within invaded areas)

Socially Optimal Harvest: Baseline, **C**ommercial, **R**estoration



✓Limited Budgets

✓Where is the marginal resource unit available for research, better spent?

Model & Assumptions

Probability of "success" / "research hit" matter in allocation of $

P_C, P_B, P_R $\qquad\qquad$ R_C, R_B, R_R

- Assymetric Probabilities of Success
  - Research in the **Frontier** area **(B)**
    - Improves information on external damages
  - Research in the **Invaded** area **(I)** (C & R)
    - Reduces missing information on commons problem
    - Improves information on external damages

More diffuse chances of proving directly applicable to management decisions

$$P_I(P_C, P_R)$$

$$0 < P_B < P_I \leq 1$$

Avenues for improving Social Welfare: Commons problem & External damages

✓C & R carried out in tandem by research vessels, east of 26° E *(Assumption with empirical merit)*

✓B & I are independent s.t an increase in P_I due to exogenous factors, does not reinforce P_B

*(As long as areas West & East of 26° E share similar ecological characteristics, $1 spent in **B** type increases the Marginal Benefit from the I type, **particularly through R**)*

The Decision maker's problem

$$\max_{R_B, R_I} W = P(R_B)P(R_I) = [1-(1-P_B)^{R_B}][1-(1-P_I)^{R_I}]$$

s.t. $\quad R_B + R_I = R_T$ $\quad$ R_T: Total budget available for RKC-related research.

- First Order Conditions (F) (imply optimal research dollar allocation) R_B^o, R_R^o
- Second Order Conditions (imply the existence of a unique maximum)

- As long as $0<P_B<P_I\leq 1$. holds, then $R_I^o < R_B^o$ also holds

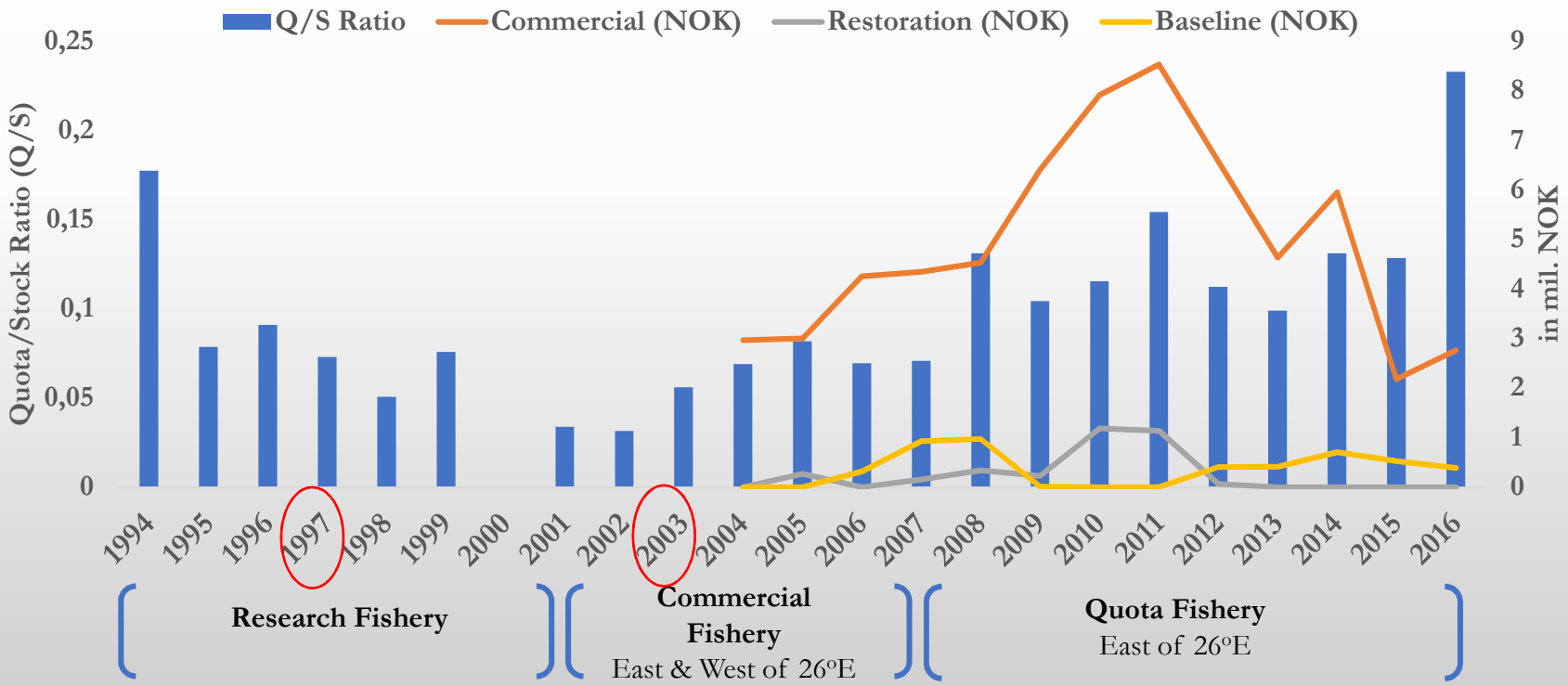
The optimal allocation of research resources favors, at the margin, the most challenging type of research

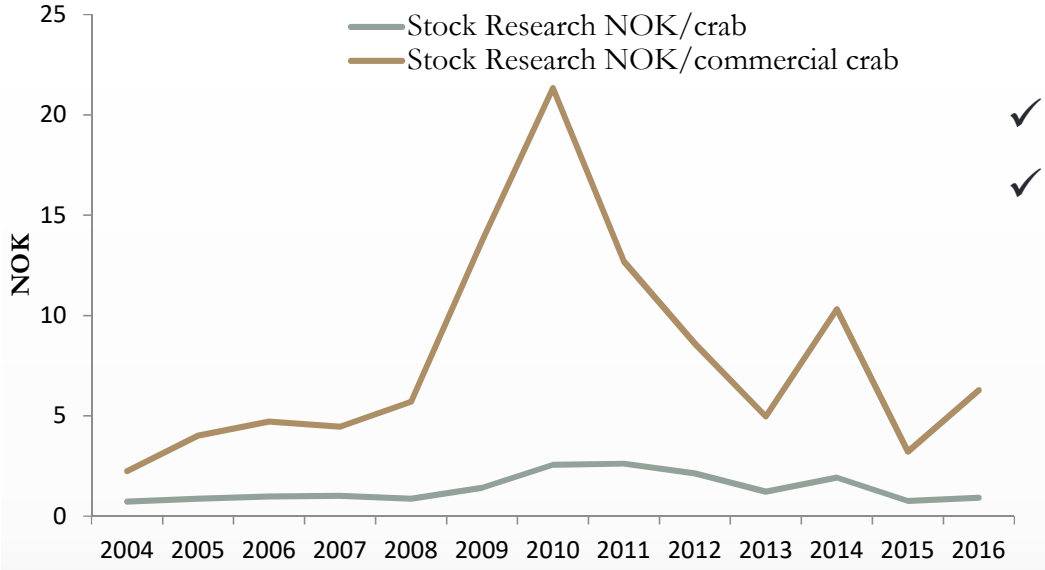
- Comparative Statics

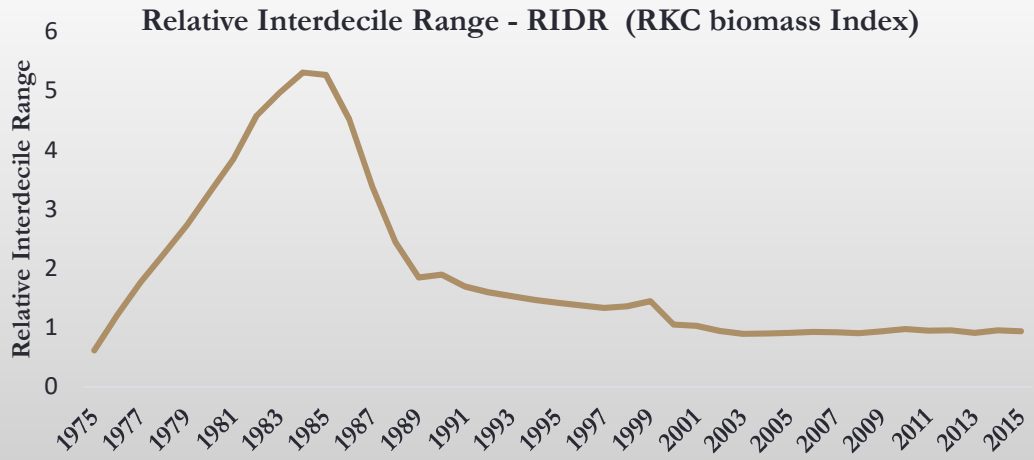
$$\left.\frac{\partial F}{\partial P_I}\right|_{P_I^o} \overset{s}{=} \frac{\partial R_I^o}{\partial P_I} < 0 \quad \text{and} \quad \left.\frac{\partial F}{\partial P_B}\right|_{P_I^o} \overset{s}{=} \frac{\partial R_I^o}{\partial P_B} > 0$$

IMR (Public research institution)

- **Primary responsibility**: advice to national authorities (e.g. Ministry that sets TACs), industry & society
- **Research group**: "Benthic Resources and Processes" leads RKC research
- **Research interests**: Optimal & sustainable shellfish management – Impacts from introduced benthic species







- ✓ Stock uncertainties start shrinking
- ✓ Investments in C type may
  - ✓ have resulted in efficient models
  - ✓ not further advance our understanding (small payoffs from additional investments)

Policy Recommendation

Restrict resource allocation in
Commercial Research
to annual stock estimates,
to allow space for overlooked
Baseline Research
at the western frontier

Extensions

- External Inputs to Baseline Research: MAREANO
  - >700 mil. NOK program (Norwegian Environment Agency)
  - seabed characteristics, biotopes, distribution of benthic fauna communities & biodiversity
  - no such research efforts taking place except for few recent benthic megafauna studies

- Streamline scientific information flows across agencies with overlapping interests; Investments in MAREANO can be better used for identifying Baseline
- Failure to do that creates costly blockages in effective management
- 1 more $ spent on **Baseline** research, given current allocations, should have a higher expected return that 1 $ spent on **Commercial** research
- A problem of fragmented management; Research goals need to be expanded beyond fisheries management to include invasive species management

Conclusions

- Imbalanced resource allocation (ad-hoc 26°E) rather than weighting **bioeconomic trade-offs** from invasion/fishery
- The controversial crab in Norway has been triggering polarized reactions
  - UN Convention on Biological Diversity
  - RKC industry
- Ranking formula needed for research types with different objectives
- Research resource allocation for IAS with a commercial value
  - Decision makers are poised between investing more resources in better understanding
    - harvesting potential
    - ecosystem impacts
  - Importance of prioritizing criterion as a means of identifying the underlying **bioeconomic trade-offs**


Melina Kourantidou
mkour@sdu.dk
Thank you very much
for your attention.
This work was generously supported by:
Belmont Forum, Nordegio, International Network Programme (INP)