Bio-economic analysis for Arctic Marine Resource Management Policy

Niels Vestergaard

Department of Environmental and Business Economics

Centre for Fisheries & Aquaculture Management & Economics (FAME)

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Background

- Climate change
- Nature is not stable – climate change will not make it more stable.
- Fishing opportunities will open up, while others will close down.
- Management systems will be challenged.
- Short run, medium run and long run issues.
- Temporary and transient periods will be important – we are not that used to analyze such periods/intervals.

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Arctic marine management issues

- Future changes in Arctic marine ecosystems will depend on global climate change and on our ability to regulate and manage exploitation pressure at sustainable levels.
- There is a lack of integrated, cross-sectoral ecosystem-based analysis of the Arctic marine management.
- The analysis could include both the choices for implementing regulatory tools and how they will affect the many ecosystem-dependent values derived from them.
- The ability to maximize these values depends critically on the ways in which the dynamic bio-economic properties of the resources are impacted by the human behavior induced by the regulations (or lack thereof).

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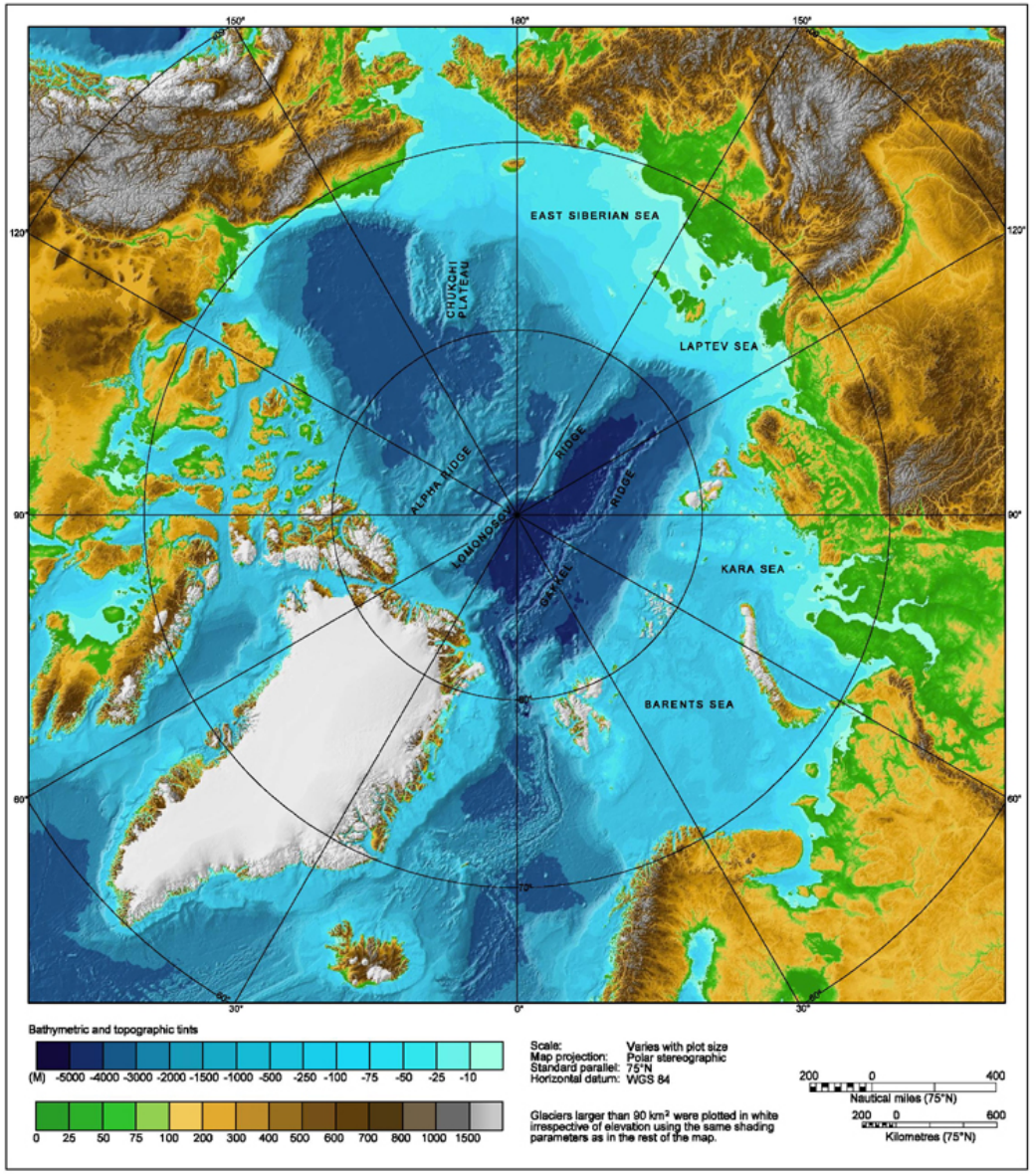
Fishery expectations

- Changes in potential fish production are shown to most strongly mirror changes in phytoplankton production.
- Due to both higher temperature and higher primary production (due to less ice cover and hence more sunlight) the (Sub)-Arctic fish stocks are expected to move north and some (if not most) of them to increase in biomass size.
- Polar amplification. As an example, predictions for year 2100 indicate that the temperature at Equator will be 1C-2C higher, while at the North Pole the increase in temperature is predicted to be 6C-8C higher.
- This will in turn form the basis for increased fishing in the region in the next many decades.

Fisheries expectations

- Cheung et.al.: Climate change may lead to large-scale redistribution of global catch potential, with an average of 30–70% increase in high-latitude regions and a drop of up to 40% in the tropics.
- Wassman et. al. (2011), McBride et. al (2014), and Christiansen et. al (2014): Northward expansion of various subarctic as well as temperate species, while the abundance of indigenous species are in decline.
- Strong gradients exist in species richness from warmer, subarctic waters to colder, Arctic waters, implying a high potential for species expanding into Arctic waters as temperatures increase.

Bathymetric map of Arctic Ocean



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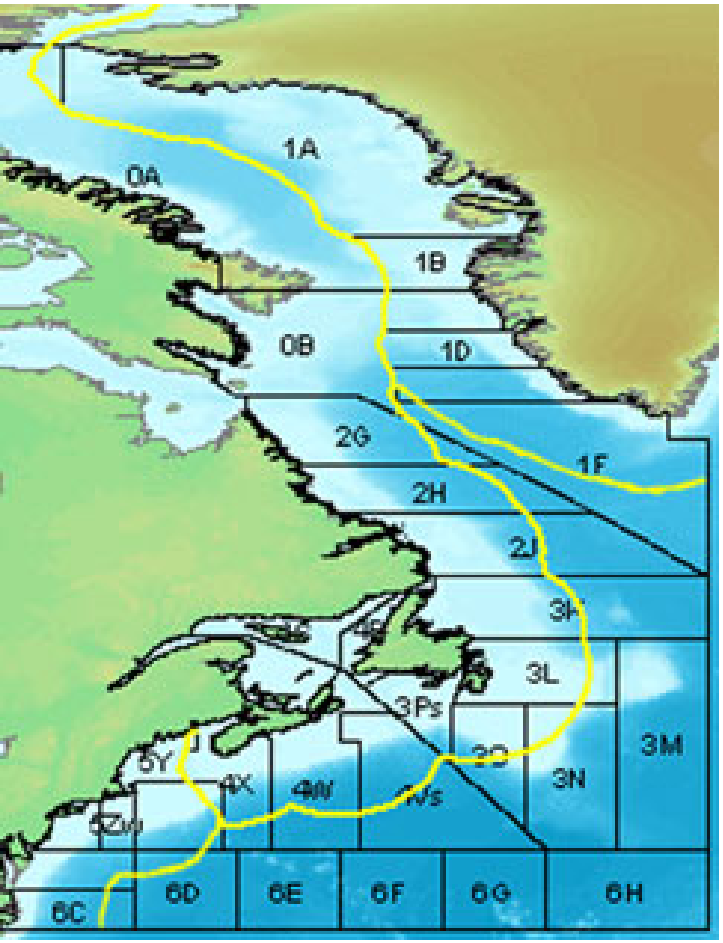
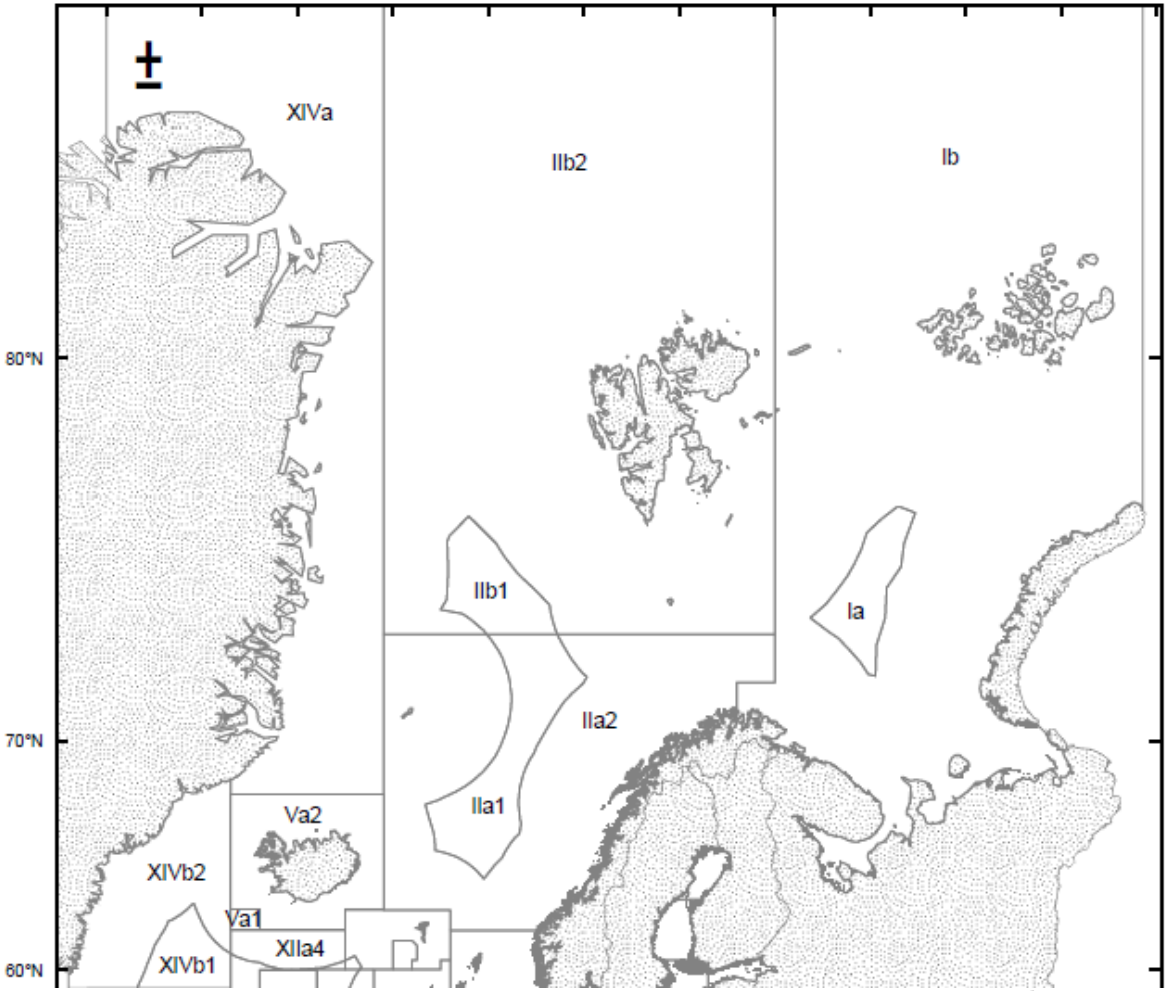
Nafo areas



ICES areas



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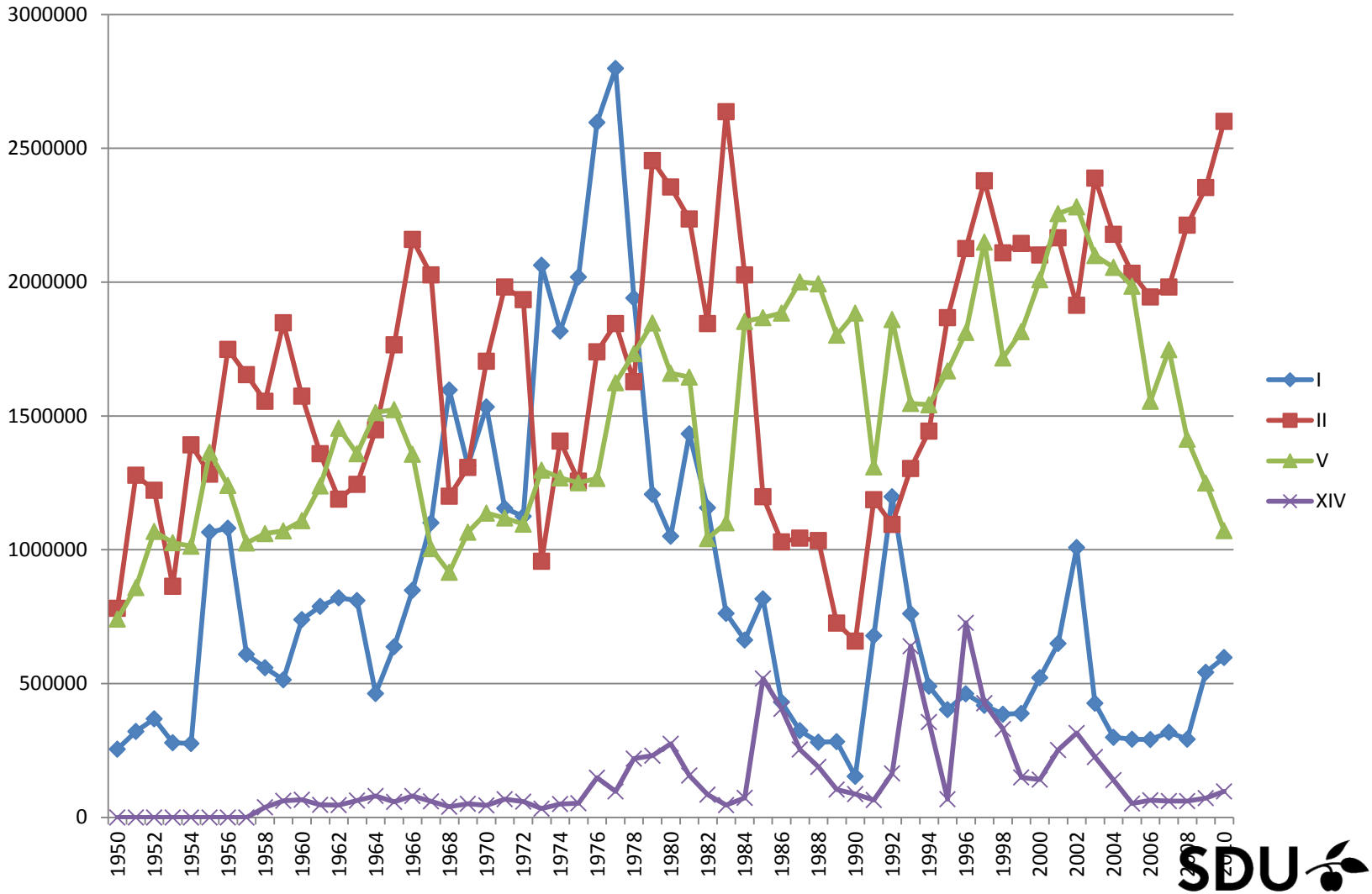
Catches in ICES areas I, II, V and XIVa+b (tons)



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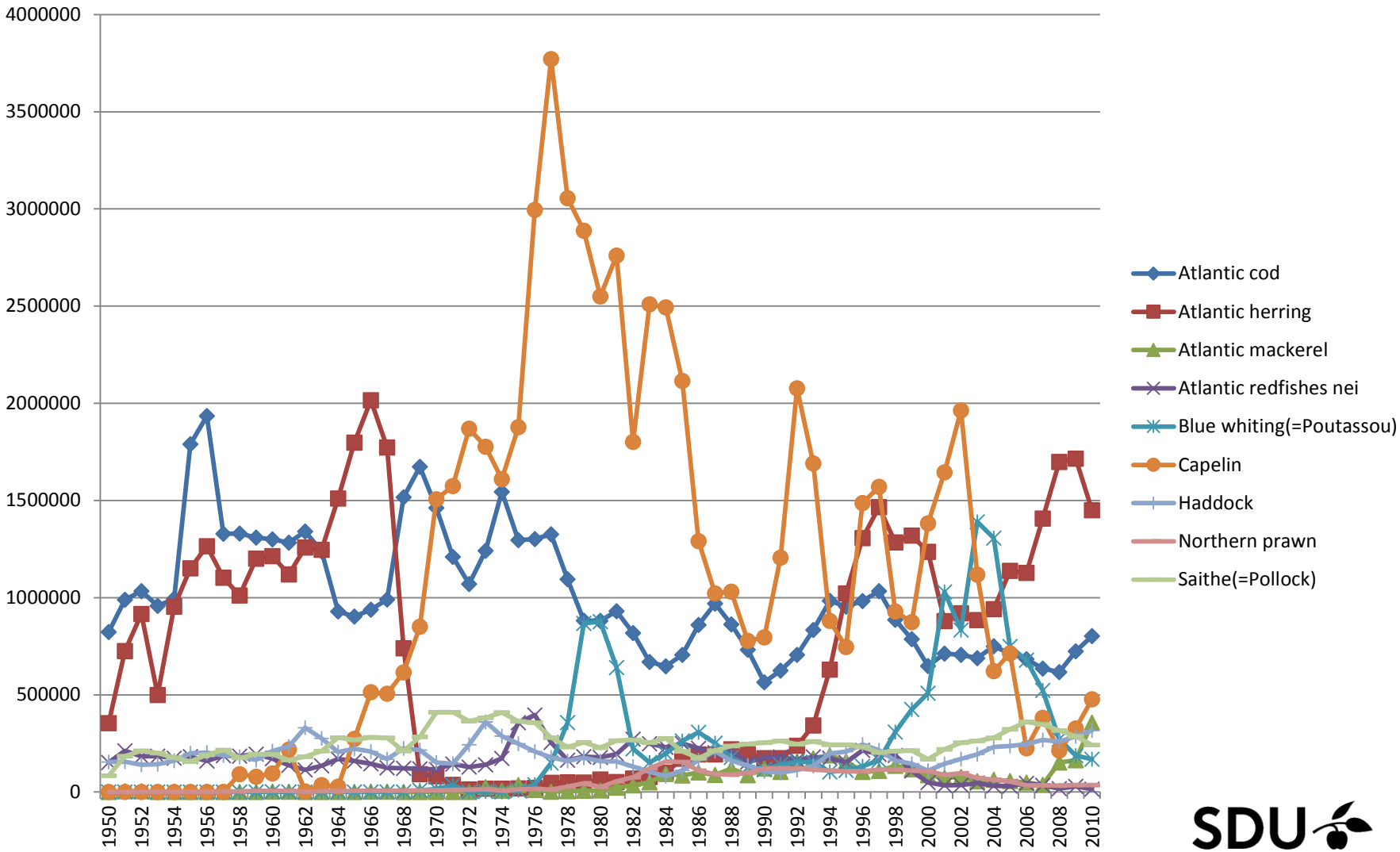
Catches in ICES areas of species



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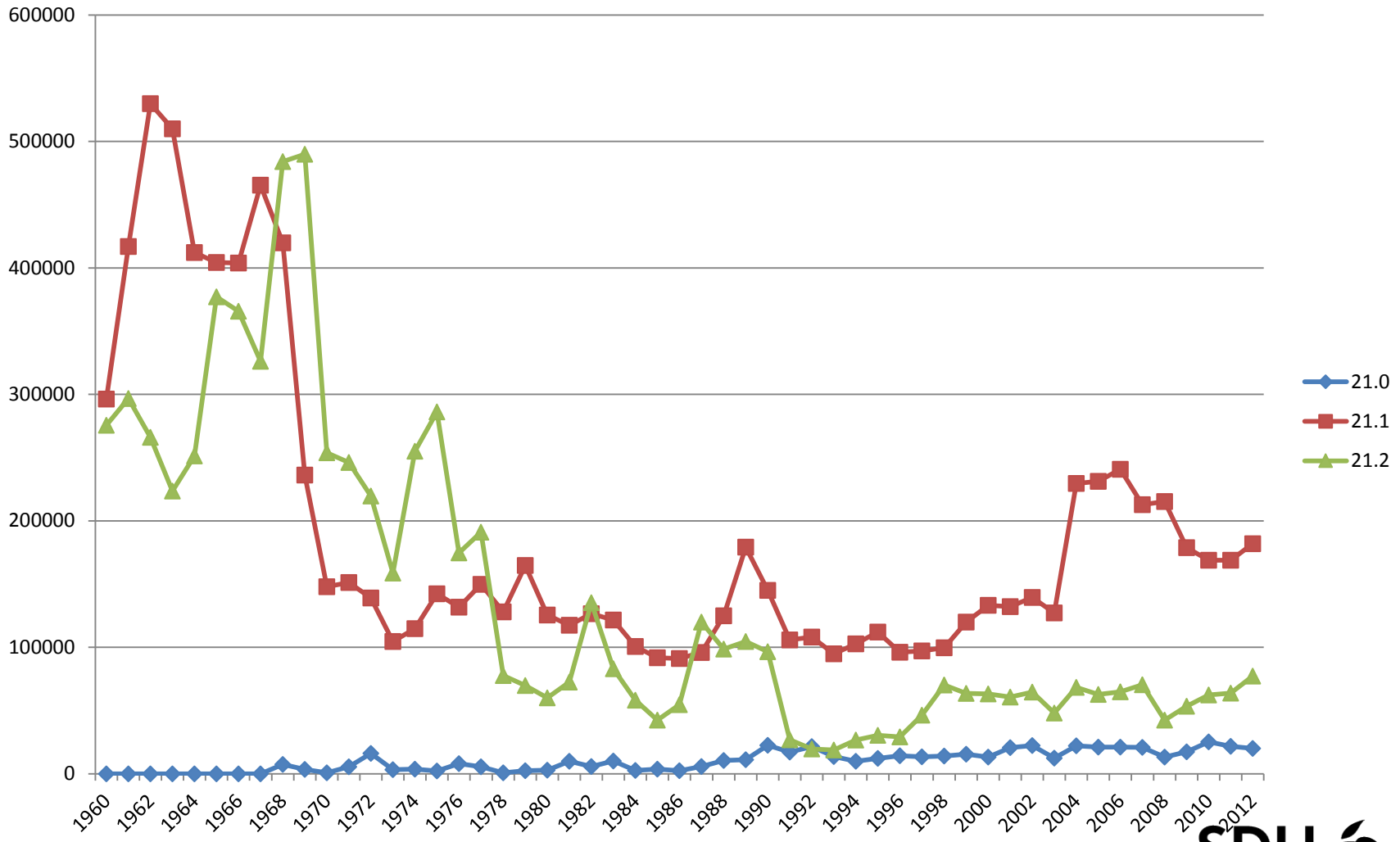
Catches in Nafo areas



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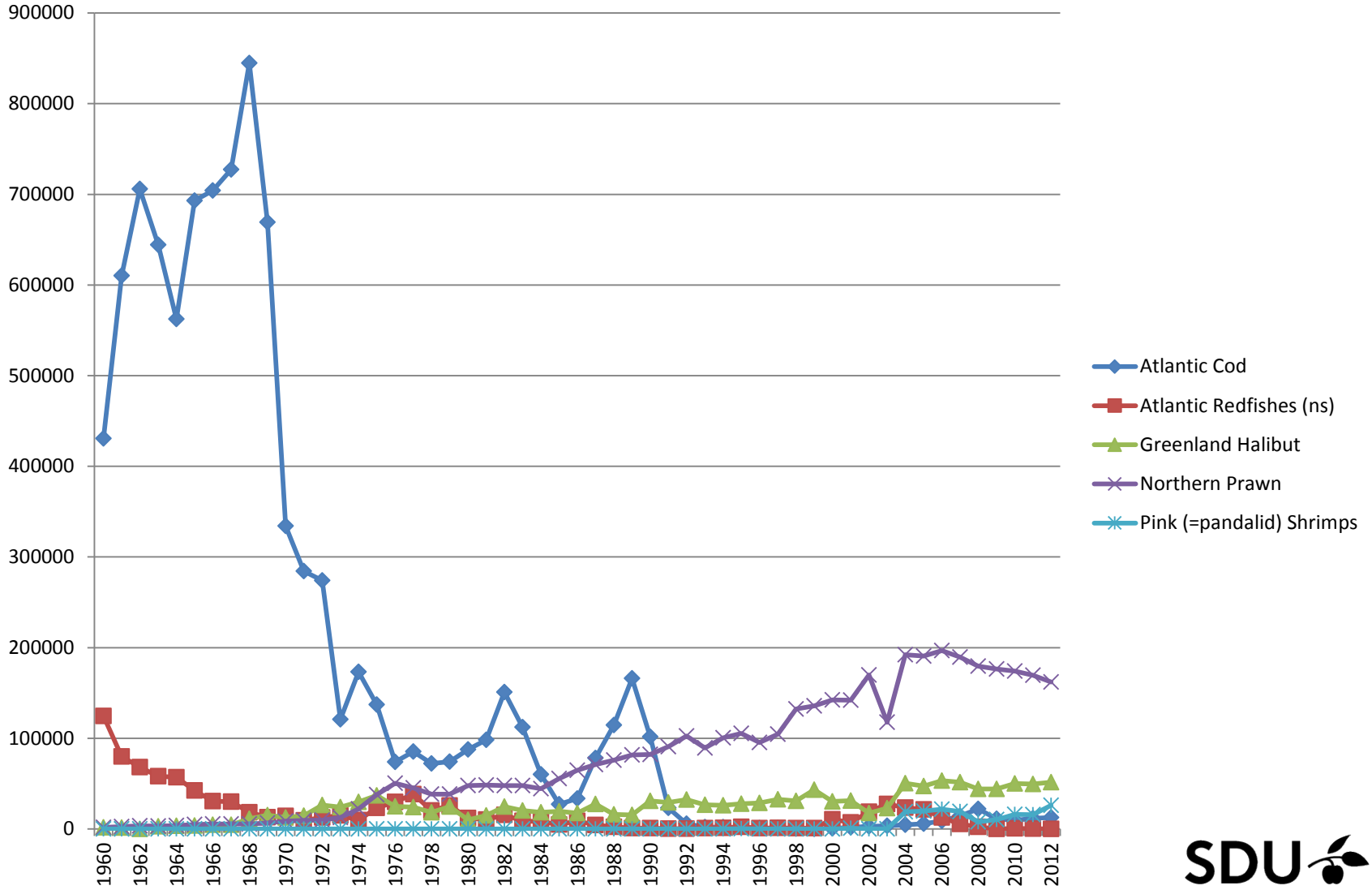
Catches in Nafo areas



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Catches in Arctic Ocean

- Zeller et. al. 2011. Arctic fisheries catches in Russia, USA, and Canada:

- "Cumulative fisheries catches for FAO Statistical Area 18 for the period 1950–2006 have been officially reported as 12,700 t, by Russia (former Soviet Union), while no catches have been reported by USA or Canada.

- This compares with our reconstructed total catches of over 950,000 t, being 770,000 t by Russia, 89,000 t by USA, and 94,000 t by Canada.

- With regard to individual LMEs, over 80% of total catches were taken in three exclusively Russian LMEs, illustrating a marked reliance of the relatively large local population on coastal marine resources"

Fundamental uncertainty

- We are **not** looking at a case where there is uncertainty around some mean value;
- The set of potential states is unknown, much less the probabilities, effect of actions or their net benefits
- The uncertainty is not only related to climate change; but also to our response with respect to the Arctic opportunities (mining, shipping, tourism etc.)
- Scenario analysis is a tool to be applied when there is fundamental uncertainty.
- Scenario analysis can at best inform about the sample space; how does it look like and what ranges are likely?

Scenario analysis

- Examples: IBM, Shell, IPCC, MEA.
- Scenario planning is a method for thinking creatively and systematically about complex futures.
- Scenarios are sets of plausible stories, supported with data and simulations, about how the future might unfold from current conditions under alternative human choices.
- Decision-makers can assess the robustness of alternative policy options by determining how each policy would play out in each of the different futures.
- In scenario planning, unlike decision theory, it is not necessary to assign probabilities or values to the alternatives (this is also a weakness).

Building scenarios

- Find the key factors driving change and development.
- It is also where the fundamental uncertainty is.
- Scenario structure method
  - combines two or more key drivers of change to give a range of possible scenarios
- Actor analysis
  - Question 'who are the most important actors in the scenarios and how might they be expected to act?
- Actor analysis often supplement the scenario structure method.

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Millennium Ecosystem Assessment (MEA)

Driving Forces	Importance	Uncertainty
Demographic Drivers		
Economic Drivers	**High**	**High**
Sociopolitical Drivers	**High**	**High**
Cultural and Religious Drivers		
Science and Technology Drivers		
Climate Variability and Change		
Plant Nutrient Use		
Land Conversion		
Biological Invasions and Diseases		
Tourism		
Land Use Change		

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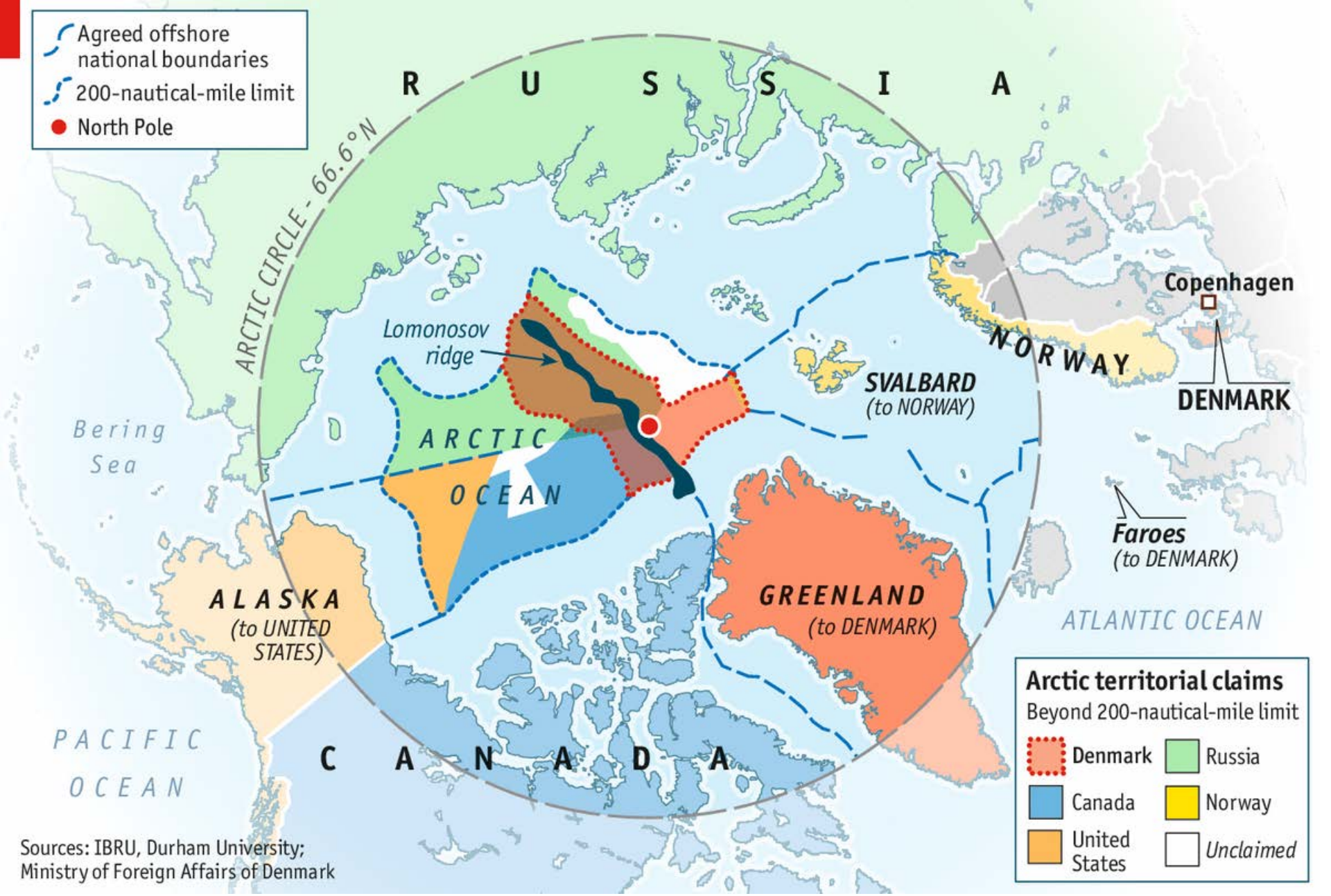
Uncertainties

- Stable legal climate
- Radical change in global trade dynamics
- Oil prices ($US55-60 to $US100-150)
- Major Arctic shipping disaster
- Rapid climate change
- China, Japan and Korea become Arctic maritime nations
- Transit fees
- Conflict between indigenous and commercial use
- Arctic maritime enforcement
- Escalation of Arctic maritime disputes
- New resource discoveries
- World trade patterns



Sources: IBRU, Durham University; Ministry of Foreign Affairs of Denmark

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The Governance Axis

- The governance driver is about the degree of relative stability of rules for marine use both within the Arctic and internationally.
- Less stability implies shortfalls in transparency and a rules-based structure, and an atmosphere where actors and stakeholders tend to work on a unilateral basis.
- More stability implies a stable, efficiently operating system of legal and regulatory structures, and an atmosphere of international collaboration.

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Resource Development and Demand

- The level of demand for Arctic natural resources and trade. This factor exposes the scenarios to a broad range of potential market developments.
- More demand implies higher demand from more players and markets around the world for Arctic resources, including increased access for trade in the Arctic Ocean.
- Less demand implies fewer players interested in fewer resources.

Four Scenarios

- Poor governance structure and high global demand: **Open access rush**.
- Poor governance structure and low global demand: Low economic growth and an **underdeveloped Arctic.**
- More stable governance structure and high global demand: **Arctic is integrated into the world economy with conservation of ecosystems**
- More stable governance structure and low global demand: **Arctic as an eco-preserve**

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Future work

- Bio-economic modeling of fisheries can be applied and each scenario can form a basis for framing the management issue.
- The northward movements of fish stocks, due to climate change, create time and spatial externalities.
- How does the cooperative optimal fishery policy of shared stocks look like with exogenous given fish stock movements across jurisdictions? And how will the independent fishery policy of each state look like?
- How does this type of spatial externality evolve over time?