Marine Invasive Species Economic Issues for the Arctic

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Marine Invasive Species

Ships enter the Arctic Ocean where they can jeopardize production opportunities of nature (commercial, recreational, existence values of marine resources)

Ships are vectors of potential threat to Artic with Unintentional, mobile aquaria of biological pollution: hitch hiking invasive species

- 3 vectors: ballast water and hull fouling for commercial and recreational vessels, ship infrastructure in and away from ports
- Collision threat to marine mammals (spatial competition of shipping lanes through traffic and sound)
- Bulk Cargo and Resource Extraction-supplies from South to North and moving raw product out of North to South for processing and sales is happening will increase faster than East-West shipping without replacing Panama Canal

Several types of ships for Arctic

Vector Management

- Vector direction, magnitude and flow influences marine invasive species risk with a transport matrix including transfer coefficients between shipping source, intermediary and destination ports.
- Ship transport density distribution
- Contagion for Artic Ports and Beyond
- Motivators of Vigilance for public management: With higher production value, disincentive to not cooperate because potential damage lowers benefits in shared space
- Motivators of Vigilance for ships: Speed, Weight, Cost, Avoidance of Potential Damage

Incomplete and Uncertainty Policy?

- IMO and Arctic states as signatories to IMO conventions as platform with draft Polar Code
- Koivurova & Molenaar and Young indicate the Arctic Council is consensus based and cannot impose legally binding obligations.
- MARPOL 73/78 and SOLAS 74 do not include the vectors of marine invasive species, cetacean risk for Part I-A Safety and II-A-Pollution Prevention relates to Sewage and solid waste garbage on the ship.
- February 2004 International Maritime Organization (IMO) suggests numerical limit on invasive species in ballast water emissions (entering and exiting 200 mile EEZ)
- North-South dimension ignored
- Aim: disclosing information makes biosecurity threat less unknown. What policy does this and links repercussion to the shipper?
- Make information disclosure a source of financial incentives for abatement options of vectors.

Maritime View to Arctic from the Americas-North-South and East-West vectors for invasive species

Arctic Ratification of IMO Policy

- 5 of eight member states of the Arctic Council have ratified the IMO BWM Convention (Norway, Russia, Canada, and Denmark, and Sweden)
- United States, Finland, and Iceland have not.
- Although not a signatory, the United States' federal regulations require mandatory ballast water reporting and management of overseas ballast water (with inspection at ports)
- With the policy gap, need to explore economic incentives towards protection against marine invasive species

Tracking of ships spatial and dynamic movements episodically in Arctic:

- Monitoring capabilities in Vardo, Norway, Murmansk, Russia for VTS with remote surveillance monitoring for Barents area.
- IMO suggests same approach around Arctic requiring ships of 5,000 gross tons or more, tankers, hazardous cargos, ships longer than 200 meters and nonfunctioning vessels to notify either Vardo or Murmansk, VTS including automatic identification system, long range identification and tracking, web map service and satellite based synthetic aperture radar.
- Canada and U.S. Coast Guard Arctic area with similar technology
- Characterize dynamic (and spatial) risk values per vessel based on type of ship, cargo, age, flag of ship, water and sea conditions, traffic information, distance from shore, etc. wider than port

Shipping and Arctic ports with different information on risk and pollution control is similar to international trade between exporters and importers

- Asymmetric Information
  - shipper risk abatement to reduce biosecurity threat (hidden action, moral hazard)
  - shipper abatement cost (hidden characteristic, adverse selection)
- Instrument
  - Mechanism design contract to overcome information asymmetry, pollution externality

- Ports offer access for shippers so outcome of port access should be basis of contract between port and shipper

Overcoming the information gap

- Moral hazard with private information of transporters and unobservable abatement effort Without observation, there's incentive to underinvest, unless some check ensues (ballast water reporting , low sulfur fuel requirement).
- Create instruments to overcome information asymmetry and encourage revealing the hidden information. Sharing of information is the primary interest for consensus building and addressing biosecurity in an era of global interdependence.

Access to Arctic Ports with Contract

- Contract with incentives for a desireable level of abatement of the shippers. Make agent's payment contingent as a function of the outcome (clean access).
- If port (principle) knows the shipper's indirect utility function or production function (on timing and volume of ballast, cargo, hull, ie emissions) to anticipate shipper actions and work out optimal strategy. Make contract spatial, tied to transport matrix. Monitoring would help if recommended abatement is not always visible (with remote surveillance).

At any given Arctic port…

- How about a random access penalty?
- If total ambient concentration exceeds the targeted IMO guidelines at a common site, the port manager redistributes a portion of a random fine minus damages to society from noncompliance back to the other shippers.
- The random penalty increases the expected costs of shirking and induces the targeted control level without having to monitor the actions of all shippers.
- Random penalty mechanism has less information requirement to implement than taxes or subsidies. But, need monitoring at the receptor port site and data on ambient concentration. Studies not involving shipping have been done by Xepapadeas (1998) and Holmstrom (1982) for producers (not shippers) with [illegible] et al (1994) indicating risk

North South Modeling Analysis

- Applied Game Model
- Asymmetric incentives across countries (different pollution control costs, flow and stock effects, ability to pay, damages)

Integrated Model Components –with multiple decisionmakers acting simultaneously

- Minimize expected net costs of abatement and damages due to invasive species

- Constraint: State equation of invasive species dynamics with transport matrix of invasive species and whale collision risk between ports
- Incentives help combat invasive species with uncertain damages and asymmetric information

- For policy, make use of existing *technology of surveillance for more* and port reporting charges (need two policy instruments to address two problems: multiple vectors & asymmetric info)

For Cetacean Threat and Ship:
Ship traffic density, noise map, whale distribution

- Satellite data and AIS data with risk assessment by spatial overlap of acoustic habitat forecasts toothless cetaceans (baleen and bowhead) as more vulnerable to noise (hydrophone and speaker records)and disorientation with others affected (narwhal, fin) (Williams et al, 2010, 2014).
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- Costs to ships: lost time in dry dock repair, lengthy insurance inspection, physical damage.
- In particular locations, spatial competition between whales and ships, traffic separation option may be ideal not speed change, similar to latest findings for blue whale in more southern waters.

Items to Ponder

With policy gaps, need to explore economic incentives for abatement of marine invasive species-

Assembling various components of public and private sector vector management for the Arctic and vectors involves a variety of social and natural scientists along with policymakers.

One island economy example of focused vigilance on information based policy is:

- NZ 1993 Biosecurity Act, Section 154, penalty for incorrect information about abatement that includes fines and prison time.