Looking for non-indigenous species in Canada: Preliminary results from a multi-year, multi-discipline program

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The Canadian Experience

• To better understand AIS and their impacts, Canada has two major Science programs:

• The Canadian Aquatic Invasive Species Network (CAISN): in Year 3 of 5
  – A joint venture between NSERC, academia and government

• The Canadian Alien Invasive Species Program: in Year 4 of 5
  – DFO Canada is the responsible agency for aquatic invasive species
CAISN Overview

• Projects designed to look at AIS on a national level
• The network contains 3 nodes
  – East Coast, West Coast and Great Lakes
• The network addresses three major themes
  – Theme I: Vectors and Pathways
  – Theme II: Factors Affecting Establishment
  – Theme III: Risk Assessment and Mitigation
• Includes researchers from 15 universities, federal and provincial government labs, and shipping, aquaculture and recreational stakeholders
CAISN Theme I

• Project 1.1: Determining AIS propagule pressure on Canadian aquatic ecosystems
  – Ballast water discharge information will be used as a proxy for propagule pressure and GIS-database developed

• Project 1.2: Identifying AIS in ballast water
  – Quantifying and comparing AIS in different ballast water vectors
    • Intercostal ships (exchange required)/Intracostal ships (S of Cape Blanco, exchange required)/Intracostal ships (N of Cape Blanco, no exchange required)
CAISN Theme I

• Project 1.3: Determining actual propagule pressure
  – Tracking changes in AIS abundance/composition during a transoceanic voyage
  – Potential AIS with robust tolerances, hence higher invasion risk, should be identified

• Project 1.4: Examining the relationship between AIS propagule pressure and invasion success in ports
  – Expect ports with more propagule pressure will have more AIS thus eight ports will be surveyed on both WC and EC with different levels of propagule pressure (1.1)
CAISN Theme II

• Project 2.2: Examining the relationship between AIS establishment and stress
  – Characterize the number and abundance of AIS inhabiting similar habitats with different levels of stress in both intertidal and subtidal habitats
  – Characterizing the interactions between two non-indigenous bivalves in BC (varnish and Manila clam)
  – Characterizing how some non-indigenous tunicate species are able to differentially colonize artificial and natural substrates
CAISN Theme III

• Project 3.2: We will conduct Hazard Analysis and Critical Control Points (HACCP) risk assessments to identify and reduce likelihood of dispersal of tunicates associated with aquaculture facilities in Prince Edward Island and British Columbia
  – We are documenting all stages of harvesting and processing of shellfish aquaculture species to be able to identify control points and suggest mitigation measures
  – By contrasting differences between mussel aquaculture on the EC and oyster aquaculture in BC we aim to develop guidelines for best practices for industry
DFO-AIS Program Overview

• Projects designed to look at AIS on both national and regional levels

• Each of DFOs 6 regions plus NCR participating
  – Newfoundland, Maritimes, Gulf, Quebec, Central & Arctic, Pacific

• The program addresses three major themes
  – Research
  – Monitoring
  – Risk Assessment (CEARA)
  – Rapid Response Planning
DFO Research

- Research has focussed on:
  - priority species including several tunicate species (*Didemnum vexillum*, *Botryllus schlosseri* (golden star tunicate), *Botrylloides violaceus* (violet tunicate), *Styela clava* (club tunicate) and European green crab (*Carcinus maenas*)
  - priority vectors (sea chests, ballast sediment, recreational boating)
Tunicate Research

- Determining abiotic (temperature, salinity) factors affecting survivorship, growth, and reproduction of invasive tunicate species.

![Graph showing colony size (# of zooids) vs Time in the experiment (d)]

- B. schlosseri
- B. violaceus
Tunicate Research

- Characterizing biotic (predation, competition) interactions between native species and non-native tunicates
Green Crab Research

• Characterizing habitat preferences of European green crab (*Carcinus maenas*) in BC
  – *C. maenas* exploits lower salinity waters
  – *C. gracilis* dominates full salinity waters
Green Crab Research

• Characterizing vertical distribution of larvae in the water column and potential dispersal
Sea Chest Research

Fig. 1. Schematic diagram of a vessel’s sea-chest system.
Sea Chest Research

• Collect vessel history data
• Collect sea chest data
• Determine percent cover and types of organisms in sea chests
  – replicate quadrat sampling
  – timed inspections for macro-organisms
• Retain specimens for laboratory identification
  – scrapings of smaller quadrats
DFO Monitoring in SoG

- Two new monitoring studies are providing valuable baseline information
  - Intertidal Monitoring Program (2005-2007)
    * beach surveys that have included: quadrat sampling, timed walks, crab trapping
  - Subtidal Monitoring Program (2006-2008)
    * settling plates and tunicate collectors; standardized area scraping of subtidal floating structures
Intertidal AIS Monitoring – 2005

- 24 sites around the Strait of Georgia
- Each site sampled at low tide (<1.0 m)
- Teams of 2 spent 4 hours scouring the beach and collecting representative samples
- Samples processed in the lab to lowest taxonomic level possible
- Both native and non-native species identified
- Data collected was presence/absence rather than density/abundance
  - provides a baseline for future studies/monitoring
Intertidal AIS Monitoring – 2005
Select Intertidal SOG AIS
DFO Monitoring Beyond the SoG

• Intertidal Monitoring Program (2006-2008)
  – Surveys designed to look for known AIS using a check list approach, especially where habitat types are known
  – Crab trapping also conducted
  – Surveyed waters around Vancouver Island and parts of the Central and North Coasts
Subtidal AIS Monitoring – 2006

- 9 sites sampled around the Strait of Georgia
- Collectors deployed at each site in spring 2006
  - Both tunicate collectors and vertical tiles
- Collectors are being retrieved at 4-month intervals
- Samples are being processed in the lab to lowest taxonomic level possible
- Both native and non-native species being identified
- Data collected is relative abundance, and spatial distributions on collectors
Subtidal AIS Monitoring – 2006
Subtidal AIS Monitoring – 2006
Subtidal AIS Monitoring – 2007

• 170 additional sites sampled around BC providing coastwide coverage
• Paired tunicate collectors deployed at each site in spring 2007 (thanks to many volunteers)
• Collectors were retrieved during the fall of 2007 and samples are being processed to test specific hypotheses about factors affecting AIS distribution patterns, environmental tolerances, biological interactions with native species, etc.
Subtidal AIS Monitoring – 2007
## Preliminary Data: SoG AIS

<table>
<thead>
<tr>
<th>Survey</th>
<th>No. Taxa</th>
<th>No. Species</th>
<th>No. AIS</th>
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<tr>
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<td>200</td>
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<tr>
<td>Subtidal</td>
<td>11</td>
<td>53</td>
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CEARA Overview

• Center of Expertise for Aquatic Risk Assessment
  – This is a virtual center of expertise
  – There is a director and manager in Burlington, ON
  – There is a National Executive Committee with representation from each region and NHQ
  – There is an expert network (both government and non-government scientists involved)
Recent Marine Risk Assessments

- Tunicates completed 2007
  - 5 species (Therriault and Herborg)
- European green crab and Chinese mitten crab completed 2008 (Therriault, Herborg, Locke and McKindsey)

- Goal is to identify the biological risk posed to Canadian aquatic ecosystems by non-indigenous species

Risk = Prob. of Introduction  X  Impact of Introduction
General RA Framework

- Arrive
- Survive
- Reproduce
- Spread

Consequences
Tunicate Survey Results: Vectors and Impacts

Vector importance

Impact level
GARP Predictions: Colonial
## Aquatic Organism Risk Potential

<table>
<thead>
<tr>
<th>Ecological Consequence</th>
<th>Very High</th>
<th>High</th>
<th>Moderate</th>
<th>Low</th>
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<th>Rare</th>
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<td><strong>Very Low</strong></td>
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**Probability of Introduction**

- Very High
- High
- Moderate
- Low
- Very Low
- Rare
- Low
- Moderate
- High
- Very High
GARP Predictions: Crabs

Green Crab

Chinese mitten crab
## Crab Risk Assessment Results

<table>
<thead>
<tr>
<th>Element</th>
<th>Rating</th>
<th>Uncertainty</th>
</tr>
</thead>
<tbody>
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<td>Estuarine</td>
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<tr>
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<tr>
<td>Finfish Aquaculture</td>
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<td>Finfish Fishery</td>
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<tr>
<td>Wildlife Health Consequences</td>
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<td>Habitat Consequences</td>
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<tr>
<td>Genetic Consequences</td>
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<tr>
<td>Freshwater</td>
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<td>Estuarine</td>
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<td>Very High</td>
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<tr>
<td>Finfish Aquaculture</td>
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<td>Shellfish Fishery</td>
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<tr>
<td>Finfish Fishery</td>
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<tr>
<td>Wildlife/Human Health Consequences</td>
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<tr>
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<tr>
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<td>High</td>
</tr>
<tr>
<td>Genetic Consequences</td>
<td>Low</td>
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</table>
Current Risk Assessments

- New Zealand mud snail
  - GARP modeling to predict potential distribution
  - Risk Assessments with Regional focus

- Recreational boats
  - Survey of boaters to understand movements and vessel maintenance
  - Dive surveys to characterize species actually found on vessels
Next Steps

• Develop an overall framework for aquatic invasive species

• Develop policies and regulations to be able to respond to new invasive species introductions

• Develop a rapid response plan

• Develop a monitoring network focused on priority species and priority locations
New introduction

Risk assessment

Management assesses need to undertake control options

Control option not undertaken

Control option undertaken

Identify and implement control option to reduce/eradicate

Monitor & evaluate effectiveness of control option

Continue to monitor AIS

Early Detection

Rapid Response

Monitoring & Evaluation
AIS Reporting/Communications

• AIS Reporting
  – Phone: 1-888-356-7525
  – E-mail: AISPacific@pac.dfo-mpo.gc.ca
  – Take a picture if possible
  – Record date and location (GPS if possible)
  – Note habitat associated with the potential AIS
  – Follow up on reports made

• Develop Communications Products
  – Brochures
  – Web pages
Acknowledgments

• Funding
  – DFO’s Aquatic Invasive Species Program
  – CEARA
  – CAISN

• People
  – All the people who participated on field sampling teams
  – 6 graduate students
  – Dr. Anya Epelbaum (tunicate data)
  – Dr. Matthias Herborg (GARP modeling data)
  – Dr. Claudio DiBacco and Remi Daigle (green crab data)