Does diet determine the impact of invasive tunicates in shellfish aquaculture?: application of stable isotopes

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Outline

- Background
- The Potential Risk of NIS Tunicates
  - Predicting distributions
- What is the Impact of NIS Tunicates?
- Applying Stable Isotopes
- Next Steps
- Land-Sea Interactions

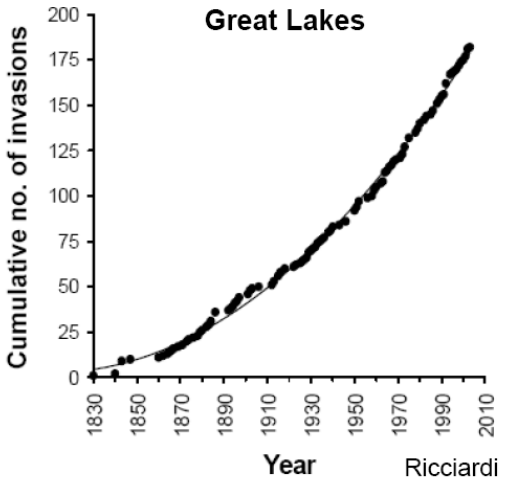
What is Invasive?

- Government of Canada (2004) defines invasive alien species as:

"those harmful alien species whose introduction or spread threatens the environment, the economy or society, including human health"

Background

- Non-indigenous species (NIS) continue to be re-distributed globally at alarming rates (marine and FW)
- Many potential vectors and pathways for NIS, very few of which have any regulations
- NIS are a global concern due to negative impacts on biodiversity and ecosystem function



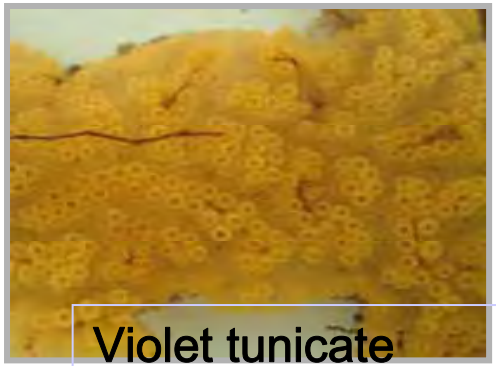
Background

- Recently, NIS tunicate introductions have received much attention, including Canada
- These tunicates have become a major pest for shellfish aquaculture, especially in Atlantic Canada

Invasive Tunicates

Golden star tunicate
Botryllus schlosseri

Clubbed tunicate
Styela clava



Violet tunicate
Botrylloides violaceus

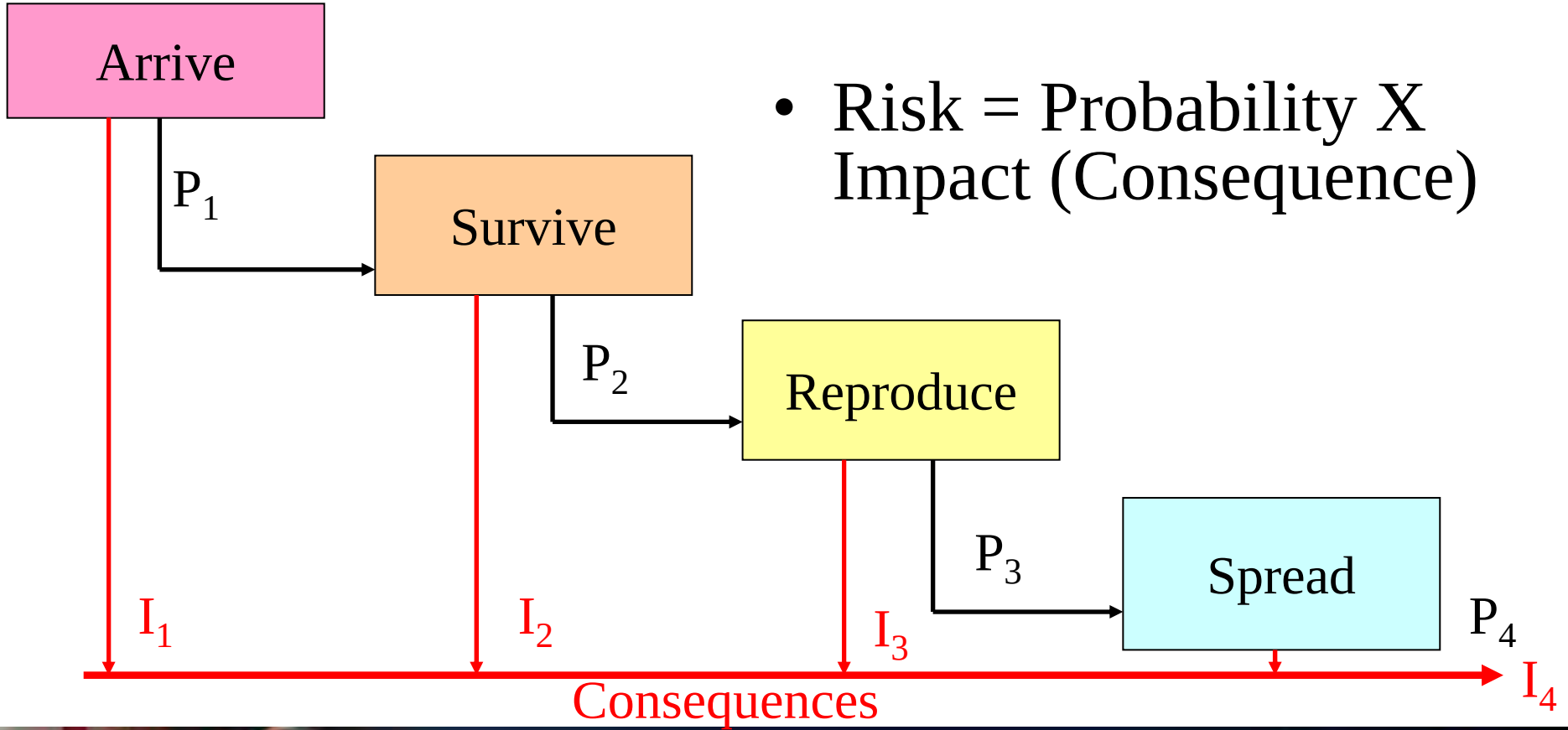
Didemnum vexillum

Vase tunicate
Ciona intestinalis

Role of Risk Assessment

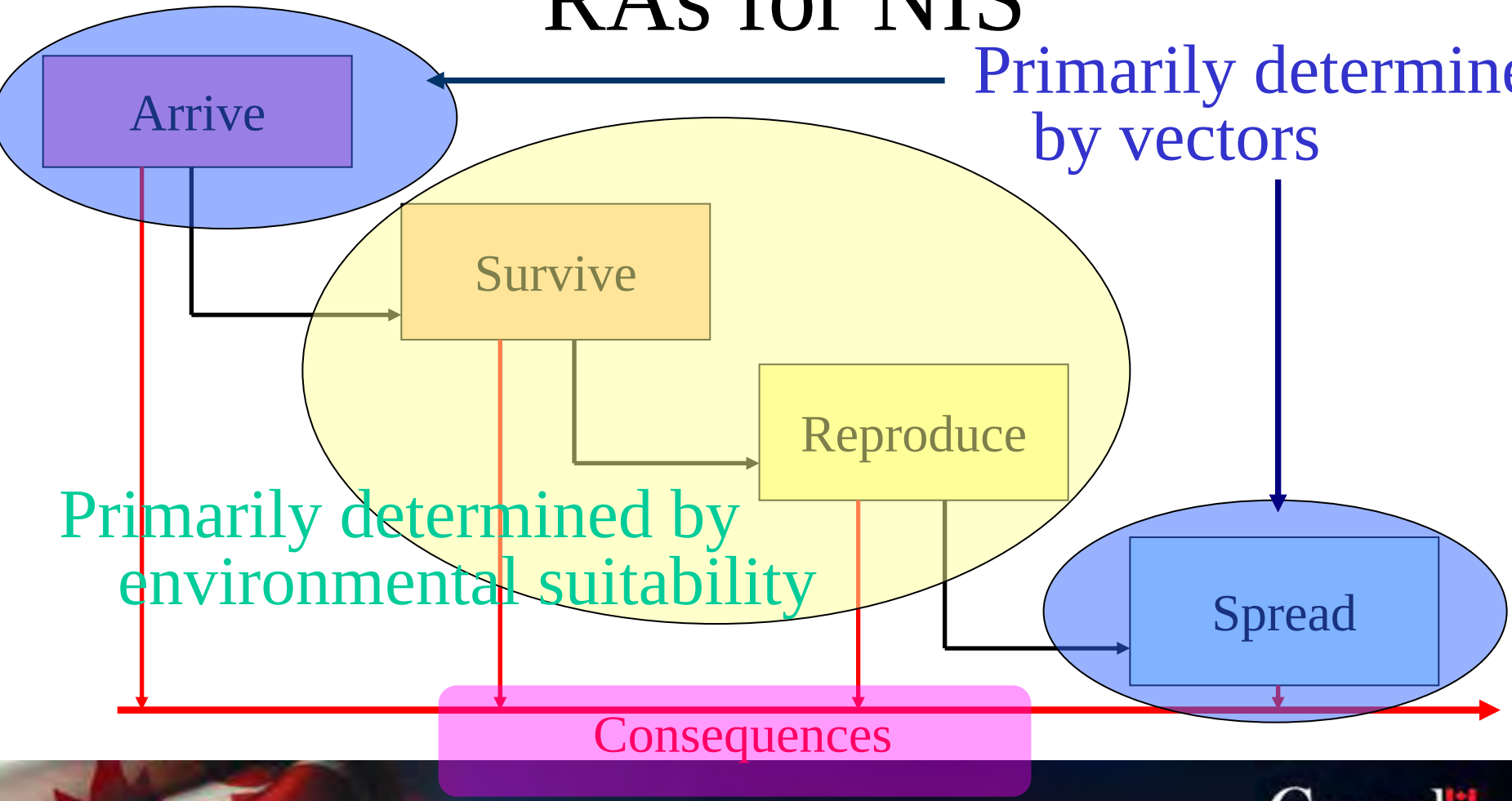
- Previously, using available literature and expert opinion we were able to conduct a biological risk assessment for each of these five tunicates on each coast (Therriault and Herborg, 2007)

Risk Assessments for NIS

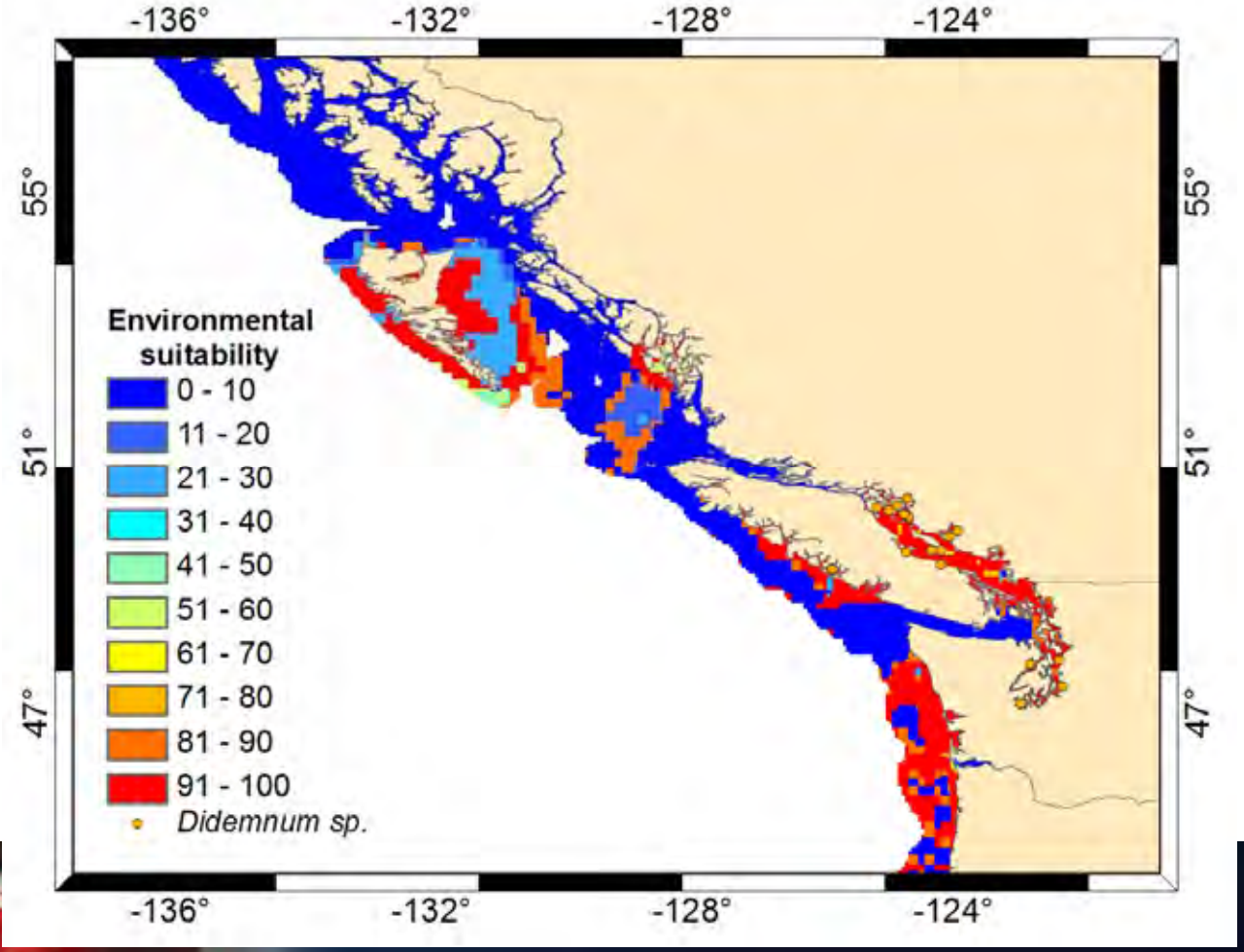


- Risk = Probability X Impact (Consequence)

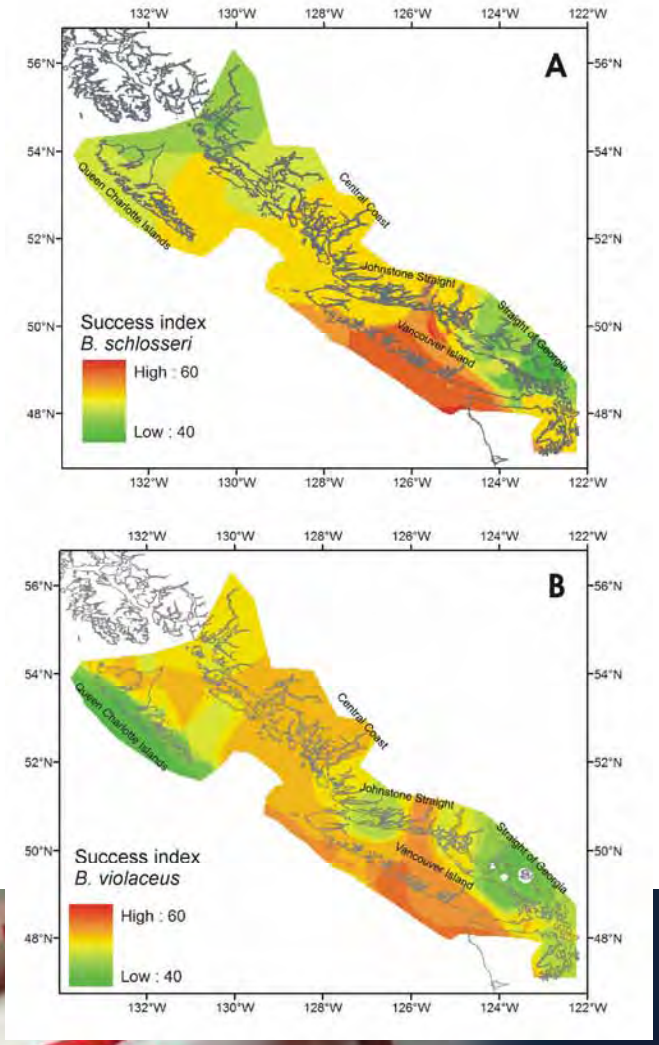
RAs for NIS


Arrive
Primarily determined by vectors
Survive
Reproduce
Primarily determined by environmental suitability
Spread
Consequences

Didemnum vexillum GARP Predictions



Lab Derived Predictions



- Experimentally derived survival and growth data were combined with monthly oceanographic temperature and salinity data to predict locations where botryllid tunicates should thrive

But What is the Impact?

- Modelling efforts have suggested the five non-indigenous tunicates could have extensive distributions on each coast (potentially invasive)
- Literature suggests impacts could be quite high
- However, should we be concerned?
  - For management, this equates to what the potential impact of these NIS tunicates could be (truly invasive)

Aquatic Organism Risk Potential

Ecological Consequence	Very High					
	High					*D.* sp (EW)
	Moderate				*C.i.* (W)	*S.c.* (EW) *C.i.* (E) *B.s.* (EW) *B.v.* (EW)
	Low					
	Very Low					
		Rare	Low	Moderate	High	Very High
	Probability of Introduction					

The Issue and Goal

- Impacts, at least in shellfish aquaculture, differ markedly between Atlantic and Pacific Canada
  - Different cultured species?
  - Different native communities?
  - Different environments?

- If we resolve the mechanisms responsible for invasions it will provide clues for mitigation and risk assessment of other NIS

Our Approach

- To better understand the impact of NIS tunicates in Canada, especially in shellfish aquaculture environments, we are looking at potential competition as an impact
  - Size/type of prey exploited by NIS tunicates and cultured species
  - Source/type of food particles used by NIS tunicates and cultured species

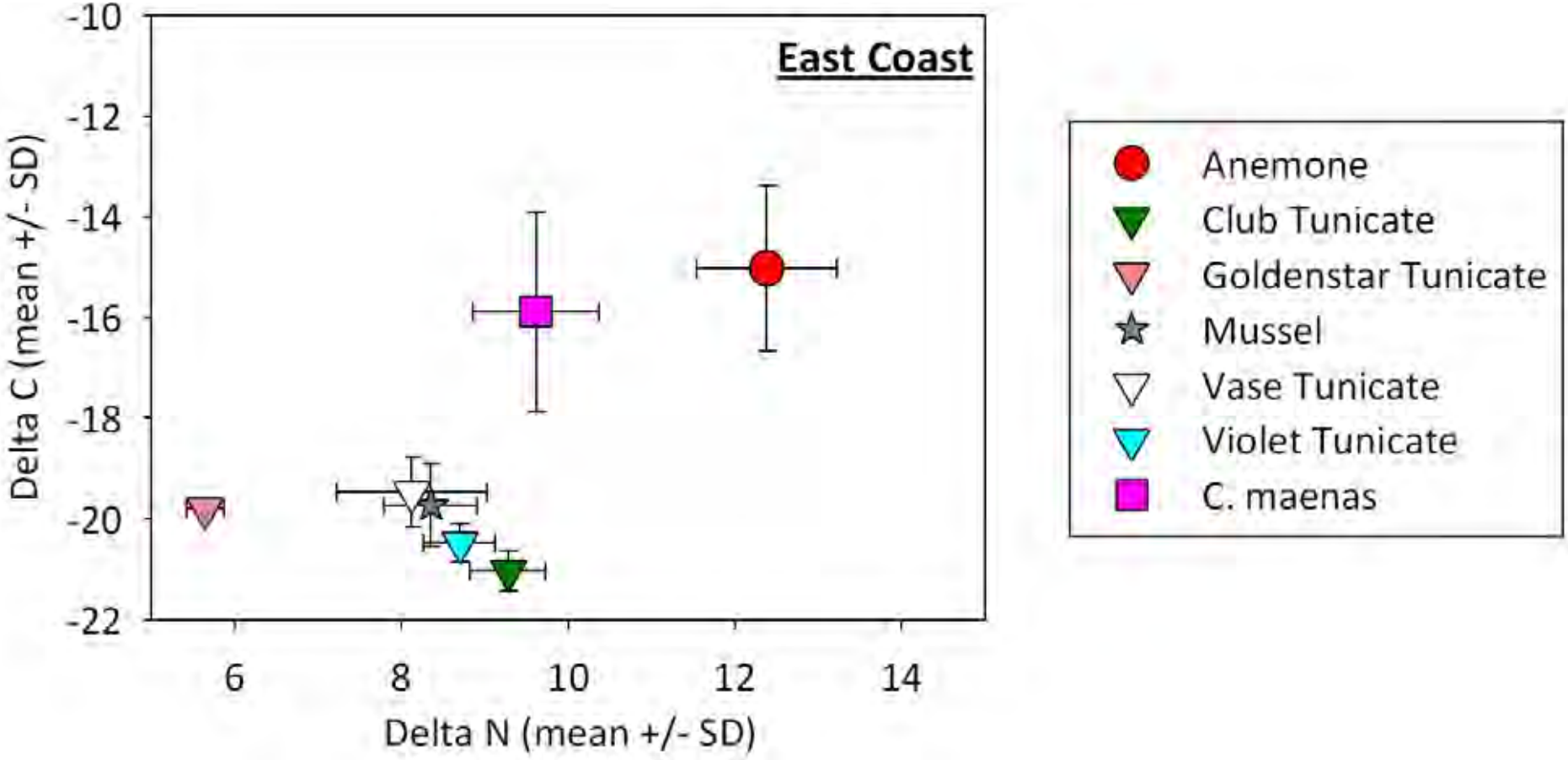
Stable Isotopes

- Stable isotope analyses have been used extensively to infer trophic relationships
- Further, these analyses can be used to infer the potential source of these elements
- Here, were characterized delta-Carbon ($\delta\ ^{13}C$) and delta-Nitrogen ($\delta\ ^{15}N$) signatures to explore potential diet overlap between native/cultured bivalves and non-indigenous tunicates

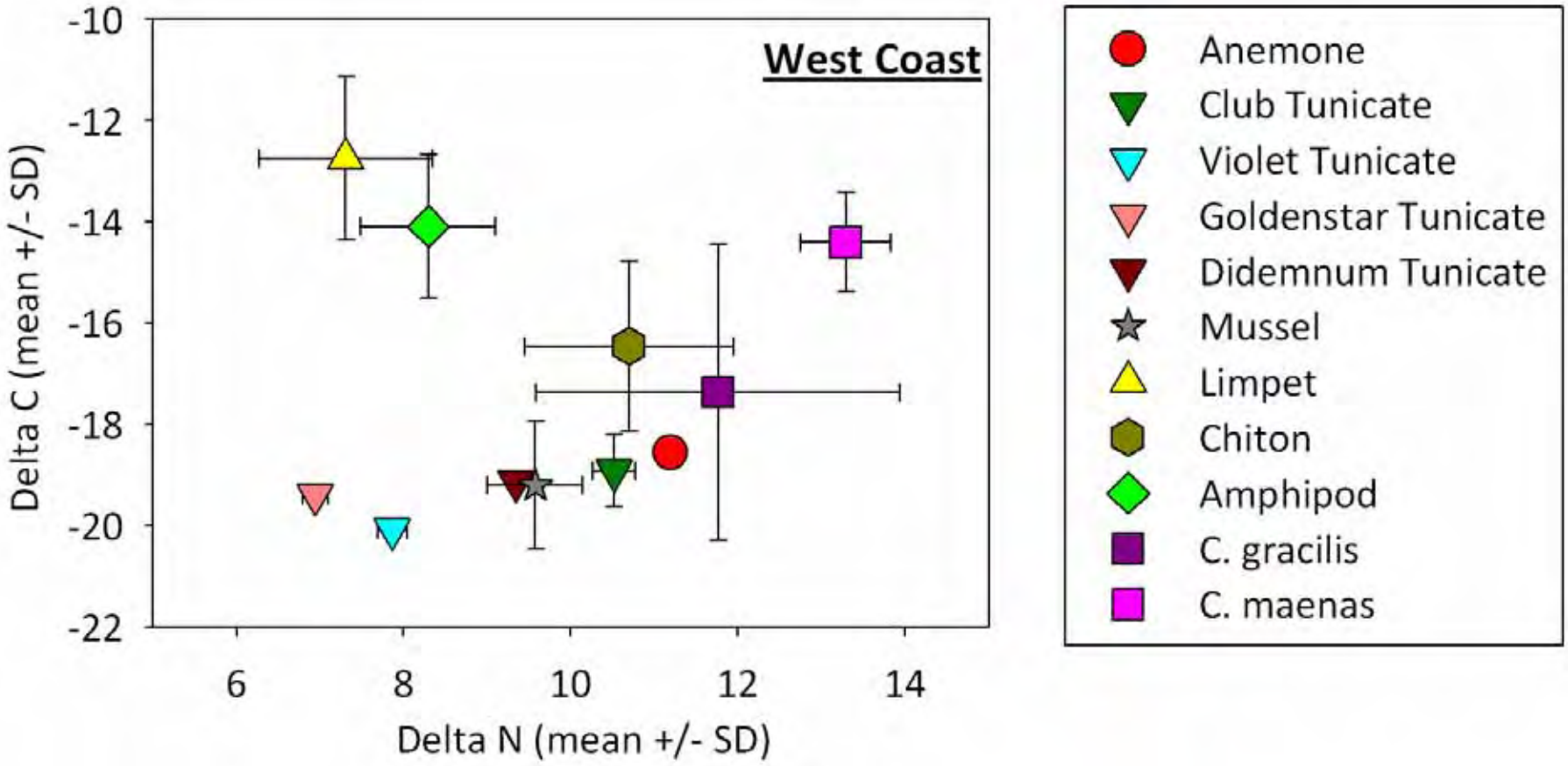
Sampling

- 30 individuals of each species were collected from each site in PEI (East Coast) and BC (West Coast) during late summer 2010
- Species were primarily filter-feeding members of the fouling communities at shellfish aquaculture sites
- delta-Carbon ($\delta\ ^{13}C$) and delta-Nitrogen ($\delta\ ^{15}N$) signatures were determined from tissue samples

Results


East Coast
-10
-12
-14
-16
-18
-20
-22
Delta C (mean +/- SD)
6
8
10
12
14
Delta N (mean +/- SD)
Anemone
Club Tunicate
Goldenstar Tunicate
Mussel
Vase Tunicate
Violet Tunicate
C. maenas

Results


West Coast
Delta C (mean +/- SD)
-10
-12
-14
-16
-18
-20
-22
6
8
10
12
14
Delta N (mean +/- SD)
Anemone
Club Tunicate
Violet Tunicate
Goldenstar Tunicate
Didemnum Tunicate
Mussel
Limpet
Chiton
Amphipod
C. gracilis
C. maenas

Results

- Marked differences in isotope signatures, both $\delta\ ^{13}C$ and $\delta\ ^{15}N$, between Atlantic Canada and Pacific Canada

- On both coasts invasive tunicates appear to be competing with blue mussel (*Mytilus* sp.)
  - *Ciona intestinalis* (Atlantic) very similar
  - *Didemnum vexillum* (Pacific) **identical**

Results

- The two botryllid tunicates (*B. schlosseri* and *B. violaceus*) and *S. clava* have invasion histories on both coasts

- Our results suggest *B. schlosseri* is utilizing a different food source on the east coast based on the lower $\delta\ ^{15}N$ contribution

Next Steps

- Are NIS tunicates able to exploit a food source native species are under-utilizing?
  - Field experiments to measure depletion rates of native/cultured species and NIS tunicates
  - Determination of particle sizes depleted by native/cultured species and NIS tunicates

Next Steps

- Direct sampling of different size fractions of potential food sources (suspended particulate organic matter (POM)) available to both NIS tunicates and *Mytilus* mussels
  - Riverine sources
  - Brackish or estuarine
  - Coastal marine

Next Steps

- Temporal sampling in 2011 (Sept, Oct, Nov) to determine if preferred food sources change over time and/or if NIS tunicates are better at switching to alternate POM sources than native/cultured species
  - If so, could suggest why tunicates are more invasive in some areas and not others

Land-Sea Interactions

- Determining the source of POM for NIS tunicates will help explain current invasions but also could be used to infer impacts in other systems that have more/less of the desired POM sources available

- If POM derived from terrestrial sources then upland land use practices could be mediating invasion dynamics in coastal systems