Climate Change and Marine Invasions

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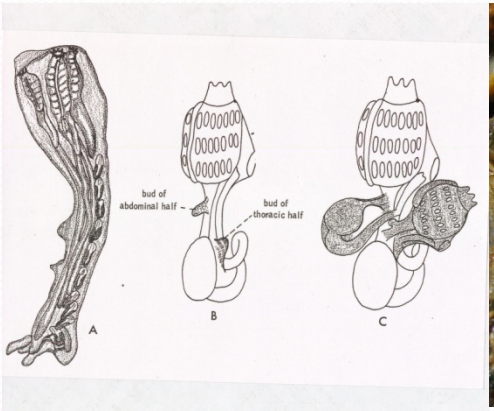
MIT Sea Grant College Program
NEANS Panel Meeting, May 23, 2012

Overview

- Observed climate changes in the Northeast
- What do we know of climate change effects on communities from NIS
- Observations, conjecture, and cause and effect
- What can we do?



Reported Changes in Northeast Climate

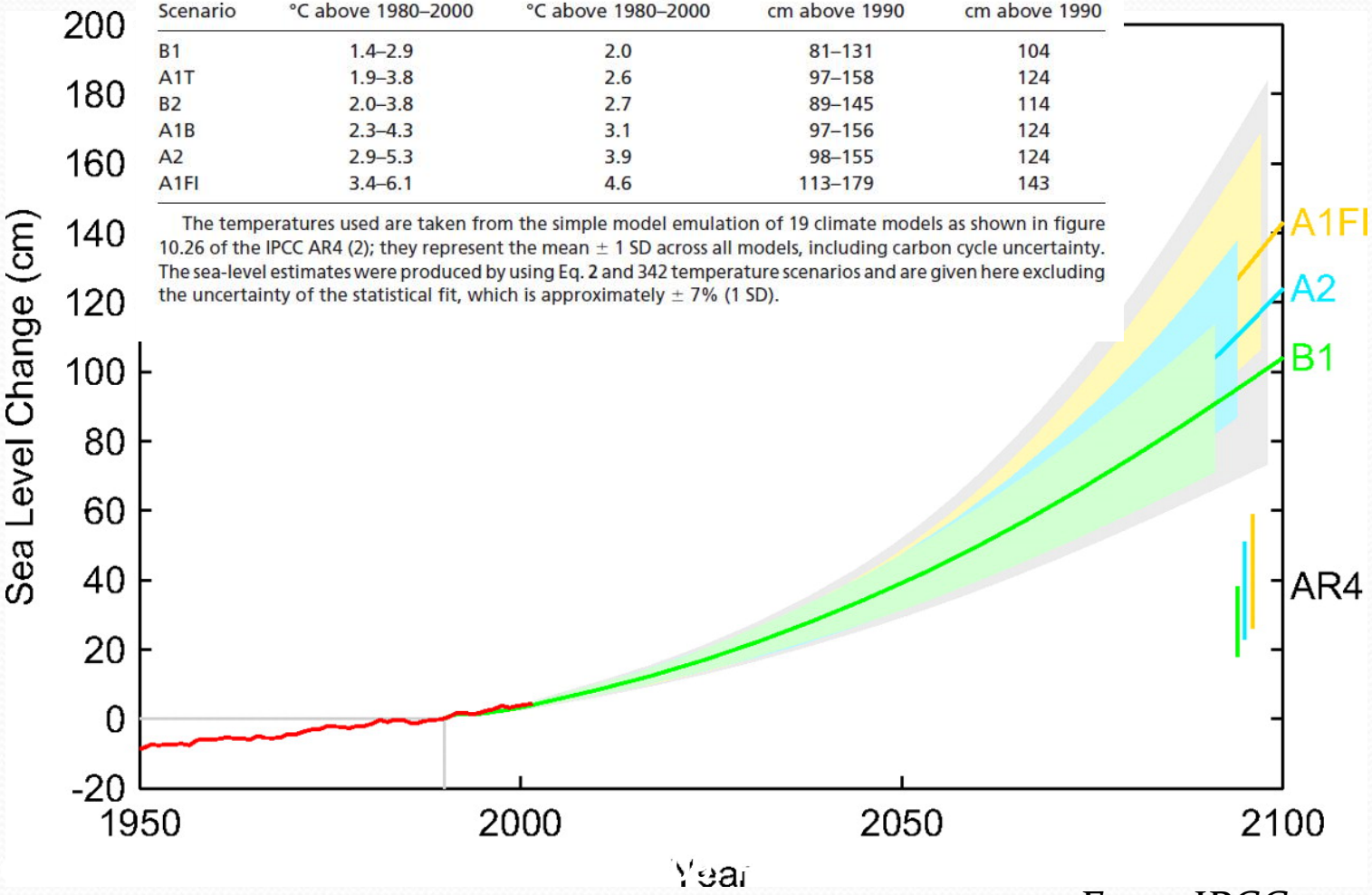
- > than 95th percentile days daily maximum increased by 1.7 occurrences and winter nights minimum increased by 2.9 occurrences since 1960 (Haydoe et al. 2007)
- March/April snowpack decreased and days advanced of flow in rivers by 7-14 days among other changes (Hodgkins et al . 2002-2008)
- Increased stream and water table height are reported, but cloud cover may influence evapotranspiration.
- Boreal forests will decrease and oak-hickory forests will move northward; growth will increase
- Marshes are resilient, but marsh die off may offset resiliency (Bertness et al. several papers)
- Annual temperatures across the Northeast have warmed almost 2^0F since 1970

The most recent SLR projections

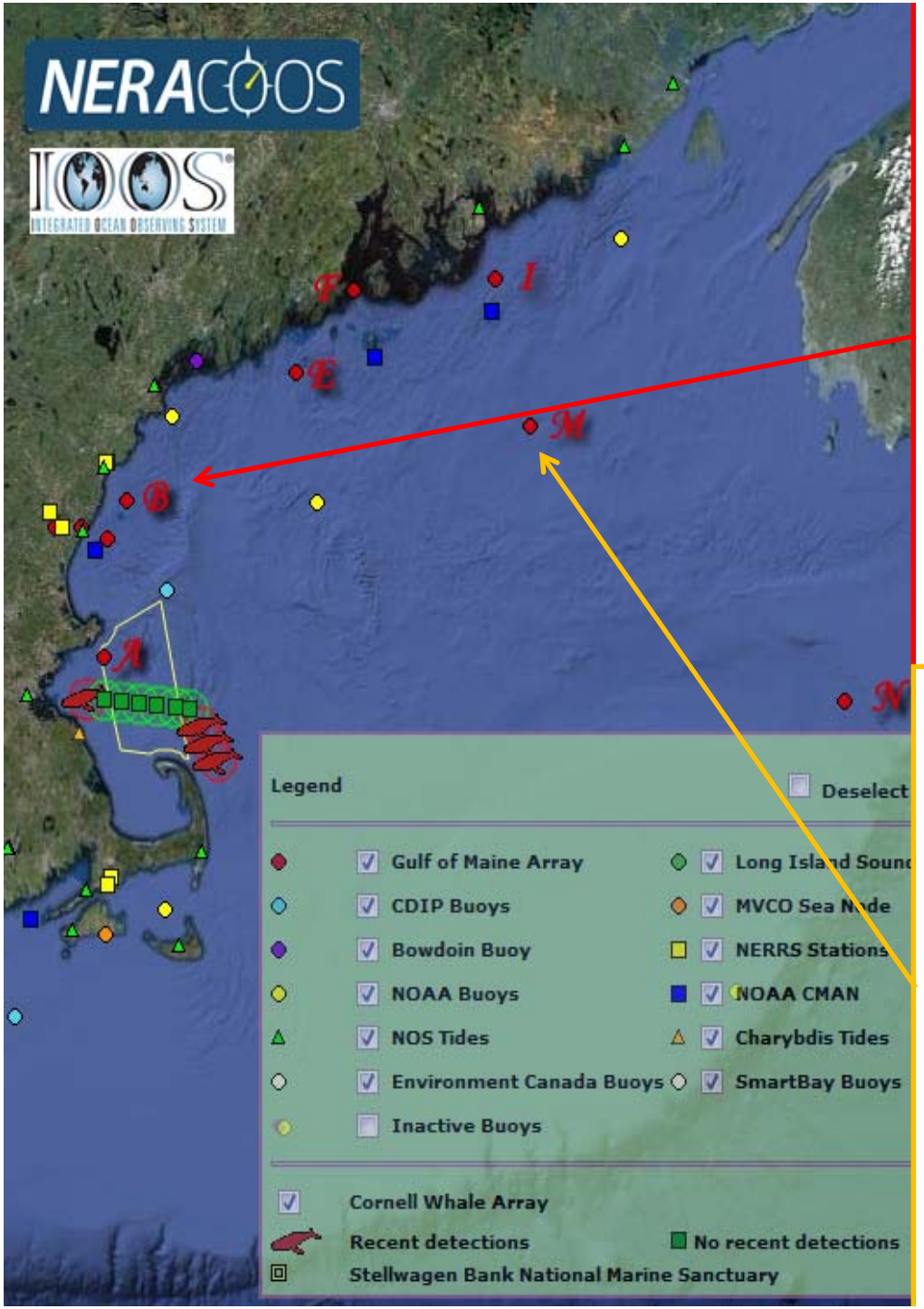
Table 1. Temperature ranges and associated sea-level ranges by the year 2100 for different IPCC emission scenarios

Scenario	Temperature range, °C above 1980–2000	Model average, °C above 1980–2000	Sea-level range, cm above 1990	Model average, cm above 1990
B1	1.4–2.9	2.0	81–131	104
A1T	1.9–3.8	2.6	97–158	124
B2	2.0–3.8	2.7	89–145	114
A1B	2.3–4.3	3.1	97–156	124
A2	2.9–5.3	3.9	98–155	124
A1FI	3.4–6.1	4.6	113–179	143

The temperatures used are taken from the simple model emulation of 19 climate models as shown in figure 10.26 of the IPCC AR4 (2); they represent the mean ± 1 SD across all models, including carbon cycle uncertainty. The sea-level estimates were produced by using Eq. 2 and 342 temperature scenarios and are given here excluding the uncertainty of the statistical fit, which is approximately ± 7% (1 SD).



From IPCC


NERACOOS
IOOS
INTEGRATED OCEAN OBSERVING SYSTEM
F
I
E
M
B
A
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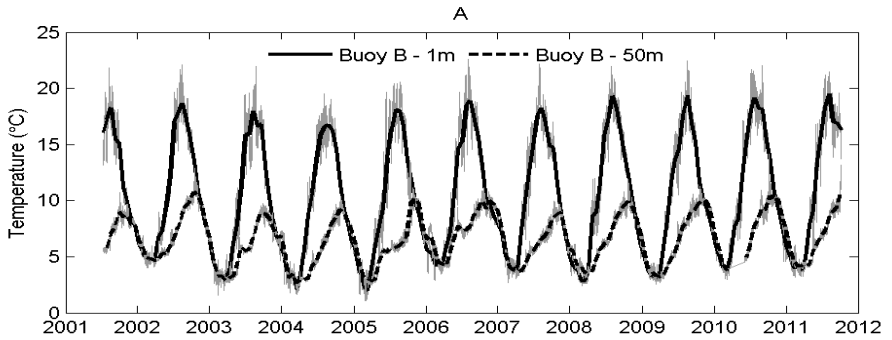
Legend
Deselect
Gulf of Maine Array
Long Island Sound
CDIP Buoys
MVCO Sea Node
Bowdoin Buoy
NERRS Stations
NOAA Buoys
NOAA CMAN
NOS Tides
Charybdis Tides
Environment Canada Buoys
SmartBay Buoys
Inactive Buoys
Cornell Whale Array
Recent detections
No recent detections
Stellwagen Bank National Marine Sanctuary


A
Buoy B - 1m
Buoy B - 50m
Temperature (°C)
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10
5
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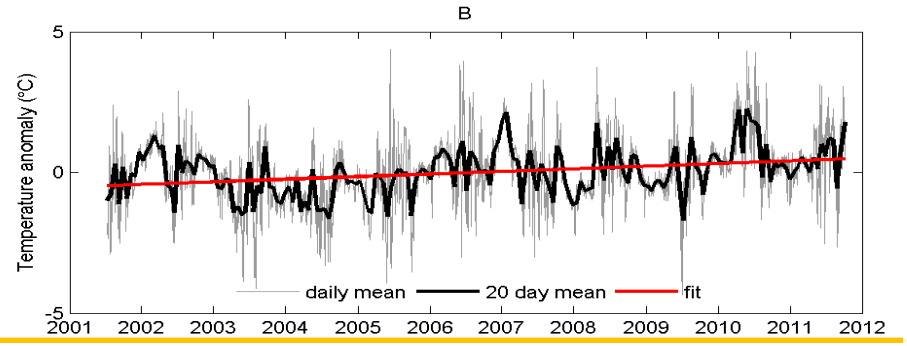
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012


B
Temperature anomaly (°C)
5
0
-5
daily mean
20 day mean
fit
2001
2002
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2004
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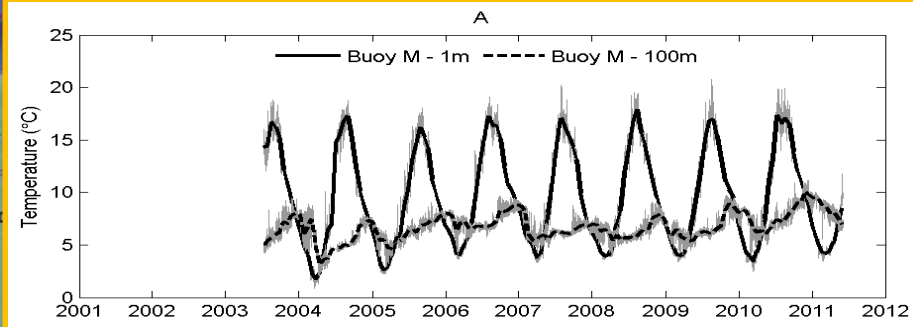
A
Buoy M - 1m
Buoy M - 100m
Temperature (°C)
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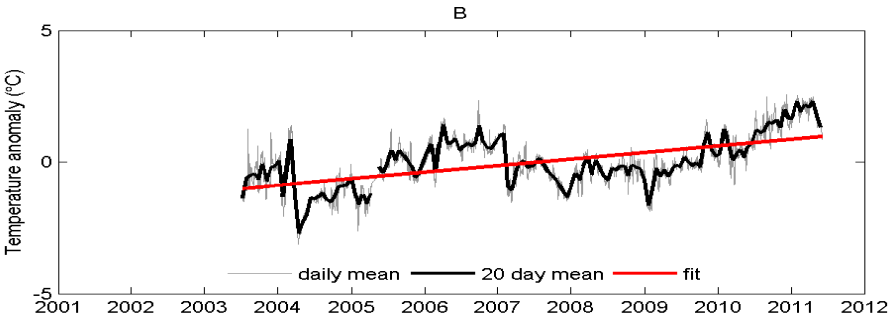
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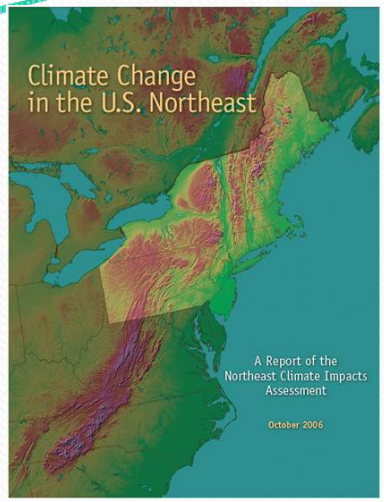
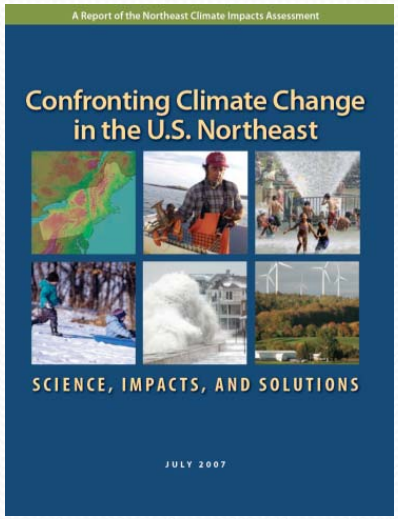


: http://www.climatechoices.org



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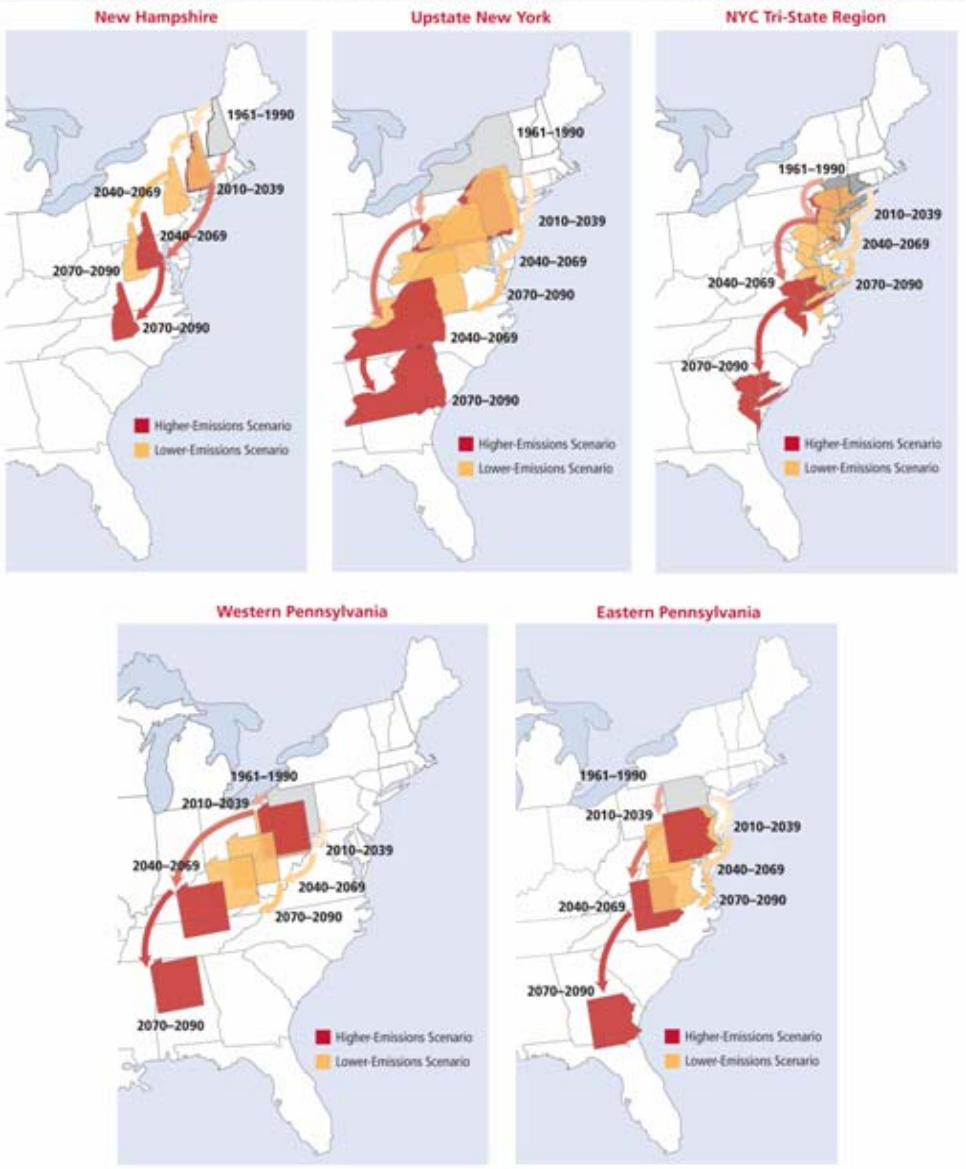


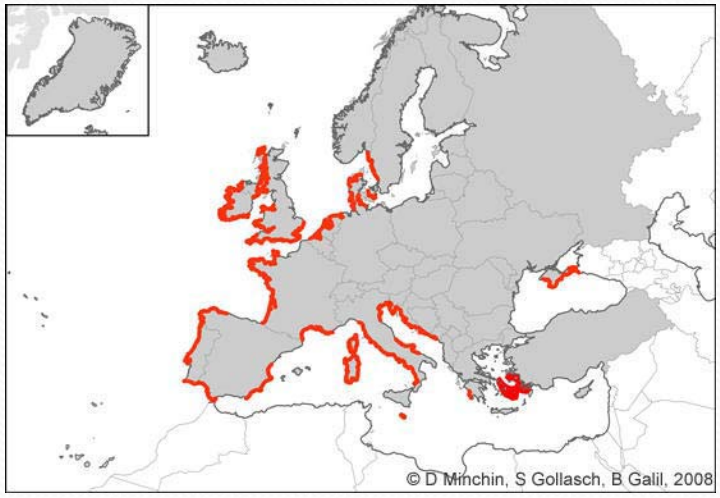
Source: NECIA, 2007 (see: www.climatechoices.org/ne/)

Examples: High probability: *Crassostrea gigas*

- Introduced by France; but already in most European countries

- Predicted not to spread from areas of aquaculture along coast (based on temperature requirement for reproduction)

- Increased temperatures
  - Survival outside predicted area
  - earlier reproduction
  - larval survivability and spread



From DAISIE

Competes with mussels, stabilizes sediments, increases biodiversity

Example: Moderate probability: *Codium fragile* spp. *fragile*

Photo: P. Erickson

- Found in Europe and US; several species in Europe
- Needs long periods of warm temperature for reproduction; not expected to survive in cold waters
- Multiple introductions; Long Island Sound 1957 and Maine (1970s or earlier)
  - Temperature differences in tolerance
  - Possible expansion in UK by 2080

Competes with eelgrass, nuisance on beaches, poor quality food for herbivores

Range Shifts, Range Expansion

- Range shifts – regime changes
- Range expansion – all species


Photo: J. Pederson

- Not enough long-term records to evaluate post-invasion impacts on species, e.g., extinction
- Regions of transition are likely to yield insights into whether climate is a major driver of shifts in non-native species

Community Changes with Warming Temperatures

- Over 30 year period, community shifts with tunicates dominating (Harris, Dijkstra)
- Literature survey shows 70% of species appear to be shifting poleward (Sorte et al. 2010)
- Arctic voyages are likely to increase and open pathway for invasions

Photo: G. Lambert

Historical trends (Sherman & Lentz, 2010)

SHEARMAN AND LENTZ

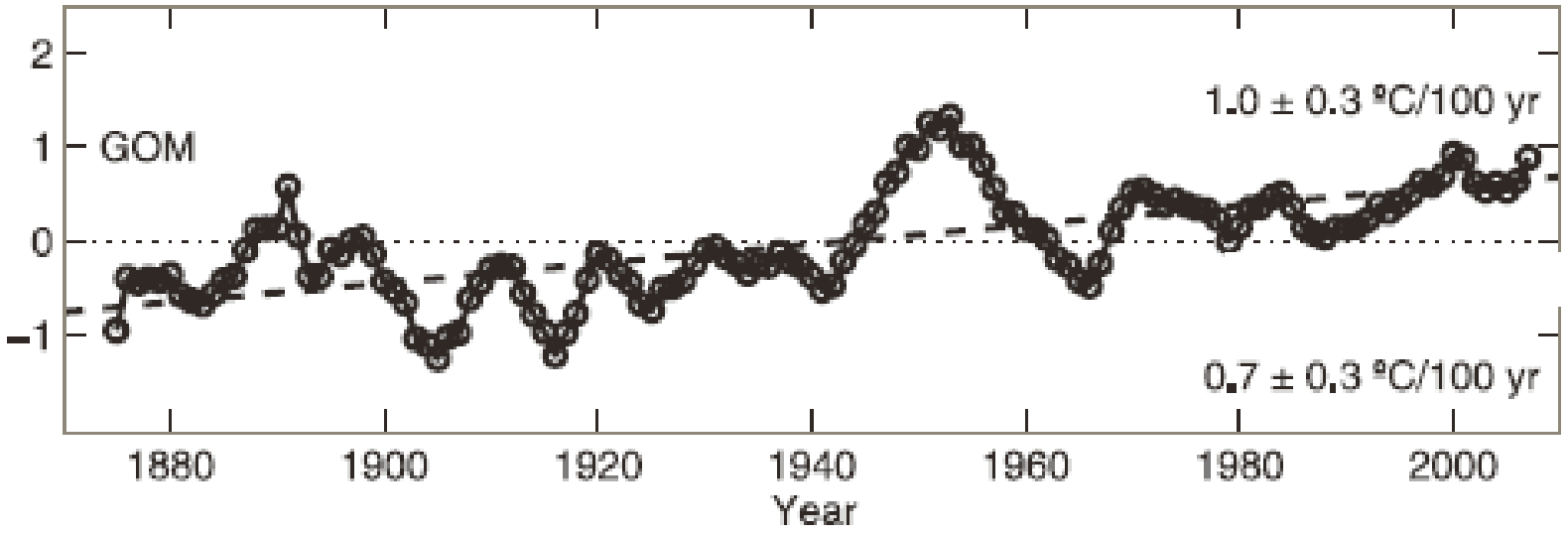


FIG. 8. Composite average SST anomalies (black) for GOM, MAB, SAB, and FL, smoothed with a 5-yr running mean, plus regional surface air temperature anomalies (gray) for the northeast United States, southeast United States, and Labrador. Best linear fits are plotted (thick dashed lines), and trends with 95% confidence intervals are noted.

Stages in the sequential transitions of a successful invasion process. (Modified from Maggs *et al., 2010, and Walther, G. R., et al., 2009.)*

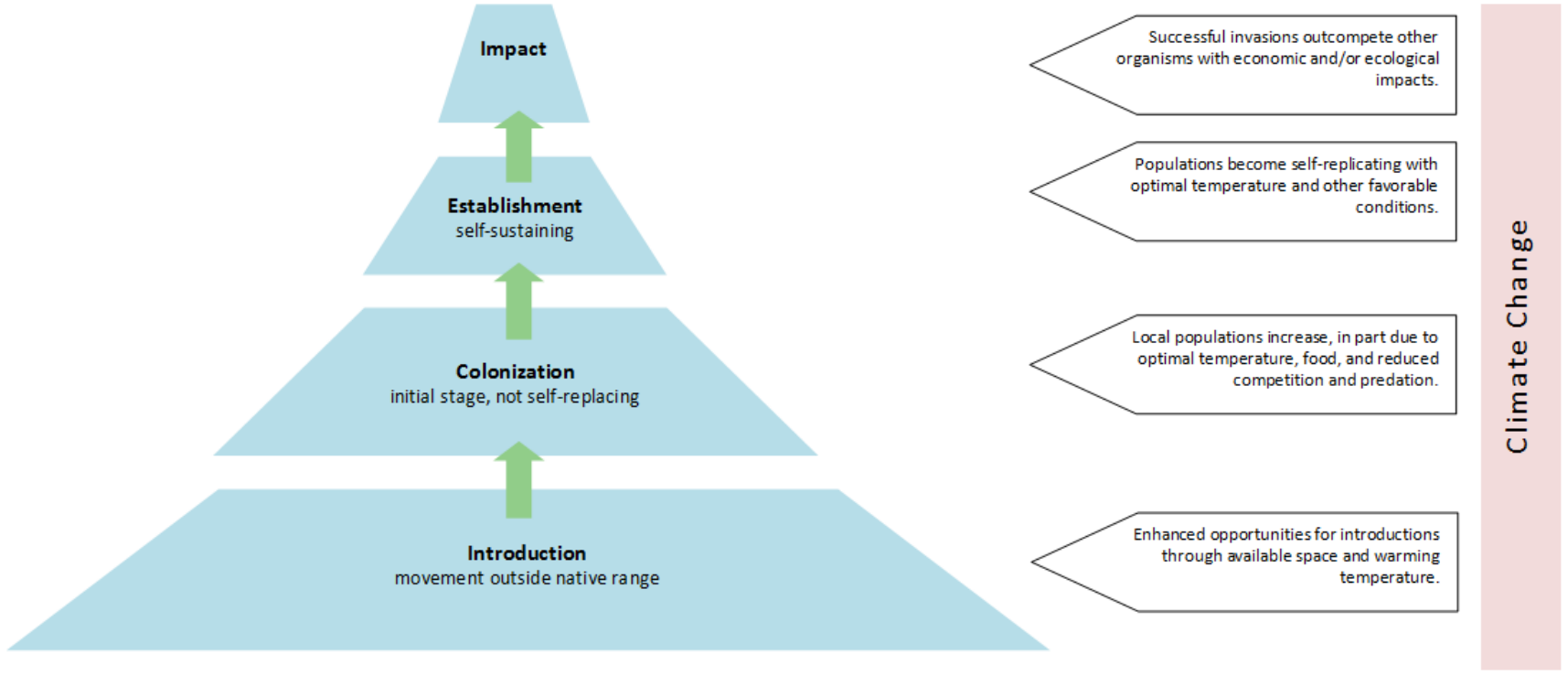


Photo of *Botrylloides violaceus*, *Tricellaria inopinata*, and *Hydroides elegans* temperature in Eel Pond 10^{o} C in Dec. than previous years

Photo: J.Pederson

Challenges and Options: suggested way forward

- Lack of long-term data on transitional species
- We develop a list of transitional species for New England
- NEANS Panel members send me a list of 10 transitional species (by June 15th)
- I will compile and return these
- NEANS Panel will identify ways to monitor change – citizen monitors, state agencies, etc.
- Input data on NEMIS
- Volunteers to help frame the data we need