# Secular Change, Variability and Other Complications

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Investigation of Nearshore Migration of Atlantic Salmon
in the Gulf of Maine Region

Workshop #2: Bays and the Gulf of Maine

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## Secular change, variability and other complications:
## What do you do when science isn't omniscience?

…which of course it never is, but the life history of salmon makes research prioritization about as hard as it gets for fish because of life history stanzas, transitions, multiple habitats, dispersion and the great distances involved.

- A large list of very reasonable hypotheses
- Detecting significant changes in already high rates of mortality without a lot of background data
- Indirect and delayed effects
- additive, spatially complex and possibly contradictory environmental effects from escapement to return

- plausible high-impact periods amenable to study
    - riverine dynamics
    - smoltification (physiology)
    - outmigration (bottleneck)

## What about the bigger picture at the Coastal and Gulf of Maine scale [climate forcing]?

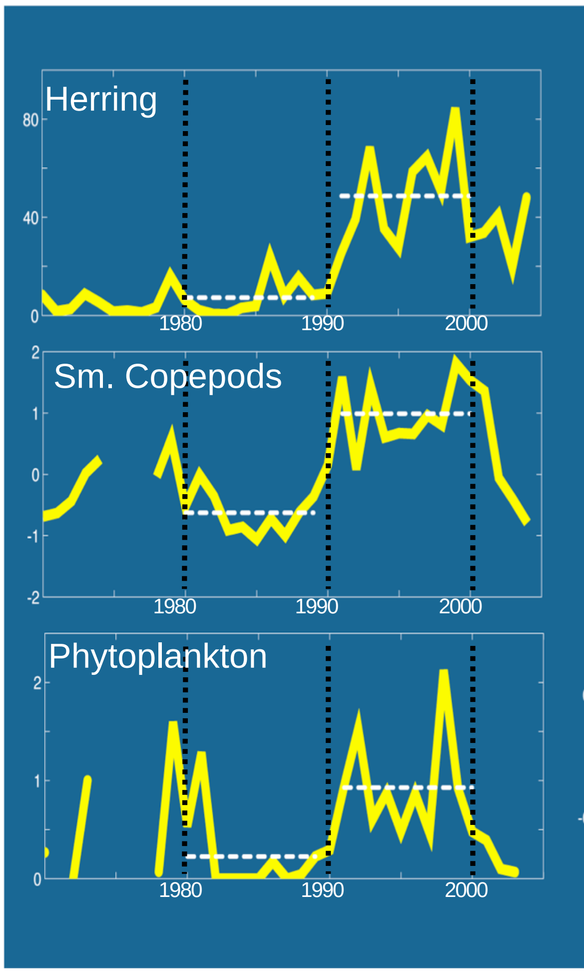
1. Temperature/circulation/production/predators – temporal patterns, values, stratification across a large spatial domain
   Link N. Atlantic models (AOGCMs) with coastal shelf/GoM models
   T/S/N and circulation, surface production (timing, “particle”-size distribution), spatial distribution. Is temperature a stressor (in the ocean) or are the linked effects the problem (*e.g*., phenology, prey, predators)?

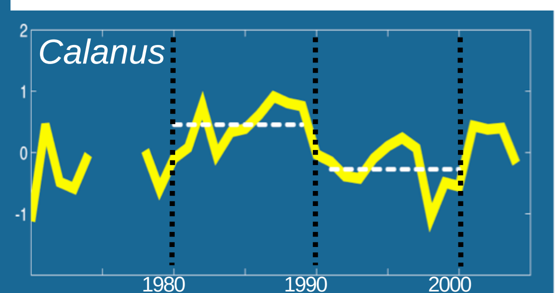
2. Trophic Impacts – Top-down and bottom-up, Down-scaling (e.g., from CPR, ferry track, other—gliders) and “upscaling” from fixed platforms in coastal ocean observing. COOA transect is good example—we need other critically located studies to do this. Penobscot Bay, Down East coast (Bay of Fundy system). Vessels. In conjunction with coupled bio-physical models. Models extend your observations and challenge your understanding. Missing links—anadromous species, small forage fish, micro-nekton

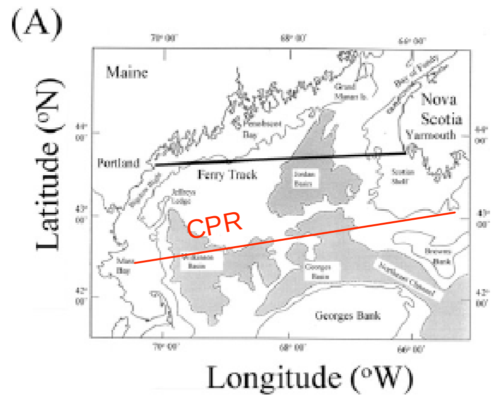
3. Effects of altered freshwater discharge regimes on the coastal ocean, including stratification, nutrients, circulation, plankton production and distribution (advective effects), nekton (prey & predators), and acidity.

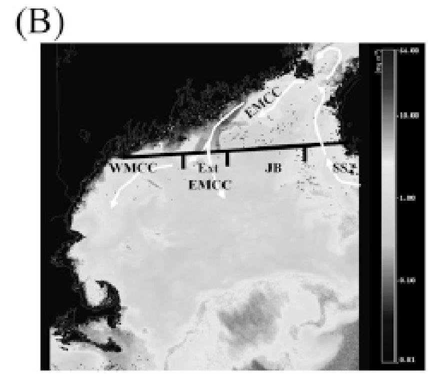
# Downscaling….

A.Pershing



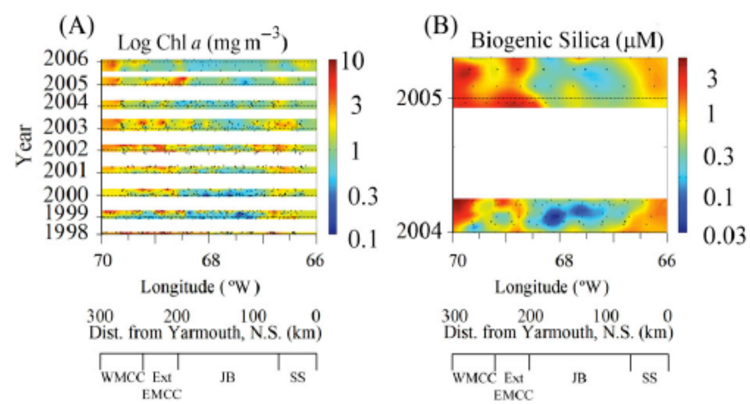




B. Balch et al. (2008)

J. Plankton Res. 30: 119-139.




……Upscaling

## the system is already in a state of change relative to the recent past

BY J. SALISBURY, M. GREEN, C. HUNT, AND J. CAMPBELL

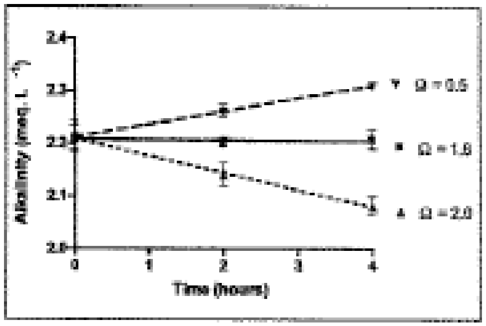



*Fig. 1. Laboratory results demonstrating the effect of increased acidification on soft-shelled clam larvae. The increase in alkalinity with time at  = 0.5 indicates that shell dissolution is occurring, as the gain in alkalinity of the solution is proportional to the decrease in shell material. Even when seawater is supersatured at  = 1.6, the rate of alkalinity change ($CO_3^{2-}$ uptake) is effectively zero. At  = 2.0, the decrease of alkalinity indicates shell formation and growth.*

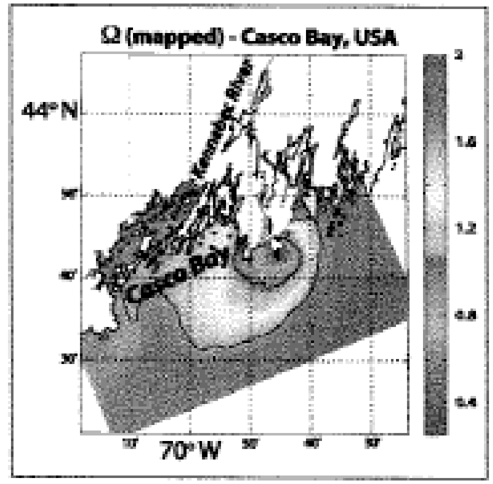



*Fig. 2. Mapped  for the surface waters of the Kennebec plume and Casco Bay, Gulf of Maine, on 20 June 2005. Contours of Ω = 1.0 (inner) and Ω = 1.6 (outer) are shown as black curves. The 1.6 contour intersects the outer islands and peninsulas of Casco Bay, where the value of the shellfish harvest exceeds $35 million per year. The Kennebec is a moderately sized river system whose average discharge is 438 cubic meters per second.*

Frequency of extreme events?

## Salmon research needs to:

- integrate with other climate change, environmental, fisheries and biodiversity studies to coordinate push, planning, funding
- pursue a “no regrets” approach to research and management/conservation that is aimed at understanding & managing for the functional aspects of the system and not just a highly prized species (wadrs)