Mechanisms of Marine Ecosystem Predictability
Along U.S. Coasts

Mike Jacox
on behalf of the
NOAA Marine Prediction Task Force

PICES Annual Meeting
Yokohama, Japan
October 30, 2018
2017 NOAA MAPP Competition: “Research to explore seasonal prediction of coastal high water levels and changing living marine resources”

NOAA National Ocean Service (NOS):
Coastal resilience and coastal intelligence through improved products and services

NOAA National Marine Fisheries Service (NMFS):
Increased production, delivery and use of climate-related information in fisheries management and protected species conservation
2017 NOAA MAPP Competition: “Research to explore seasonal prediction of coastal high water levels and changing living marine resources”
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The Marine Prediction Task Force (MPTF) coordinates the activities of researchers supported through the MAPP/NMFS FY17 grant competition

Membership
All funded PIs are MPTF members
Co-chairs are Mark Merrifield, Antonietta Capotondi, and Mike Jacox
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**Objective**
To help U.S. coastal communities and economies anticipate the threat of climate-related hazards by developing NOAA’s capability to produce relevant seasonal marine predictions for U.S. coastal regions
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**Common Threads/Interests**
**Sources of predictability**
Modeling and prediction tools
Forecast assessment / skill metrics
Great Australian Bight Tuna
(Evanson et al. 2015)

Pacific Northwest Sardines
(Kaplan et al. 2015)

Physical Forecast

Empirical Relationship
Great Australian Bight Tuna  
(Evanson et al. 2015)  

Pacific Northwest Sardines  
(Kaplan et al. 2015)  

Physical Forecast  

Empirical Relationship  

Habitat Forecast
Question:

*Reviews in Fish Biology and Fisheries* 8, 285–305 (1998)

When do environment-recruitment correlations work?

Ransom A. Myers

Department of Biology, Dalhousie University, Halifax, Nova Scotia, Canada B3H 4J1. E-mail: Ransom.Myers@Dal.Ca
Question:

When do environment–recruitment correlations work?

Answer: Not very often

Reviews in Fish Biology and Fisheries 8, 285–305 (1998)

RANSOM A. MYERS

Department of Biology, Dalhousie University, Halifax, Nova Scotia, Canada B3H 4J1. E-mail: Ransom.Myers@Dal.Ca
Motivation 1: Address concerns of non-stationarity

Question:

When do environment–recruitment correlations work?

Answer: Not very often

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Reviews in Fish Biology and Fisheries 8, 285–305 (1998)

RANSOM A. MYERS
Department of Biology, Dalhousie University, Halifax, Nova Scotia, Canada B3H 4J1. E-mail: Ransom.Myers@Dal.Ca
Anomaly Correlation Coefficient

-1   -0.8   -0.6   -0.4   -0.2.   0     0.2.   0.4.   0.6   0.8      1

JFMAMJJASOND

California Current SST Forecasts

Skill Above Persistence

Lead Time (months)

Initialization Month

Jacox et al. (2017)
California Current SST Forecasts

Skill Above Persistence


Jacox et al. (2017)
Anomaly Correlation Coefficient

-1   -0.8   -0.6   -0.4   -0.2   0     0.2   0.4   0.6   0.8      1

JFMAMJJASOND

California Current SST Forecasts

Skill Above Persistence


Jacox et al. (2017)

Jacox et al. (2017)
Motivation 2: Conditional forecasting
Motivation 3: Inform model development
The diagram illustrates the mechanisms of marine ecosystem predictability along U.S. coasts. It shows connections between various oceanic and atmospheric phenomena:

- **AL PDO** (Atlantic Multidecadal Oscillation) and **NPO NPGO** (North Pacific Oscillation) are highlighted with arrows indicating their 1-6 month time scale.
- **Kuroshio** and **Japan** are connected with arrows indicating 5-10 years of coupling.
- **ENSO** (El Niño-Southern Oscillation) is connected with arrows indicating 1-2 years of coupling.
- **W-E Boundary Coupling Surface** is indicated with arrows showing 2-4 years of coupling.

These connections help in understanding the predictability of marine ecosystems along the U.S. coasts. Courtesy: Manu Di Lorenzo.
Anomaly Correlation Coefficient
Mechanisms of marine ecosystem predictability along U.S. coasts

- **W-E Boundary Coupling Surface**: ~2yr - 4yr
- **Subsurface**: ~5yr - 10yr
- **Enso**: ~1yr - 2yr
- **ATL PDO**: 1mo - 6mo
- **NPO NPGO**: ~5yr - 10yr

Courtesy Manu Di Lorenzo
Tropical SST anomaly pattern “optimal precursor”

CCS SST anomalies 10 months later

 Courtesy Antonietta Capotondi
Tropical SST anomaly pattern “optimal precursor”

**CCS SST anomalies 10 months later**

Di Lorenzo et al. (2015)
ATMOSPHERE/OCEAN TELECONNECTIONS

- ALPDO
- NPO NPGO
- ENSO

W-E BOUNDARY COUPLING SURFACE
~2YR - 4YR

SUBSURFACE
~5YR - 10YR

TROPICAL/EXTRA-TROPICAL COUPLING
~1YR - 2YR

KUROSHIO

JAPAN

NORTH AMERICA

 Courtesy Manu Di Lorenzo
Sea Level Anomaly (cm)

-12 -8 -4 0 4 8 12

Observed
CFSv2 Forecast (Lead 4)

180˚W 140˚W 100˚W

2015 2016 2017 2018

Courtesy Matthew Widlansky
Observed

CFSv2 Forecast (Lead 4)

Sea Level Anomaly (cm)

Honolulu (21.3°N, 157.9°W)

Sea Level Anomaly (cm)

Tide gauge
Satellite
Forecast

Courtesy Matthew Widlansky
CCS Subsurface Salinity Index (ORA S3)
CCS Subsurface Salinity Index (ORA S3)

Gyre Salinity Index ~ 10 years prior (ORA S3)

\[ R = 0.76, > 99\% \]

Pozo Buil and Di Lorenzo (2017)
CCS Subsurface Salinity Index (ORA S3)

Gyre Salinity Index ~ 10 years prior (ORA S3)

CCS Subsurface Salinity Index (Argo)

\[ R = 0.76, > 99\% \]

Pozo Buil and Di Lorenzo (2017)
NOAA Marine Prediction Task Force
(2017-2020)

Walleye pollock
Snow crab
Regional ecosystem drivers
Swordfish (target catch)
Leatherback turtles, California sea lions, Blue sharks (bycatch)
Coastal sea levels

Dungeness crab

Ground fish (flounders, Atlantic cod, butterfish, silver hake)

Forage fish (herring, mackerel)
Whales (shortfin pilot, fin, humpack)