A Climate of Change:
Preparing for an uncertain fishing future by bringing communities together with climate and marine scientists to understand predictive capabilities and information needs

Susie Arnold, Nick Battista, Heather Deese

Contact: sarnold@islandinstitute.org

Photo credit: Joel Woods
Preliminary 2015 Commercial Maine Landings By Ex-vessel Value
Total: $616,522,118 as of 2/19/16

- Lobster: 81%
- Soft clam: 4%
- Atlantic herring: 2%
- Worms: 1%
- Groundfish: 1%
- Scallops: 1%
- Oysters: 1%
- Urchins: 1%
- Blue mussel: <1%
- Other species: 6%
- Elver: 2%
Coastal Fisheries of Maine

1927

Fish Invertebrates

Frequency of Occurrence (% of all “inner” fishing grounds)

Lobsters Softshell Clams Herring Sea Urchins Blood Worms Angler fish Ocean Quahog Blue Mussels Cod Hakes

% Harvested Fisheries Value

Lobsters Softshell Clams Herring Sea Urchins Blood Worms Angler fish Ocean Quahog Blue Mussels Cod Hakes

Elvers (glass eels)

Today

Harvested Species

Slide modified from Steneck 1997
A Climate of Change - workshop series

- Hosted the 1st Climate of Change workshop in Portland on July 31 & Aug. 1, 2013
Experts call for greater urgency in adapting fisheries management to climate change

August 1

Message to Maine fishermen: Adapt to climate change

PORTLAND, Maine — John Bullard, northeast regional administrator of the National Oceanic and Atmospheric Administration Fisheries, sees climate change as not just a cause for immediate alarm, but also an opportunity.

“A crisis is a horrible thing to waste. It looks like a normal day out there, but it’s not — it’s not normal,” Bullard said Thursday during the second day of the two-day first-ever Climate of Change conference, organized by the Rockland-based Island Institute, on the Portland waterfront.

OCEANS: Maine fishermen fear warmer waters spell 'beginning of the end' for lobster catch (Tuesday, September 3, 2013)

Portland symposium highlights climate change

Conference looking at climate change, coastal industries

Updated 8:47 PM EDT Jul 31, 2013

Marine experts: Gulf of Maine has become a cod-forsaken place, endangering all fisheries

August 1

More than climate seen threatening Maine fisheries

Scientists at a Portland symposium say further study is needed to determine what is causing problems in the ocean.

By Seth Koenig, BDN Staff
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Posted July 31, 2013, at 4:43 p.m.
Preparing for an Uncertain Fishing Future:
Bringing communities together with climate and marine scientists
to understand predictive capabilities and information needs

A workshop in the Island Institute’s *Climate of Change* series, December 18, 2014

Organized by the Island Institute and co-hosted with Maine Coast Fishermen’s Association, Maine Lobstermen’s Association, and Cape Cod Commercial Fishermen’s Alliance. Facilitated by Laura Taylor Singer, SAMBAS Consulting LLC

Overview of the Workshop

Maine’s fishermen make investments in their communities and businesses every season. Because fishermen are keen observers of the natural world, they regularly make business decisions based on shifting environmental conditions. However, the Gulf of Maine is changing at a rapid rate and in ways never before seen by today’s fishermen. Seasonal forecasting and longer-term projections can suggest time frames over which changes may occur. While we know that these projections will not be able to ‘predict’ the future, through an understanding of likely future conditions in the Gulf of Maine they can provide insights relevant to the business decisions that people are making today.

The “Predictive Capabilities Workshop” brought together a diverse group of climate and marine scientists, fishermen, and other marine stakeholders to provide practical links between current climate projection work and the real world issues facing Maine’s fishermen and coastal communities. Participants learned about climate models and other forecasting methods and also heard perspectives about the issues facing fishermen as they adapt to future changes in the Gulf of Maine (GOM).
Sea Surface Temperature ~ 2.5 to 3.5 °C & Bottom Temp. ~ 3 to 6 °C by 2080

This finer scale resolution, leads to much more detailed predictions.

CM2.6 resolution is: ~ 6 miles x 30 miles

Bottom Temperature – Projection (1% CO₂ per year);
Years (61-70) – (1-10)

Saba et al., 2015
Gulf of Maine Lobster Forecasting

Project Overview

We are forecasting the timing of when the Maine lobster fishery will shift into its high-landings mode for the summer. Our goal is to provide 2-3 months advance notice of this uptick so that the lobster industry can prepare appropriately for the high-landings period.

2016 Forecast

March 16 Forecast

<table>
<thead>
<tr>
<th>Extremely Early</th>
<th>Very Early</th>
<th>Early</th>
<th>Normal</th>
<th>Late</th>
<th>Very Late</th>
<th>Extremely Late</th>
</tr>
</thead>
<tbody>
<tr>
<td>53%</td>
<td>46%</td>
<td>1%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Fishermen’s Decision-Making Timelines

- How soon will we see changes in each fishery?
- How and when is OA going to impact lobster?
- Which species are coming? When?
- What is the plan for licensing new fisheries?

<table>
<thead>
<tr>
<th>Item</th>
<th>Timeline</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traps (5-6 years)</td>
<td>2015-2025</td>
<td>$100/trap; 800 traps</td>
</tr>
<tr>
<td>Engine</td>
<td>2020-2025</td>
<td>$30,000</td>
</tr>
<tr>
<td>Electronics (7-10 years)</td>
<td>2020-2030</td>
<td>$5,000 - $10,000</td>
</tr>
<tr>
<td>Boat</td>
<td>2030-2040</td>
<td>$250,000</td>
</tr>
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</table>
### Envisioning the Gulf of Maine in 2030

<table>
<thead>
<tr>
<th>Climate</th>
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</thead>
<tbody>
<tr>
<td>- Warmer</td>
</tr>
<tr>
<td>- Fresher</td>
</tr>
<tr>
<td>- More precipitation</td>
</tr>
<tr>
<td>- Sea level rise and erosion</td>
</tr>
<tr>
<td>- Stronger storms</td>
</tr>
<tr>
<td>- Acidification</td>
</tr>
<tr>
<td>- More stratified?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ecosystem</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Less lobster in southern Maine</td>
</tr>
<tr>
<td>- New fishery species from south</td>
</tr>
<tr>
<td>- Predator-prey changes</td>
</tr>
<tr>
<td>- Primary production changes</td>
</tr>
<tr>
<td>- More invasive species</td>
</tr>
<tr>
<td>- More disease</td>
</tr>
<tr>
<td>- Different marine mammals</td>
</tr>
<tr>
<td>- OA impacts</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fisheries</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Rapid response capability</td>
</tr>
<tr>
<td>- Ecosystem-based management</td>
</tr>
<tr>
<td>- Migration of permits</td>
</tr>
<tr>
<td>- Larger vessels going further offshore</td>
</tr>
<tr>
<td>- Merge regional councils</td>
</tr>
<tr>
<td>- Negotiations between states &amp; with Canada</td>
</tr>
<tr>
<td>- Conflicts for ocean space due to more ocean energy, shipping, cruise traffic, aquaculture, sand &amp; gravel mining, oil drilling</td>
</tr>
</tbody>
</table>
Incorporating Climate and Community into Regional Ocean Planning

HUMAN DIMENSIONS
- Aquaculture
- Recreation
- Commercial Fishing
- Maritime Commerce
- Energy
- Culture

MARINE LIFE
- Mammals & Turtles
- Fish & Shellfish
- Other Marine Life
- Eelgrass

ENVIRONMENT

Featured Map
Recreation Areas
- Boat launches, water trails, beaches, parks, nature preserves, and other recreation areas.

Data Explorer
Launch the Data Explorer
Anticipated Release 2015
- The Data Explorer provides maps of all available datasets. Any combination of data can be viewed on a single map.

What's Next?
Northeast Ocean Data adds data, maps, and website enhancements on a rolling basis. Find out what's currently in development.

Anticipated Release: Winter 2015

Resources for:
- Scientists
- Managers
- Decision-makers
- Educators
- Students
- Citizen scientists

Learn more about these resources

Contact Us
- For support questions or comments, contact us by phone or email.

Northeast Ocean Data
- Supports ocean planning in the northeastern United States using open, shared data

Maps and data for ocean planning in the northeastern United States

Human Dimensions
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- Recreation
- Commercial Fishing
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- Energy
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Thank you.

www.IslandInstitute.org/climateofchange

Questions?
A Climate of Change - video series

Short documentaries on the impacts of climate change and ocean acidification on fishing communities - [http://www.islandinstitute.org/program/marine-programs/climate-change](http://www.islandinstitute.org/program/marine-programs/climate-change)

Part 1: Warming waters in the Gulf of Maine

Scientists, managers, and fishermen have all begun to discuss how we can and should be planning for the inevitable, but unpredictable, climate impacts on the marine ecosystem.

Part 2: Ocean acidification in Alaska

Ocean acidification is a global problem, but its impact on the Arctic. The state of Maine is looking towards Alaska and other places to learn more about the experiences of fishermen there.
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Part 3: Fisheries collapse and adaptation in Appalachian oyster fishery

Part 4: The future of shellfish and seaweed aquaculture in Maine

Not yet available online
Gulf of Maine Sea Surface Temperature:

Since 1982:
~1°C every 40 years

Since 2004:
~1°C every 4 years

Mills et al. 2013