Toward an integrated environmental information system in the Gulf of Maine

Philip Bogden, CEO
GoMOOS, Inc
Integrating…in a Distributed Way

1. GoMOOS – User-Driven Nonprofit
   (Bridging the valley of death)
2. Toward a Regional Association
   (System of interoperable systems)
3. What makes you think it can happen?
   (Standards enable innovation)
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Operational Goals

To provide data and information that serve public and private sector needs to:

- Solve practical problems,
- Predict events, and
- Further understand natural systems...

...in the Gulf of Maine.

A Coastal Oceanic Analog of...

...the National Weather Service.
GoMOOS is Regional and Multisector

Serving all Gulf of Maine states and provinces:
Nova Scotia, New Brunswick, Maine, New Hampshire, Massachusetts, on south…

Partners:

• Research Institutions
• Government Agencies
• Educational Institutions
• Private Industry
• Nonprofits
User Needs

- Mariners – safety, rescue
- Shipping – safety & efficiency
- Mammals – endangered species assessment
- Aquaculture – site selection & water quality
- Lobster fishing – recruitment prediction
- Petroleum Industry – spill response
- Shellfishing – spat collection, site selection
- Military – national security, operations test bed
- Coastal Management – eutrophication
- Commercial & Sport Fishing – stock assessments
- Research – long-term observations, infrastructure
GoMOOS Members

**Research/Education:**
- Bedford Institute of Oceanography (Canada)
- Bigelow Laboratory for Ocean Science
- Bowdoin College
- Dalhousie University (Canada)
- Maine Maritime Academy
- Rutgers University
- University of Maine
- University of Massachusetts
- University of New Hampshire
- University of Rhode Island
- Woods Hole Oceanographic Institution

**Industry:**
- Bath Iron Works
- James W. Sewall Company
- Maine Lobstermen’s Association
- Portland Pipe Line Corporation
- Satlantic, Inc. (Canada)
- RD Instruments, Inc.

**Marine Operations:**
- Atlantic Pilotage Authority (Canada)
- Eastport Port Authority
- Federal Marine Terminals (Canada)
- Penobscot Bay & River Pilots Assoc.
- Saint John Marine Pilots (Canada)
- Saint John Port Authority (Canada)

**Government:**
- Maine Dept. of Marine Resources
- Maine Science & Technology Foundation
- Maine State Planning Office
- Massachusetts Coastal Zone Management
- Massachusetts Water Resources Authority
- Stellwagen Bank National Marine Sanctuary
- Massachusetts Coastal Zone Management
- Massachusetts Water Resources Authority
- Stellwagen Bank National Marine Sanctuary

**Nonprofit:**
- Gulf of Maine Aquarium
- Island Institute
- New England Aquarium
Technical Program

Real-time data acquisition:

Weather – surface winds, air temperature, visibility (fog), light flux, cloud conditions

Ocean conditions – current, waves, temperature, salinity

Water quality – dissolved oxygen, water clarity, turbidity, nutrients

Ocean biology – irradiance, algal biomass, productivity, community structure, acoustics (whales)

Modeling & Prediction: circulation & waves

Data & Information Management: adding value
Science Team

University of Maine
- Neal Pettigrew (Chief Scientist): Buoys & Currents
- David Townsend – Nutrient measurements
- Andrew Thomas – Satellite remote sensing
- Huijie Xue – Circulation modeling
- Lewis Incze – Upper trophic levels

Bigelow Laboratory
- Collin Roesler – Phytoplankton and bio-optics

Woods Hole Oceanographic Institution
- James Irish – Wave measurements

Bedford Institute of Oceanography
- Peter Smith – Wave modeling & prediction
- William Perrie – Wave modeling & prediction
Mooring Team

“Have buoy, will travel”

University of Maine
  Dr. Neal Pettigrew
  John Wallinga
  Linda Magnum
  Robert Stessel

Woods Hole Oceanographic Inst
  Dr. James Irish

Bigelow Laboratory
  Dr. Collin Roesler
  Dr. Andrew Barnard
GoMOOS Shelf Buoy

Real-Time, Modular Design
HF Radar Installation
Integrating…in a Distributed Way

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3. What makes you think it can happen? (Standards enable innovation)
The System is Evolving

Maine Dept. of Marine Resources
Mass. Division of Marine Fisheries
New Hampshire Fish & Game
U.S. Geological Survey
Up-to-date information on weather and oceanographic conditions in the Gulf of Maine

Hourly Buoys Data

Buoys and Stations Collecting Weather and Ocean Data

Northern Shrimp

Explore northern shrimp fisheries information with this interactive mapping tool that brings together shrimp catch data with relevant environmental conditions.

Data Providers

- Maine Dept. of Marine Resources
- Northeast Fisheries Science Center

Wave Forecasts

Predictions - up to 48 hours - of wave height and period.

Weather Forecasts

Regional Weather

- Coastal Marine Forecasts
- Marine Prediction Center
- Atlantic Forecast
- Mount Washington

National and Canadian Weather

- Weather Channel.com
- Weather Underground.com
- The Weather Network

Atmospheric Conditions

Information about the latest weather conditions on the ocean includes wind, air temperature, visibility, and cloud cover index along with descriptions of the data.

Ocean Biology

Plant Life

Using light to measure phytoplankton, photosynthesis
The System is Evolving

Nutrient Monitoring

Dave Townsend
(Univ. of Maine)

&

Friends of Casco Bay

(…& EPA?)
Integrating…in a Distributed Way

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3. What makes you think it can happen? (Standards enable innovation)
Standards Enable Innovation

- WWW → HTTP & HTML
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- Climate Modeling → OPeNDAP/DODS & CF
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- Census of Marine Life → DiGIR & Darwin Core
Standards Enable Innovation

- WWW ➔ HTTP & HTML
- Climate Modeling ➔ OPeNDAP/DODS & CF
- Census of Marine Life ➔ DiGIR & Darwin Core
- EPA ➔ HTTP & (XML + Data Schema)
Standards Enable Innovation

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- EPA → HTTP & (XML + Data Schema)
- Coastal IOOS → OPeNDAP + ???
Standards Enable Innovation

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• Climate Modeling → OPeNDAP/DODS & CF
• Census of Marine Life → DiGIR & Darwin Core
• EPA → HTTP & (XML + Data Schema)
• Coastal IOOS → OPeNDAP + ???
• Web GIS → HTTP & (XML + OGC Services)
National Federation of Regional Systems

Regional Systems
- Regional priorities
- Effects of climate change & Effects of land-based sources
  - Resolution,
  - Variables

National Backbone
- Satellite remote sensing
- In situ sensing reference & sentinel station-network
- Link to global ocean component
- Data standards & exchange protocols
Integrating…in a Distributed Way

1. GoMOOS – User-Driven
   (Research → Operations → Research)
2. Toward a Regional Association
   (Cultural & technical challenges)
3. What makes you think it can happen?
   (A: Demos are here. …EPA?)
Thank You
1. GoMOOS – User-Driven
   (Research → Operations → Research)
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   (Cultural & technical challenges)
3. What makes you think it can happen?
   (Demos are here – EPA…?)
Basic Science (old paradigm)

Exercise: Justify the infrastructure ($) needed to enable testable hypotheses for all of:
   a) North Atlantic Oscillation
   b) Wind-Driven Circulation
   c) Bio-physical coupled models

Correct answer must address two points:
   • NSF can’t afford it.
   • Congress needs a cost/benefit analysis.
User-Driven Science (new paradigm)

a. North Atlantic Oscillation…
   *Fisherman: “That NAO index looks like my revenues over the last 20 years.”*

b. Wind-Driven Circulation…
   *Headline: “USCG improves search & rescue, saving $30M in one year.”*

c. Bio-physical coupled models…
   *Headline: “HAB warning saves lives!”*

*This System Must Operate 24/7!*
Maritime Shipping Industry

3,500 transits/yr
50 million tons

202,000 transit hrs
$43 million ops.

1% time savings
= $500,000/yr
Time and safety

Average value per fishing day = $4.1M

“...I check for the official gale warnings, then go to the [GoMOOS] web site to see if the wind is actually blowing now. I can get a day’s work in...”

--Scallop from Stonington, Me.
Connecting Fisheries to the Physical Environment

Climate change

Stock assessment
  -- chlorophyll/productivity
  -- circulation

Aquaculture siting
  -- dissolved oxygen
  -- salinity
  -- sea surface temp.
  -- currents
Oil Spills: Contingency Planning, Prevention, and Recovery

Julie N –
180,000-gal. spill,
Portland Harbor
September 1996

Real-time
-- Wind
-- Waves
-- Currents
-- Predictive models
U. S. Coast Guard:

2nd largest user of GoMOOS web site

6000 missions/yr
500 saved lives
28 lives lost/yr

4% success after 2 hours,
1% increase in effectiveness = 6 more lives saved per year
24/7 User Need For HF Radar:

Coast Guard Search & Rescue
Wastewater Management

New Boston Harbor Sewage Outfall
- Boundary conditions for nutrients & currents
- Dissolved oxygen

Helps meet costly monitoring requirements
New Frontiers for Resource Management: Biological Observations

*Alexandrium tamarense*: Agent of paralytic shellfish poisoning (red tide)

Experimental technologies

Future: Red Tide predictive index

Photo credit: Larry Fritz
Cost-Effective System for Research and Operations

- The system must produce long-term research-quality data.
- The system must operate 24/7 to accommodate user needs.
- No individual user can afford to pay for the entire system.
- The U.S. national system will be a federation of linked regional systems.
Estimated Annual Benefit
Potential for 5 Sectors

1. Search and rescue (lives saved)
2. Oil spill mitigation
3. Efficiencies in commercial fisheries
4. Recreational fishing days
5. Maritime transportation – vessel operating costs

$33+ million per year

Source: Kite-Powell and Colgan, 2001, for NOAA
Estimated Annual Costs
For a Regional Ocean Observing System

Capitalization (over 3 years): +/- $12M
  • 10 – 13 buoy locations
  • 4 CODAR units
  • Data management system

Operation & Maintenance: +/- $4 M/yr

...Conservative cost-benefit ratio = 1:10.
Lessons Learned So Far…

1. Useful information is Critical
   • Data ? Information. The path is not obvious.
   • Users must be engaged – we’re market driven.

2. Operational needs (24/7) are strenuous!
   • Just ask the scientists involved in the system.
   • The model is new to researchers, and evolving.

3. Research & Operations must be linked!
   • System must be based on sound science.
   • Real-time QA/QC can’t wait for peer review.

If GoMOOS were a car…?
   …Honda Insight, Volvo, Chrysler
Ocean Observing Systems
-- The GoMOOS Prototype --

1. GoMOOS Overview
2. User-Driven Nonprofit
   (Governance with Accountability)
3. Economic Reality
   (Bridging the Valley of Death)
4. National Scene & Ocean.US
   (Governance at the National Level)
A Revolution Is Approaching In Coastal Ocean Science.

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Is GoMOOS a Regional Prototype?

• Congress is discussing legislation that will establish the agency framework for a national coastal ocean observing system.
• The U. S. Ocean Commission on Ocean Policy is making the recommendation.
• Ocean.US, under the auspices of NOPP and the NORLC, is preparing the plan.
Present Status of National OOS

- GEM
- NEPTUNE
- GoMOOS
- NOAA
- CHAOS
- SABSOON
- NJSOS
- NGLI
- LEO-15
- SEA-COOS
- SURA
- Caro-COOPS
- CSC
- Confusion
- CBOS
- LEO
- MVCO
- Congressional Train
- Wreck
- Imminent
National Federation of Regional Systems

Regional Systems
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Why GoMOOS, Inc?

GoMOOS provides a single voice to:

- **Link research & operations**
  - Leverage local infrastructure via partnerships
  - Work efficiently with operational agencies

- **Provide governance with accountability**
  - Respond to subregional user needs
  - Respond quickly & remain innovative

- **Justify long-term funding**
  - Engage local constituencies
  - Provide a multipurpose utility, based on sound science, to support research and the public good
Up-to-date information on weather and oceanographic conditions in the Gulf of Maine

www.GoMOOS.org
Updates – March 2004

• HF Radar (CODAR) is on line
• Wave Forecasts are on line
• Northern Shrimp Tool is on line

On the National Scene:
• OpenIOOS.org is on line

Two Themes: (1) Need, (2) Integration
Standards Enable Innovation

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- Climate Modeling → CF + OPeNDAP
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- WWW \(\rightarrow\) HTTP & HTML
- Climate Modeling \(\rightarrow\) CF + OPeNDAP
- OBIS \(\rightarrow\) DiGIR + Darwin Core II
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- EPA → XML + Data Schema
- IOOS → ??? + OPeNDAP
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- OBIS → DiGIR + Darwin Core II
- EPA → XML + Data Schema
- IOOS → ??? + OPeNDAP
- OGC → XML + Web Services
Up-to-date information on weather and oceanographic conditions in the Gulf of Maine

**Hourly Buoys Data**

Buoys and Stations Collecting Weather and Ocean Data

![Hourly information](image)

Hourly information developed for marine operations includes wind, wave, visibility, air temperature, water temperatures at various depths, salinity and more. Real-time and historical data from GoMOOS and NOAA

**New**

**Northern Shrimp**

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**Atmospheric Conditions**

Information about the latest weather conditions on the ocean includes wind, air temperature, visibility, and cloudiness index along with descriptions of the data.

**Ocean Biology**

Plant Life

Using light to measure phytoplankton, zooplankton, etc.
CODAR Sea Surface Currents

Gulf of Maine

CODAR or Coastal Ocean Dynamics Application Radar
- Is a land-based high-frequency radar system
- Makes long-range measurements of sea surface currents
- Measures sea surface currents independent of fog or cloud cover
- Can measure currents for areas where two or more stations overlap
  View map of Gulf of Maine CODAR stations

Uses of CODAR sea surface current measurements
- Provides real-time information to assist with search and rescue operations
- Predicting oil and hazardous material spill movement
- Safe and efficient navigation and marine operations
- Monitoring large ocean currents that transport lobster and other larvae around the Gulf
- Education

Links to learn more about CODAR
The Physical Oceanography Group at the University of Maine
The COOL Room CODAR tutorial
CODAR Ocean Sensors, Inc.
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Atmospheric Conditions
Information about the latest weather conditions on the ocean includes wind, air temperature, visibility, and haze/dust index along with descriptions of the data.

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Plant Life
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Interactive Map

- 2000 Port samples kg/hr
- 2000 Fall survey kg/hr
- 2000 Summer survey kg/hr

Augusta
Portland
Saco
Gloucester

Gulf of Maine Ocean Observing System

Data Tools Layers Download Graphs Legend

Method
- Port samples
- Summer survey
- Fall survey

Data Year Month or Week
- CPUE [kg/hr] 2000 All
- CPUE [kg/hr] 2000 All

Units: kg lb

Query data
Click map symbol to view data.

2000 annual Port sampling by 10-minute square
- 122 - 192 kg/hr
- 193 - 252 kg/hr
- 253 - 312 kg/hr

2000 Summer survey
- 0 kg/hr
- 1 - 50 kg/hr
- 1 - 100 kg/hr

2000 Fall survey
- 0 kg/hr
- 707 - 1058 kg/hr
- 101 - 149 kg/hr

Welcome to GoMOOS - Mozilla

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