

GULF OF MAINE  
LOBSTER FOUNDATION



# Ocean Data Visualization Tools Workshop

April 17, 2025  
Ellsworth, ME

## WORKSHOP REPORT

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## Executive Summary

The Ocean Data Visualization Tools Workshop convened 30 fishing industry participants and 11 ocean data tool developers, researchers, and collaborators for a full-day workshop on April 17, 2025, in Ellsworth, Maine. The workshop was part of the Sea Grant American Lobster Initiative-funded project *Providing the lobster industry new gear technology in response to regulatory and environmental changes*. The purpose of the workshop was to connect fishermen directly with ocean observing programs and data visualization tools, gather targeted feedback on existing products, and identify emerging data needs to better support on-water decision-making in a rapidly changing Gulf of Maine.

Through plenary discussions and hands-on breakout sessions focused on the eMOLT program, the observing system near Downeast Maine, and four data visualization tools (the Mariners' Dashboard, Climatology Viewer, eMOLT Deckbox, and Fishing Ocean Data Portal), participants emphasized the importance of accurate, timely, and accessible ocean data for safety, operational efficiency, and long-term planning. Fishermen shared extensive field-based observations pointing to ecological and physical changes in the Gulf of Maine, including concerns related to dissolved oxygen, algal blooms, invasive species, shifting temperature and salinity patterns, and large-scale circulation changes. These discussions highlighted both the value of fishing-vessel-based observations and sustained sea state observations from buoys and other stations. They also identified critical gaps in monitoring coverage, particularly in Downeast Maine, nearshore habitats, riverine inputs, and offshore regions important for understanding broader circulation dynamics.

Across tools, participants consistently called for intuitive, fisherman-centered data products that balance simplicity with flexibility, offer localized and customizable views, and integrate real-time observations with historical data and models. The workshop underscored the importance of sustained collaboration between fishermen, scientists, and data providers, and reinforced the role of fishing-vessel-based observing systems like eMOLT as an essential complement to fixed infrastructure. Participants expressed strong interest in continued engagement, expanded participation, and ongoing co-development of data tools to support the resilience and adaptability of Gulf of Maine fisheries.

# Glossary

D.O.	Dissolved Oxygen
DMAC	Data Management and Cyberinfrastructure
eMOLT	Environmental Sensors on Lobster Traps and Large Trawlers
ERDDAP	A data server
FVCOM	Finite-Volume Community Ocean Model
GMRI	Gulf of Maine Lobster Institute
GOMLF	Gulf of Maine Lobster Foundation
HF Radar	High Frequency Radar
IOOS	Integrated Ocean Observing System
Maine DMR	Maine Department of Marine Resources
MCCF	Maine Center for Coastal Fisheries
MCFA	Maine Coast Fishermen's Association
MDI	Mount Desert Island
Metocean	Meteorological and Oceanographic
NDBC	National Data Buoy Center
NEFSC	Northeast Fisheries Science Center
NERACOOS	Northeastern Regional Association of Coastal Ocean Observing Systems
NOAA	National Oceanic and Atmospheric Administration
ODN	Ocean Data Network
OOI	Ocean Observatories Initiative
ONSET	Onset Computer Corp.
QC	Quality Control
SST	Sea Surface Temperature
UConn	University of Connecticut
UMaine	University of Maine
UNH	University of New Hampshire
URI	University of Rhode Island
VEMCO	Vemco Monitoring
WMO	World Meteorological Organization

# Introduction

The Ocean Data Visualization Tools Workshop brought together 30 fishing industry participants with 11 ocean data tool partners and collaborators for a full-day workshop in Ellsworth, ME. Participants and collaborators are listed in Appendix I. The Workshop was a component of the project *Providing the lobster industry new gear technology in response to regulatory and environmental changes*, funded by the Sea Grant American Lobster Initiative in 2022. This report details the workshop proceedings and outcomes.

The overarching project aims to provide lobstermen the necessary data visualization tools to navigate a changing environmental and regulatory landscape by deploying additional sensors, and developing and upgrading models and data products that effectively deliver critical information to the fleet. Improving environmental data collection and sharing within the Gulf of Maine helps lobstermen work in ways that are more strategic, surgical, cost-effective and ultimately profitable, all of which are more important than ever as the fishery faces a growing number of operational challenges. More information about the project can be found on the American Lobster Initiative storymap, "[Mapping Seafloor Temperature](#)".

The workshop was organized by the Gulf of Maine Lobster Foundation (GOMLF - Erin Pelletier and Emma Weed), and Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS - Katy Bland, Tom Shyka, and Jake Kritzer), with advising from National Oceanic and Atmospheric Administration (NOAA) Northeast Fisheries Science Center (NEFSC - George Maynard and Jim Manning [retired]).

## Workshop Proceedings

### Overview

The full-day workshop was held at the Moore Community Center Theater in Ellsworth, Maine on April 17, 2025. The morning session focused on providing context for the workshop, providing background information on the types of data available, and discussion on how data is able to meet the needs of fishermen. The afternoon session was structured around breakout sessions to enable participants to provide feedback on specific data visualization products.

Erin Pelletier kicked off the day with housekeeping notes, round-the-room introductions, and an overview of the workshop goals and agenda.

### Workshop Goals

- Provide an overview of the data types and products associated with the eMOLT program, which is a collaborative program that facilitates real-time observational data collection with the fishing industry.

- Provide an overview of NERACOOS ocean data products.
- Hear fishermen’s targeted feedback and ideas on specific data visualization products, ideas on arising information needs, and observations of changing data uses to best support on-water decisions.

See Appendix III for slides presented during the workshop.

## **Background**

### **Gulf of Maine Lobster Foundation**

During her introduction, Erin overviewed the Gulf of Maine Lobster Foundation (GOMLF), an entity established in 2000 by members of the Maine lobster industry in response to the growing demand for improved lobster science and the need to establish long-term datasets. GOMLF has been the lead organization for the eMOLT program since 2003.

### **NERACOOS**

Tom Shyka provided an overview of Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS), one of eleven Regional Associations of the U.S. Integrated Ocean Observing System (IOOS). NERACOOS works with regional operators and partners to generate data about the ocean, consolidate data, and share it with anyone who wants or needs it. Certified by NOAA as a Regional Coastal Observing System (RCOS) Entity, the data NERACOOS serves meets the high standards set for federal data gathering and management. Examples of ocean observing technologies used in the Northeast are data buoys, land-based high-frequency radars, tide gauges, gliders, and various biological monitoring technologies. Data collected across the region is integrated into oceanographic models, and is translated into information and data products that make the data accessible. See Appendix III, slides 2-33, for more detail.

### **eMOLT Program**

George Maynard provided an overview of the Environmental Monitors on Lobster Traps and Large Trawlers (eMOLT) program, which has been “democratizing ocean observing since 1996”. Jim Manning began the program in 1996, working with fishermen to deploy low-cost ONSET Tidbit temperature loggers primarily out of Massachusetts ports. These sensors archived temperature data and at certain intervals would be manually sent to Jim Manning for data download. The program expanded throughout New England through 2014 to 402 sites, with better temperature sensor accuracy using the VEMCO Minilog. George showed multiple examples of the insights gained through the early days of the program, highlighting papers (see Appendix III, slides 42-51) that show the value of these fishing vessel observations . With individual captains’ permission, he also showed examples of long-term data from individuals, which has shown increasing bottom temperatures over time.

Starting in 2015, the eMOLT system collaboratively developed and expanded to include real-time data loggers, which collect temperature profiles or dissolved oxygen/temperatures. Unlike the archival data loggers, the real-time wireless loggers sync with low-cost, on-vessel deckboxes to display data, and utilize 4G cell service to transfer data to shore-based servers. George showed visualizations of recent data collection expansion into Maine. Since 2022, Downeast Maine fishermen have been growing participants in the eMOLT system and have dramatically augmented the amount of data being collected.

After highlighting funders, and those funding sources that may be lost with prospective budget cuts, George highlighted the many uses of the data when aggregated (see Appendix III, slides 82-111), showing participants the value of the system of data beyond fishermen's individual uses. Highlighted uses of aggregated data include 1) providing insight into coastal dissolved oxygen levels when algal blooms occur, 2) data assimilation into ocean models to provide more accurate forecasts, and 3) ground-truthing ocean models to understand how well models reflect reality. See Appendix III, slides 34-111, for more detail.

## Plenary Discussion

Jake Kritzer briefly provided additional context for a group discussion, emphasizing that feedback regarding observing needs directly from users is essential to continuing to run an effective and accessible observing system that is responsive to changing environmental and economic conditions.

Emma Weed then facilitated a full group discussion, with the following prompts:

### Information Uses

- What kind of information do you rely on before heading out and when you are out on the water—and what do you wish you had more of?
- How does the ocean data provided influence your on-water decisions?
- What data do you wish existed?
- How do your data needs shift under different regulations (e.g., if the gauge increase had gone into effect, would that change any ocean data needs)?
- What models do you rely on?
- Are there examples of when ocean data confirmed something you had previously thought was happening? What about vice versa, where the data was different than you thought it would be.

### Changes Over Time

- What kind of changes have you seen and has that changed how you work?
- How are your data needs shifting over time? Are these different across seasons?

Scale - What space and time scales are important & interesting to you?

- Spatial scale: Just your fishing ground? Your lobster zone? Entire Gulf?
- Time scale: tidal, daily, weekly, monthly, seasonal, annual, decadal?

### Tools & Delivery Formats

- How do you most prefer to get information about ocean conditions? (e.g., Websites/Portals, Apps, Email updates, Newsletters mailed to you, Texts, Social media)

## Summary of Plenary Discussion

In addition to expressing steadfast support for existing observing assets in the region and passion for the use of eMOLT sensors to contextualize their fishing practices, participants primarily shared their field-based observations that have raised concerns about ecological change in the Gulf of Maine (GoM). These observations, grounded in their fishing activity and long-term experience, prompted questions about system drivers and highlighted the limitations of existing monitoring to explain observed trends. As understanding upstream conditions was viewed as critical for anticipating changes entering the Gulf of Maine, participants emphasized the need for stronger connections with Canadian researchers and fishermen (e.g., Fishermen's Scientist Research Society). The following summary of the plenary discussion is broken into the following categories: core variables and coverage of measurements; biological observations; large-scale physical oceanography changes; impacts of manmade infrastructure; data access, usability, and communication challenges.

### Core Variables and Coverage of Measurements

Participants identified several foundational environmental variables that are of continued and expanded monitoring interest. These included bottom and water column temperature, nutrient inputs, and dissolved oxygen (DO), all of which are critical for understanding recent variability and apparent reversals in warming trends. Dissolved oxygen near Jonesport was highlighted following a salmon aquaculture die-off associated with an algal bloom. Participants noted that algal blooms appear to be moving eastward, increasing concern for under-monitored areas. In response to fishermen observing dead zones, additional DO sensors have been deployed in Blue Hill Bay. These deployments were described as important for establishing baseline conditions and providing evidence to inform management. Participants emphasized the need for improved inshore monitoring of nearshore critical habitats and expressed interest in expanding the use of eMOLT sensors (approximately 180 deployed through MassTech) as well as exploring sensor placement on scallop lines.

Regional gaps in coverage were also emphasized. Riverine inputs into the Gulf of Maine were repeatedly cited as poorly characterized despite their likely influence on nutrients, temperature, and oxygen dynamics. Downeast Maine, primarily Washington County, was identified as a major coverage gap due to the absence of a buoy, leaving large portions of the coastline without a consistent offshore context. While an existing surface buoy (NDBC 44027) is located approximately 25 miles offshore, it was described as insufficient for full water column conditions and nearshore temperature monitoring, and not serviced frequently enough.

Participants also highlighted the need for improved monitoring further offshore to understand interactions between the Gulf Stream and the Labrador Current, noting the Northeast Channel (former location of Buoy N) as particularly valuable for detecting deepwater inflows to the Gulf of Maine. In its absence, participants emphasized the importance of eMOLT data in these regions, which help support system-wide understanding and improve forecasts despite inherent limitations. However, the limitations of eMOLT data were also noted. As the eMOLT sensors are frequently moved and there is interference from tides and currents, interpretation at larger scales is less straightforward.

### Biological Observations

Participants described several biological observations while lobstering that have spurred questions about system drivers of change. Increased abundance of sea squirts offshore was observed, with questions raised about potential links to dissolved oxygen conditions. Concerns were also raised about the impact of invasive crab species on early lobster settlement. Participants suggested that green crab populations in southern Maine are likely already affecting settlement and expressed concern about how blue crab range expansion into the Gulf of Maine may further influence recruitment.

Another observation was the rapid expansion of *Dasysiphonia japonica* (purple hair algae). Participants reported that it is “choking out” benthic habitats and has recently expanded offshore and further Downeast. While *Dasysiphonia japonica* has been present in the region for approximately 15 years, its recent growth raised heightened concern. A collaborator noted that research has shown *Dasysiphonia japonica* can increase acidity, although it has not been shown to affect lobster settlement. Nonetheless, participants expressed concern about broader ecosystem and harvest impacts.

### Large-Scale Physical Oceanography Changes

Participants discussed recent physical changes that diverge from longer-term trends. Following multiple years of warming, the past year (2024) was characterized by colder and lower salinity water. This raised questions about whether colder, fresher water, may be influencing conditions. Collaborators noted there may be a shift in large-scale circulation. Participants questioned how to predict the behavior of these currents on annual timescales, and [a recent paper](#) (Record et al. 2024) was repeatedly referenced as helpful for considering how deep oceanographic signals in the fall could help to forecast upcoming regime changes in the Gulf of Maine. A collaborator noted that traditionally, sea surface height at the Grand Banks has been used as an indicator of water stacking and the likelihood of the Gulf Stream pinching off the Labrador Current, with a proposed lag of one to two years before impacts are observed in the GoM. However, collaborators also noted that this approach would not have accurately predicted conditions in the past two years, suggesting a breakdown in previously reliable indicators. Nick Record's annual forecasting efforts were highlighted as a positive example of scientists ability to make forecasts, noting his accurate prediction that 2024 would be a good year for *Calanus spp.* and North Atlantic Right Whales.

### Impacts of Manmade Infrastructure

Participants questioned whether the rapid expansion of floating oyster aquaculture, particularly black oyster cages in Midcoast, could be contributing to localized warming in bays by absorbing heat. Related questions focused on how increasing water temperatures may affect plankton communities, clam spat, and lobster life stages.

Wind energy development prompted discussion of potential circulation impacts. Participants questioned whether wind farms could affect Gulf Stream flow. A collaborator noted that circulation modeling related to wind farms is underway in Southern New England and the Mid Atlantic, and emphasized the need for robust before-and-after turbine installation data to detect impacts. While the North Sea provides insight into impacts from fixed pilings, which is relevant to projects south of Cape Cod, much less is known about subsurface circulation changes associated with floating wind turbines, which would be the substructure used in the Gulf of Maine. Participants and collaborators distinguished between surface and subsurface effects and noted the latter as a major knowledge gap. A collaborator suggested that while this infrastructure may have an impact, climate-driven changes in winds and currents are likely the dominant driver of a changing Gulf Stream, citing decades of surface current data from drifters deployed throughout the Gulf of Maine.

### Data Access, Usability, and Communication Challenges

Participants discussed both the importance of access to the data, and noted specific challenges related to data access and usability. Many rely heavily on the buoy data, mainly accessing through Fishweather, Windfinder, and the Mariners' Dashboard. Participants reported regular data delays between 4–6 a.m., a particularly problematic window given that fishermen often make go/no-go decisions during this time.

Concerns were also raised about data accuracy and availability. Participants noted that at times the Portland weather buoy west-originating wind speed data appears to be tempered by the Mainland and islands, so it is not a good indicator of wind speed slightly further offshore. Additionally, the Eastern Maine Shelf buoy is visible on the Mariners' Dashboard, but water temperature data are not reliably displayed across other platforms, so the live data connections need to be reestablished.

There was strong interest in a centralized portal where users could view eMOLT data from deployments across the region. George referenced the Commercial Fisheries Research Foundation's ERDDAP system, acknowledging usability challenges, and described ongoing collaborative work to develop a more accessible public-facing data product, [Cape Cod Ocean Watch](#), which has been released since the workshop.

Participants emphasized the need for more intuitive data visualization tools, such as clickable maps that display temperature values. A collaborator described limitations of the Deckbox, which displays model output as a continental shelf-wide image, and

expressed interest in automated, zoomed-in model views tailored to individual fishing grounds, and well as integrated into the Mariners' Dashboard.

## **Breakout Session: Data Visualization Tools**

The afternoon session focused on gathering participants feedback on specific data products. Following an overview of four data visualization tools by different speakers, participants rotated through small-group breakout sessions (8 per group), each centered on a different tool. An overview (given in plenary) and takeaways from the breakout session for each tool are below. The first two tools (Mariners' Dashboard and Climatology Viewer) have a primary focus on region-wide data, while the second two tools (eMOLT Deckbox and the Fishing Ocean Data Portal) primarily focus on visualizing fishermen's individual data.

Following the breakout sessions, Tom Shyka, Riley Young Morse, Cooper Van Vranken, and Andrew Goode provided high-level takeaways from their respective discussions.

### **Mariners' Dashboard**

[mariners.neracoos.org](http://mariners.neracoos.org)

Tom Shyka provided an overview and brief, live demonstration of the Mariners' Dashboard Tool, which delivers high-quality, timely data from a growing network of buoys and sensors into the hands of mariners heading to sea. He demonstrated the ability to see real-time observations for a suite of metocean variables, and forecasts for a subset. The buoys and sensors shown on the Dashboard are from both NERACOOS-funded assets and external assets (e.g., NDBC).

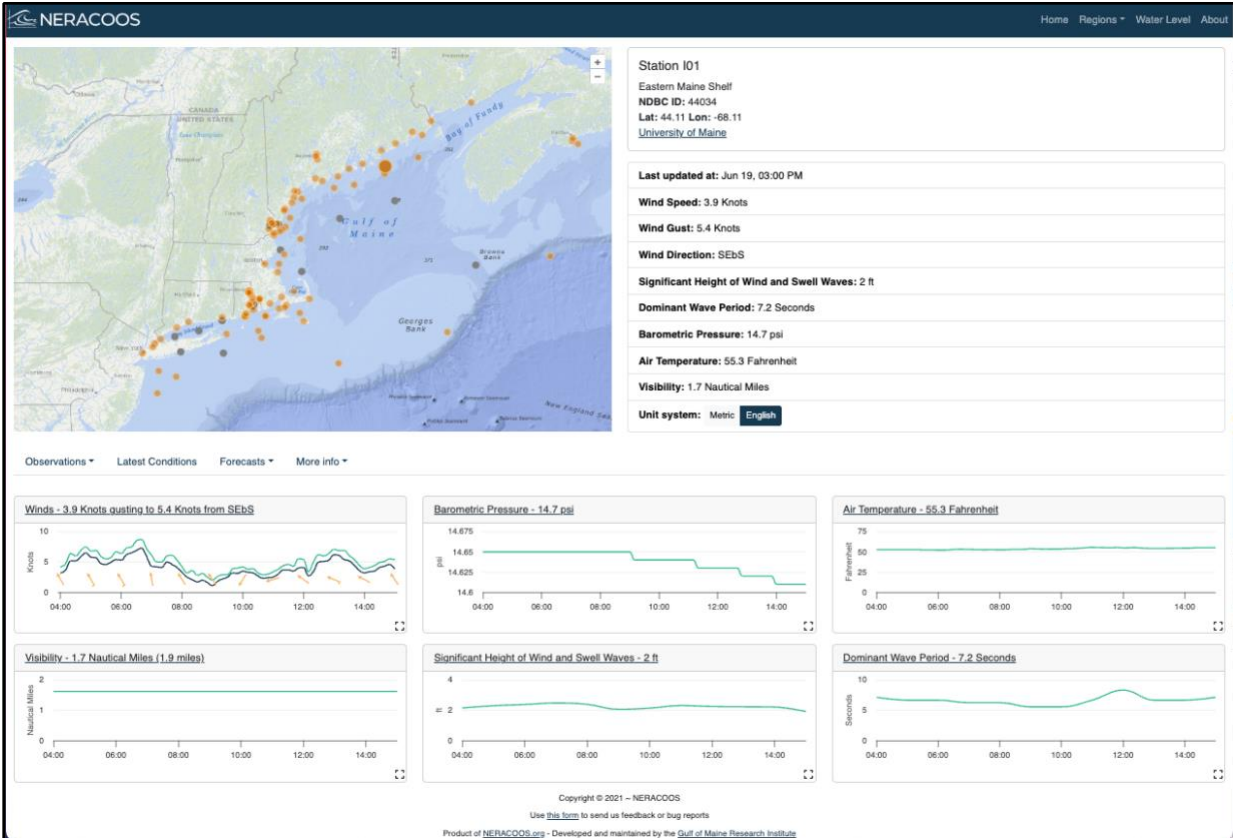


Figure 1: Screenshot of the Mariners' Dashboard

### Breakout Summary (Mariners' Dashboard)

Tom Shyka led group breakout discussions on the Mariners' Dashboard. Discussion prompts aimed to understand when and how participants looked at data, what data they were looking for, and what factors, if any, influenced their decision to go on the water that day.

At a high level, participants expressed that having buoys in the water with sustained, accurate and timely data was important for safety. Multiple participants emphasized the importance of continuing to support the delivery of sea state data from the buoys and to minimize delays in real-time updates. In addition to using the data early in the day to understand current conditions and view forecasts, participants see the data as useful for building a long-term knowledge base and understanding trends. Each participant has built their own individual mental "model" of how different combinations of conditions, temporal and spatial, result in fit or unfit fishing conditions. Participants heavily rely on this mental model, as forecasts are sometimes wrong; this may lead to a missed day of fishing (if calling for bad weather when it turns out to be okay), or worse, the conditions are more extreme than anticipated and it becomes a safety concern. The 24 hours of recent data lookback on the Dashboard can be helpful to understand how the previous day's forecast compared to the actual data, but this feature isn't a primary reason for visiting the Dashboard. More details on the breakout sessions are described below, and are

grouped into the following categories: Core and Secondary Variables; Timing of Data Use; Data Access Points; Data Visualization Insights; Buoy Locations.

*Core and Secondary Variables.*

Wind speed, significant wave height (average of highest third of waves), and wave period were consistently identified as the most important variables for determining if it is safe to go fishing. Participants expressed that peak wave height is interesting, but not as useful for decision-making as significant wave height. Air temperature is particularly useful in the winter. Visibility measurements from the NERACOOS buoys' visibility sensors are useful but not a key determinant of whether to go fishing. The visibility observations are unique to the Mariners' Dashboard because they are not being delivered by other apps. The participants also discussed the value of buoy-based webcams, which would enable them to monitor sea state and see if other vessels are operating nearby. There was some interest in this, but it was not a high priority because the decision to go to sea is often made early in the morning, when it is dark.

*Timing of Data Use* - Participants noted that they check conditions early in the day before heading out. Once out on the water, they are not as likely to check the current conditions. Instead, they will use the marine radio to understand high-level weather forecasts. Because of the importance of early morning access, participants agreed that system updates (which may cause data lags) should occur mid-day, while they are already on the water and not looking for real-time data.

*Data Access Points* - Participants shared their access points for data, and expressed differences in usability across these platforms. In addition to asking fellow fishermen already out on the water, the most used platforms are FishWeather, Windy, WindFinder, Marine Traffic, Marine Weather (App), Windfinder, Mariners' Dashboard (saved as shortcut on phone), and NOAA NDBC.

*Data Visualization Insights* - Participants highlighted that since they usually use the same set of buoys in a sub-region, it would be helpful to be able to select a set of "favorite" buoys on the Dashboard, to avoid clicking between. Although buoy pages can be bookmarked, this process should still be streamlined. Participants also indicated that they would like to be able to compare 2-3 locations of real-time data side by side. Additionally, participants noted that a way to compare forecasts for a single location would be helpful; and that additional data overlays could be useful (e.g., plankton data as an indicator for whale presence).

*Buoy locations* - Participants highlighted multiple areas where buoys would be helpful: Downeast Maine, Matinicus Rock, Jeffrey's Ledge, Cashes Ledge, and between the eastern and central Maine Shelf buoys near Seal Island. Additionally, participants expressed that bringing in more data from Canada into the Dashboard (e.g., Davis weather link) would be helpful for a more comprehensive regional picture. Additionally, participants had insights into specific buoys: Portland Buoy (44007) often reports west-originating winds much lower than fishermen have observed on the water, possibly because it is being shielded by the mainland; the

Isles of Shoals buoy is in shallow water, so the conditions being reported are often much rougher than in the general area.

## Climatology Viewer

[https://p5.neracoos.org/products/clim\\_test/drupal\\_clim.html](https://p5.neracoos.org/products/clim_test/drupal_clim.html)

Riley Young Morse provided an overview of the climatology viewer, which is a tool to visualize changes in ocean conditions across time. Climate, in a narrow sense, is usually defined as the "average weather," or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period ranging from months to thousands or millions of years (WMO definition). For certain assets shown on the viewer, two decades of hourly observations are available. Riley outlined the current climatology viewer's attributes and limitations, and contrasted those with the new climatology viewer in development. In addition to many backend changes, the new viewer will allow users to select constraints (e.g., time period to average) to create custom climatology visualizations. As part of the upgrade, more eMOLT sites will be added to the viewer. Riley prompted the breakout session by noting that user input is crucial to refine feature enhancements and implement additional functionality.

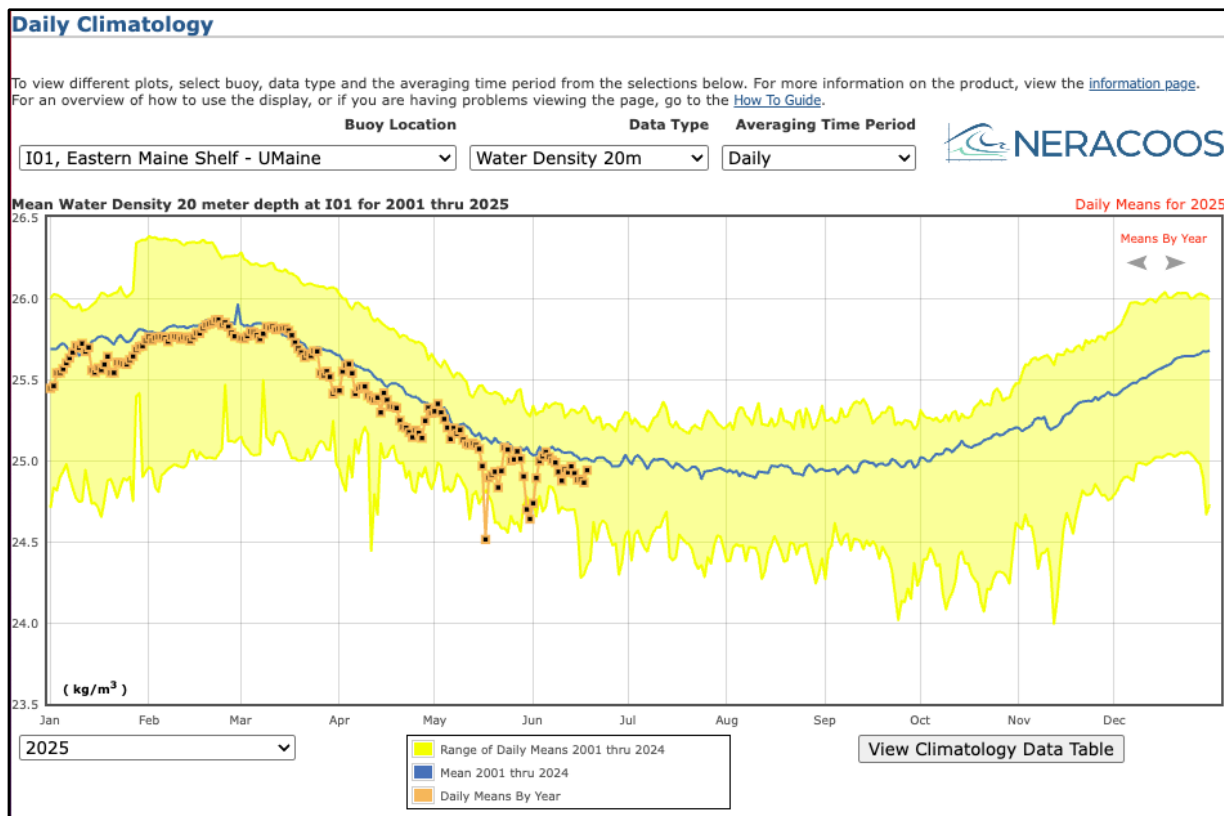


Figure 2: Screenshot of the Climatology Tool

### **Breakout Summary (Climatology Viewer)**

Riley Young Morse led the group discussions on the Climatology viewer. As many of the participants were new to the tool, the breakout group sessions largely focused on digging into the tool in more detail than in the introductory presentation. Following these smaller demonstrations, participants introduced the following ideas that could enhance usability: Ability to compare climatologies of two locations side-by-side; Ability to toggle between colorways to better see on screens (e.g., dark mode), as it is hard to look at on phones; Ability to see fishery landings data on top of climatology data; Ability to show a climatology for a specific site on the Mariners' Dashboard; Ability to overlay moon cycle and tide data; Ability to visualize multiple individual years at once against the reference period, not just a single year. As participants already know where the measured sites are, many expressed it was not necessary to add a regional map to the page. The following ideas are already planned to be included in the Climatology tool upgrade, so it was affirming to hear that these would be welcome updates: Ability to toggle between fahrenheit and celsius; Ability to change reference period to custom years.

Participants additionally asked about specific data trends, such as why 2023 salinity data were so low, and about trends across Buoy I in 2015. A Climatology tool superuser noted that she looked at the tool multiple times across the year to understand how quickly temperatures start falling in the fall and rising in the spring, to understand when lobster movement may occur.

### **eMOLT Deckbox**

On behalf of George Maynard, Andrew Goode provided an overview of the heart of the eMOLT system, the deckbox. Deckboxes are a touchscreen microcomputer outfitted with a GPS receiver to track sensor deployments and bluetooth antenna to gather data from the sensor. An integrated cell modem allows the eMOLT team to provide technical support and allows for automatic data transmission anytime the vessel is in cell range. In addition to showing data from individual hauls, the deckboxes show an image of modeled bottom temperatures across the Northwest Atlantic continental shelf, from the Doppio-ROMS model (Lopez et al. 2020).

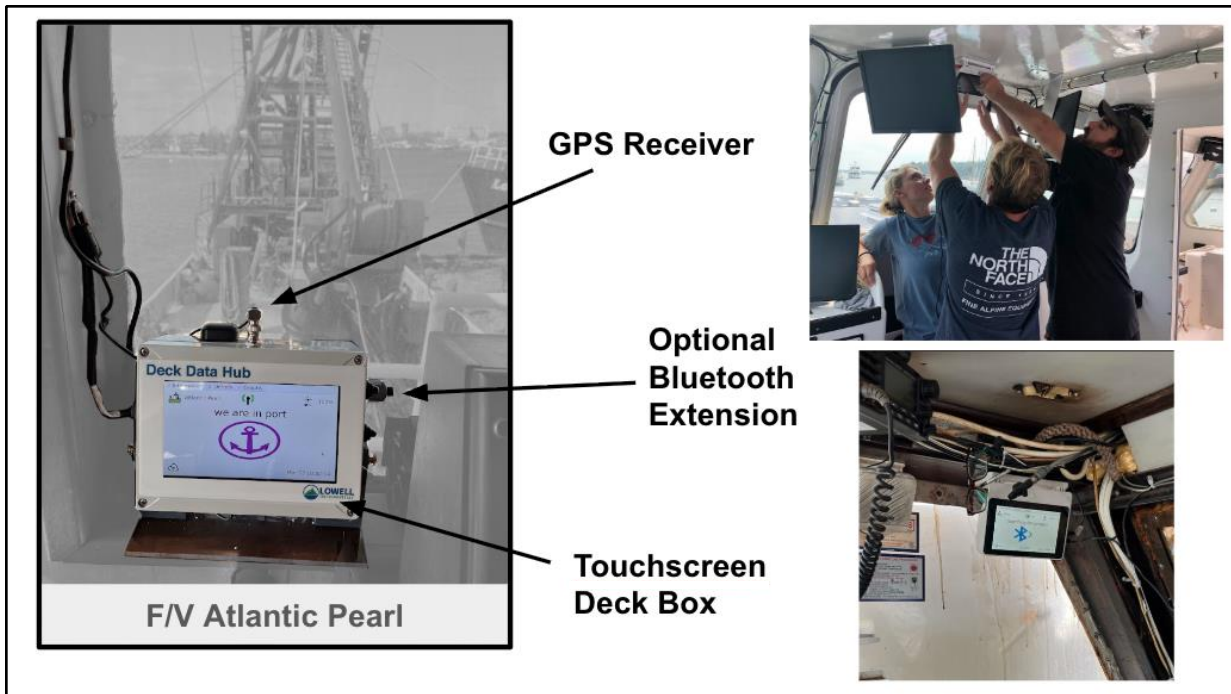


Figure 3: An annotated image of a deckbox, and deckbox installation

### Breakout Summary (eMOLT Deckbox)

Following the overview in plenary, Andrew Goode led a breakout group focused on hands-on demonstrations and discussion of two deckbox options that offer the same core functionality but differ in cost and physical design, and three sensor types. One deckbox option was the lower-cost GOMLF box, which is better suited for larger vessels where the less corrosion-resistant equipment can be protected. The second deckbox option was a ruggedized deckbox, which is more corrosion resistant and durable in harsher deck environments so it can be deployed on smaller vessels with more exposed wheelhouses. Andrew also demonstrated and discussed tradeoffs (e.g., ease of servicing; cost) of the following three compatible sensors: Lowell Instruments dissolved oxygen sensors; Moana temperature/depth sensors; and Lowell Instruments temperature/depth sensors. Participants appreciated being able to directly compare the two formats and understand tradeoffs of the sensors and deckboxes.

Discussion then turned to potential deckbox enhancements and possible use cases. There was particular interest in accessing summary statistics and vertical profiles for each haul; while ascent and descent vertical profiles are collected by the two temperature/depth sensors, they are not currently visible on the deckbox interface and need to be accessed through the Fishery Ocean Data Portal or the eMOLT ERDDAP. The groups also discussed the current spatial scale of modeled bottom temperature data (Doppio-ROMS) shown on one of the tabs, noting that outputs showing the entire Gulf of Maine are interesting but not especially useful operationally. Participants emphasized that smaller, personalized areas of interest with clearer visualization would make the data more actionable. Participants also

expressed interest in the ability to quickly document the presence of species of interest, such as black sea bass and *Dasysiphonia japonica*, associated with a certain haul.

## Fishing Ocean Data Portal (Ocean Data Network)

Cooper Van Vranken provided an overview and live demonstration of the Fishing Ocean Data Portal, a tool for individual fishermen to visualize their own eMOLT data. Cooper highlighted the ability to see plots of depth vs. temperature and depth vs. time, as gear outfitted with eMOLT sensors are deployed or retrieved, as well as average data for selected tows/soaks. The Ocean Data Network (ODN) project leads the Fishing Vessel Ocean Observing Network (FVON), which is the international coordinating group dedicated to advancing fishing vessel based ocean observing.

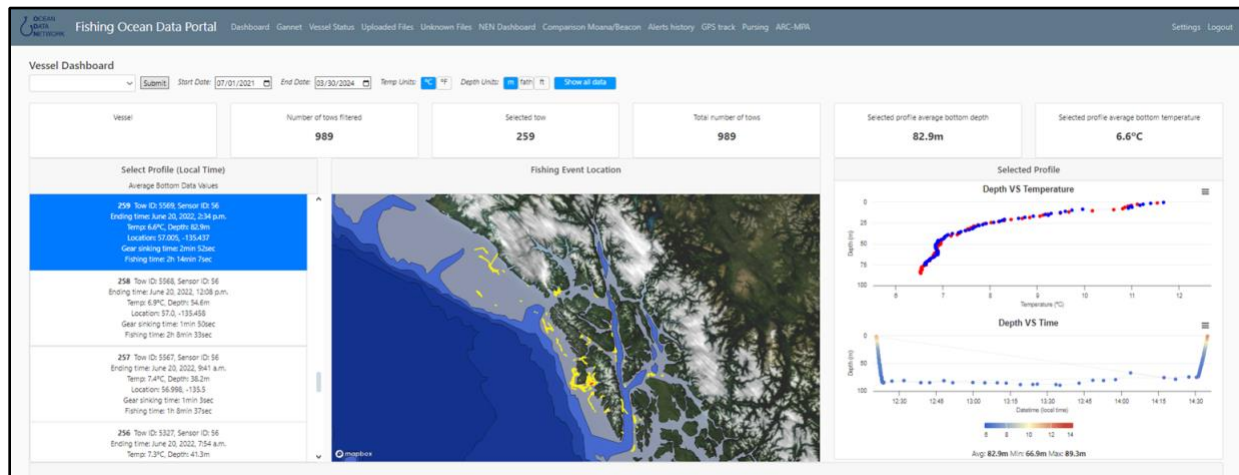


Figure 4: A screenshot of the Fishing Ocean Data Portal.

### Breakout Summary (Fishing Ocean Data Portal)

Cooper Van Vranken led breakout discussions, which spanned individuals' uses of sensor data, confidentiality considerations, data visualization requests and ideas, and the importance of integration of new technology with existing sensors and portals to enable fishermen to spend more time fishing and less time troubleshooting technology. The conversation underscored that the Fishing Ocean Data Portal (the Portal) does not replace the deckbox, but is instead a complementary tool for eMOLT users to visualize the entirety of their data to gain insight into their fishing region.

Existing eMOLT participants highlighted that by looking at their haul datasets, they are able to characterize lobster pot trawls' movement, speed, and orientation and therefore envision the physical conditions of the water column where they set (e.g., tidal and non-tidal currents at different depths; depth of thermocline; tidal movement via "bouncing" along seafloor), and compare these across different tides, seasons, and locations. These insights help these users to find "magic spots" over time that have seasonal steadiness in temperatures and tidal flow, understand

patterns across the region and make a more effective trawl set pattern, understand when spawning may occur, and see if it will be a “good season” based on early season temperature indicators. Additionally, they can identify if the gear was hauled by others between their visits. Poagie fishermen expressed interest in using the sensors to monitor the seine, which would help to properly position the seine with regards to the thermocline, and to improve techniques in currents and tides.

With regards to the data access on the Portal, participants discussed appreciation for the login and data confidentiality and in certain circumstances, expressed interest in expanding the ability to access the data. For example, a captain may be interested in sharing the data with deckhands, or there may be a group of trusted vessels that would like to share data. Publicly-available aggregated data at the 7km grid size is helpful, but for some purposes it is too coarse. Additionally, participants posited that something to explore is creating a process for embargoing individual data until retirement from the industry, to maintain competitive advantage while fishing but make the data available once competitive advantage is no longer needed. At the fishery level, participants expressed interest in sharing the data that they are already required to submit to federal and state agencies (e.g., VTR) with researchers and modelers that would aggregate and share back the data.

Participants expressed that the Portal is useful across a range of computing skillsets, and urged that if making upgrades to the Portal, to keep it simple by having the default be simple, with the option to view more complex options depending on the user interest and computing skillset. Additionally, “how-to” videos for different skill levels would make the Portal more accessible for a range of users. Participants also expressed interest in adding other relevant datasets to the Portal to provide context for the eMOLT data, as well as the ability to manually add data and non-realtime data. For example, required data like VTR and individual yield/catch data, ideally automatically added would be helpful. In the high season from June to September, daily resolution is best, while from October-March lower resolution (e.g., weekly, monthly) overlays would be sufficient. Visualizing bottom temperature models over a chart would be helpful to see differences in shoals vs. deep waters.

Participants also compared the functionality of various chart plotters, and opportunities for integration of the Portal with TimeZero systems. While on the water, the Portal isn’t usable due to high expense of wifi at-sea (e.g., Starlink). Additionally, participants discussed their experiences with troubleshooting specific issues on-board and questions surrounding functionality of the systems when in light of low battery levels disrupting data collection.

Through funding from MCFA, dissolved oxygen (D.O.) sensors becoming more widespread through the eMOLT network. Cooper prompted the group to imagine how D.O. visualizations may be most helpful on the Portal. Participants underscored that their main priority for the D.O. sensors would be to have seamless integration with existing on-board deckboxes, to not add additional screen infrastructure to the vessels.

## Wrap Up

Following the breakout session highlights from each breakout lead, the group had an opportunity to share any final thoughts from the day. As participants left the workshop, many individuals expressed interest in both becoming eMOLT participants and continuing to engage with workshop collaborators and partners to hone these data visualization products.

## References

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# Appendix I: Participant List

## Fishing Industry

Jeremy Alley	Mark Fernald	Joseph Locurto
Xander Amuso	Sam Flavin	Joe Locurto
Bill Anderson	Matt Gilley	Peter Locurto
Jim Barclay	Cote R. Hadlock	Brian Moody
Jack Cunningham	Jamien Hallowell	Forrest Moody
Jordan Drouin	Richard Howland	Ronald Musetti
John Drouin	Matthew Huntley	Nate Snow
Jeremy Elwell	Samuel Hyler	Garrett Steele
Bruce Fernald	Kristofer Koerber	Steve Train
Emma Fernald	Thea LaMastra	Dominic Zanke

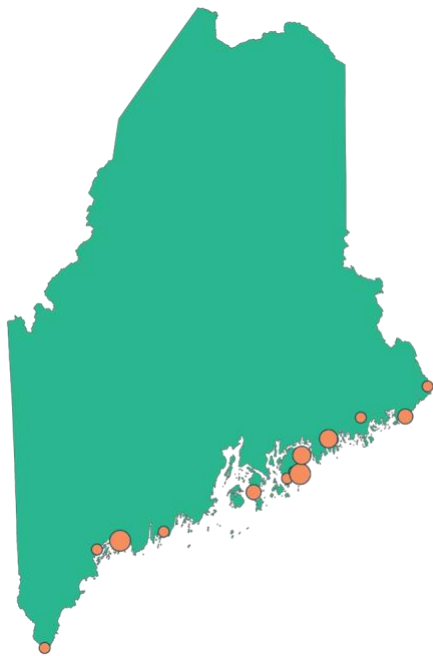


Figure 5: Geographic distribution of participants' home fishing ports, represented as a bubble chart.

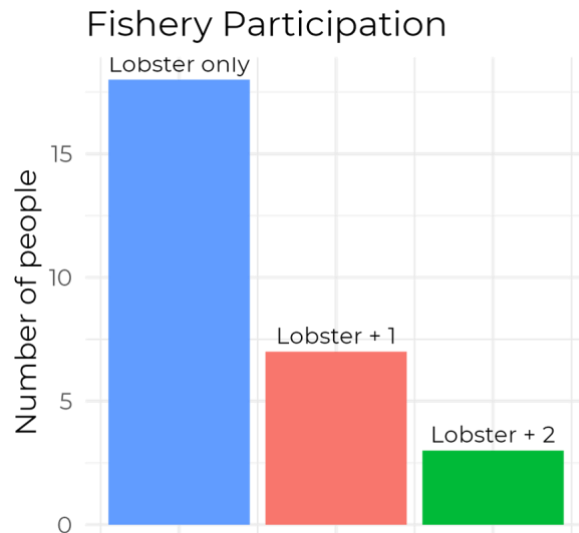


Figure 6: Fishery participation of participants, with representation of non-lobster fisheries including crab, menhaden (poagies), halibut, scallop, kelp, and Atlantic tuna.

## Partners and Collaborators

- Michelle Brown (Maine Sea Grant)
- Chris Cash (UMaine Lobster Institute)
- Andrew Goode (UMaine)
- Carl Guenther (MCCF)
- Kathleen Reardon (Maine DMR)
- Cooper Van Vranken (ODN)
- Riley Young Morse (GMRI)
- Huanxin Xu (GOMLF)\*

\*denotes remote participation from respective office location

## Workshop Organizers

- Katy Bland (NERACOOS)
- Jake Kritzer (NERACOOS)\*
- Jim Manning (NOAA NEFSC, retired)\*
- George Maynard (NOAA NEFSC)\*
- Erin Pelletier (GOMLF)
- Caitlin Shanahan (NERACOOS)
- Tom Shyka (NERACOOS)
- Emma Weed (GOMLF)

## Appendix II: Workshop Agenda

## Appendix III: Presenter Slides