South Thomaston, Maine

Maps, Case Studies, Background Information: The Nearshore and Offshore Context of a Local Lobster Fishery as a framework for studying Environmental Change
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Printed copies of these National Oceanic and Atmospheric Administration (NOAA) charts were provided at the first meeting. It was stated by fishermen that such high quality maps, especially bathymetry data, would be useful to visualize in offshore zones as well.

NOAA charts 13302 and 13301 were mosaicked together to produce the following views of the South Thomaston nearshore area.
In the map to the left, (A) and (B) are locations where impervious surfaces associated with recently constructed ‘big-box’ stores such as Home Depot and Lowes, and (C) is the location of the town dump. These three locations drain into the estuarine river to the east of South Thomaston, and were discussed as sites to pay attention to in the future, because their relationship to water quality and therefore to habitat for nearshore species is of interest to fishermen. The encircled area (D) outlines the general location where many South Thomaston fishermen live and/or keep their boats and gear.
eMOLT DATA: OCEAN MONITORING BY FISHERMEN

The eMOLT project is a non-profit collaboration of industry, science, and academics devoted to monitoring of the physical environment of the Gulf of Maine and the Southern New England shelf. In a series of phases funded by the Northeast Consortium beginning in 2001, they developed low-cost strategies to measure bottom temperature, salinity, and current velocity with the help of nearly 100 lobstermen dispersed along the entire New England coast.

The eMOLT data is used by lobster fishermen but also students and scientists studying ocean circulation models and other aspects of the ocean environment. The need for data in initialization, assimilation, and validation of models makes the eMOLT data valuable to many people. The NERACOOS and MARACOOS buoys are often integrated with this localized data in such studies.

The drifters or sensing mechanisms used in the vicinity of South Thomaston are listed in Table 1 and shown in the Figure 1 map, which was found on the eMOLT website.

Table 1. Ocean Monitoring Posted for Online Public Access by Local Fishermen*

<table>
<thead>
<tr>
<th>Year</th>
<th>Ocean Phenomena Measured</th>
<th>Name</th>
<th>Sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000-2007</td>
<td>depth, tide</td>
<td>BOB BAINES</td>
<td>TH01</td>
</tr>
<tr>
<td>2004-2012</td>
<td>temperature</td>
<td>DICK CARVER</td>
<td>DC01</td>
</tr>
<tr>
<td>2010-2011</td>
<td>temperature</td>
<td>MIKE DAWSON</td>
<td>ID02</td>
</tr>
<tr>
<td>2004-2005</td>
<td>tidal variation</td>
<td>WOODY POST</td>
<td>WP01</td>
</tr>
<tr>
<td>2001-2010</td>
<td>salinity, temperature, depth</td>
<td>JIM TRIPP</td>
<td>JT01</td>
</tr>
<tr>
<td>2003-2011</td>
<td>temperature</td>
<td>DAN MILLER</td>
<td>DM01</td>
</tr>
<tr>
<td>2006-2012</td>
<td>temperature, catch</td>
<td>JOHN MELQUIST SR.</td>
<td>OM01</td>
</tr>
<tr>
<td>2007-2009</td>
<td>temperature, wind</td>
<td>JOHN STOLZ</td>
<td>OS01</td>
</tr>
<tr>
<td>2006-2012</td>
<td>temperature, catch</td>
<td>ERIC MELQUIST</td>
<td>EM02</td>
</tr>
<tr>
<td>2005-2012</td>
<td>depth</td>
<td>CLAYTON PHILBROOK</td>
<td>CP01</td>
</tr>
<tr>
<td>2001-2007</td>
<td>tidal variation, depth</td>
<td>JAY SMITH</td>
<td>SJ01, SJ02</td>
</tr>
</tbody>
</table>

*Dates shown in Table 1 reflect the total period of the fisherman’s involvement in the eMOLT project, and may not apply to the specific buoy shown in the map (Figure 1.)
Figure 1. eMOLT drifters and buoys in the South Thomaston vicinity.
NERACOOS and Bathymetric Maps: Ocean Monitoring by Buoy

The Northeastern Regional Association of Coastal and Ocean Observing Systems is a nonprofit organization focused on integrating subregional resources and data for use in coastal and ocean contexts in the northeastern United States. NERACOOS maintains two buoys near South Thomaston, seen in the map to the left. The Penobscot Bay Buoy is located to the east of South Thomaston, in water that is approximately 70 meters deep. The Central Maine Shelf Buoy is located to the southwest of South Thomaston, in water that is approximately 90 meters deep. Temperature data is gathered hourly by these buoys at water depths of 1, 2, 20 and 50 meters. The final section of this book contains graphs and analyses of daily and monthly temperature data collected at these buoy locations from 2001 to 2013.

Central Maine Shelf Buoy (E01) ---
43.71 Latitude, -69.35 Longitude

Penobscot Bay Buoy (F01)
44.05 Latitude, -68.99 Longitude
The values in Table 1 were recorded on the date when the temperature range between 1m and 50m depths was greatest at the Penobscot Bay NERACOOS Buoy. The average temperature between all four water depths (1m, 2m, 20m, 50m), the range between 1m and 50m depths, and the maximum (at 1m depth) and minimum (at 50m depth) temperatures are shown in Table 1 for each year from 2002-2012.

The peak temperature range between 1m and 50m depths, referred to here as ‘summer unmixing,’ occurred every year from 2001 to 2013, on dates ranging from August 22nd (2004) to July 7th (2010). The peak range has been occurring progressively later in the summer over time, as seen in Table 5. The peak summer unmixing dates are highlighted in orange for July 2002 (Table 6) and July 2013 (Table 7).

Tables 2 and 3 show an upward trend in the magnitude of the range between temperature values at 1m and 50 depths between 2001 and 2013, and also an upward trend in the maximum temperature values recorded for the 1m water depth. Though there is significant variability present in these data, these trends could be valuable to study further. Table 4 shows no clear trend in temperature values between 2001-2013 at the 50m depth on the dates of peak unmixing.
Table 4. No Clear Trend in 50m Water Depth Temperatures during Peak Summer Unmixing

Table 5. Peak Summer Unmixing dates occurring later in summer

Table 6. Peak Summer Unmixing seen in Orange.
**AVERAGE MONTHLY TRENDS:**

**INCREASING WATER TEMPERATURES**

(but with significant variability)

Linear trend lines derived from average monthly temperature data for July (Table 1) and November (Table 2) are shown for the Central Maine Shelf Buoy. Linear trend lines derived from the average monthly data for July (Table 3) and November (Table 4) are shown for the Penobscot Buoy. All plots show an upward trend, but it should also be noted that there is still significant variability in the monthly average values. These trends are a good baseline, however, to compare with other data sources such as fishermen’s temperature measurements and temperature records from other sources.

Only the 50m trend line is shown for November data from both buoys, because the four trend lines are so closely overlapping at this time of year that they would not all be visible. This overlapping of trend lines is due to the similarity of water temperatures at all depths measured between November and March. A divergence in temperature between the 1-2m and 20-50m depths occurs every year between April and October, as seen in the graphs of daily average temperature and ‘summer unmixing’.

Note: An $R^2$ value is shown for all trend line graphs in this booklet (pages 14-15 and 22-23.) The $R^2$ value represents the degree of variability present in the data. $R^2$ is measured on a scale from 0 to 1. The higher the $R^2$ value is, the lower the variability, and the greater the predictability of the trend.
Table 3. Monthly Average Temp (F) at Penobscot Buoy
Jul, 2001-Jul, 2012

\[ y = 0.428x + 55.368 \]
\[ R^2 = 0.5546 \]

\[ y = 0.3444x + 54.553 \]
\[ R^2 = 0.4541 \]

\[ y = 0.135x + 50.356 \]
\[ R^2 = 0.1486 \]

\[ y = 0.2063x + 48.226 \]
\[ R^2 = 0.3821 \]

Table 4. Monthly Average Temp (F) at Penobscot Buoy
Nov, 2001-Nov, 2012

\[ y = 0.2077x + 48.233 \]
\[ R^2 = 0.3986 \]
Temperature data

The following pages include all analyses of temperature data derived from NERACOOS buoy information. Monthly and daily temperature values are included.

Note: An $R^2$ value is shown for all trend line graphs in this booklet (pages 14-15 and 22-23.) The $R^2$ value represents the degree of variability present in the data. $R^2$ is measured on a scale from 0 to 1. The higher the $R^2$ value is, the lower the variability, and the greater the predictability of the trend.
Central Maine Shelf Daily Average Temperatures

2001-2002

2002-2003

2003-2004

2004-2005

2005-2006

2006-2007

2007-2008

2008-2009

2009-2010

2010-2011

2011-2012

2012-2013

1m water depth
2m water depth
20m water depth
50m water depth
Penobscot Bay Daily Average Temperatures

Daily Average Temp (F)

1m water depth
2m water depth
20m water depth
50m water depth
Central Maine Shelf Monthly Average Temperatures, 2001-2013

January

February

March

April

May

June

July

August

September

October

November

December

Legend:
- 1m water depth
- 2m water depth
- 20m water depth
- 50m water depth
Penobscot Monthly Average Temperatures, 2001-2013

January

February

March

April

May

June

July

August

September

October

November

December

1m water depth
2m water depth
20m water depth
50m water depth
Central Maine Shelf Monthly Average Trends

January

- Month: January
- Equations:
  - Linear (50m): $y = 0.11x + 42.14$, $R^2 = 0.061$
  - Linear (2m): $y = 0.197x + 38.471$, $R^2 = 0.258$
  - Linear (50m and 2m): $y = 0.172x + 39.201$, $R^2 = 0.3664$

February

- Month: February
- Equations:
  - Linear (50m): $y = 0.197x + 38.471$, $R^2 = 0.258$
  - Linear (2m): $y = 0.088x + 36.023$, $R^2 = 0.167$
  - Linear (50m and 2m): $y = 0.187x + 36.471$, $R^2 = 0.168$

March

- Month: March
- Equations:
  - Linear (50m): $y = 0.204x + 40.764$, $R^2 = 0.2964$
  - Linear (2m): $y = 0.204x + 37.764$, $R^2 = 0.2964$
  - Linear (50m and 2m): $y = 0.172x + 39.201$, $R^2 = 0.3664$

April

- Month: April
- Equations:
  - Linear (50m): $y = 0.448x + 43.063$, $R^2 = 0.627$
  - Linear (2m): $y = 0.34x + 40.317$, $R^2 = 0.5228$
  - Linear (50m and 2m): $y = 0.236x + 35.529$, $R^2 = 0.3166$

May

- Month: May
- Equations:
  - Linear (50m): $y = 0.145x + 43.627$, $R^2 = 0.386$
  - Linear (2m): $y = 0.350x + 38.817$, $R^2 = 0.2228$
  - Linear (50m and 2m): $y = 0.236x + 35.529$, $R^2 = 0.3166$

June

- Month: June
- Equations:
  - Linear (50m): $y = 0.306x + 48.405$, $R^2 = 0.6157$
  - Linear (2m): $y = 0.321x + 43.329$, $R^2 = 0.6279$
  - Linear (50m and 2m): $y = 0.305x + 43.329$, $R^2 = 0.6157$

July

- Month: July
- Equations:
  - Linear (50m): $y = 0.38x + 56.152$, $R^2 = 0.6279$
  - Linear (2m): $y = 0.218x + 46.011$, $R^2 = 0.0867$
  - Linear (50m and 2m): $y = 0.313x + 42.264$, $R^2 = 0.4611$

August

- Month: August
- Equations:
  - Linear (50m): $y = 0.147x + 50.348$, $R^2 = 0.1267$
  - Linear (2m): $y = 0.136x + 50.908$, $R^2 = 0.1977$
  - Linear (50m and 2m): $y = 0.333x + 48.702$, $R^2 = 0.8881$

September

- Month: September
- Equations:
  - Linear (50m): $y = 0.848x + 57.339$, $R^2 = 0.4665$
  - Linear (2m): $y = 0.286x + 51.513$, $R^2 = 0.2695$
  - Linear (50m and 2m): $y = 0.286x + 51.513$, $R^2 = 0.2695$

October

- Month: October
- Equations:
  - Linear (50m): $y = 0.386x + 50.233$, $R^2 = 0.2637$

November

- Month: November
- Equations:
  - Linear (50m): $y = 0.286x + 46.111$, $R^2 = 0.4665$
  - Linear (50m and 2m): $y = 0.286x + 46.111$, $R^2 = 0.4665$

December

- Month: December
- Equations:
  - Linear (50m): $y = 0.353x + 60.278$, $R^2 = 0.4668$
  - Linear (2m): $y = 0.292x + 61.513$, $R^2 = 0.2226$
  - Linear (50m and 2m): $y = 0.292x + 61.513$, $R^2 = 0.2226$
Central Maine Shelf Monthly High Temperatures, 2001-2013

January

February

March

April

May

June

July

August

September

October

November

December
Central Maine Shelf Monthly Low Temperatures, 2001-2013

January

February

March

April

May

June

July

August

September

October

November

December

Graphs showing monthly low temperatures for different months and depths from 2001 to 2013.
Penobscot Bay Monthly Low Temperatures, 2001-2013

January

February

March

April

May

June

July

August

September

October

November

December

Legend:

- 1m water depth
- 2m water depth
- 20m water depth
- 50m water depth
Thank you to all of the participants in the spring 2013 VCAPS South Thomaston meetings for sharing your knowledge and insights with us, and thank you especially to the residents of the South Thomaston area for welcoming us to your community.

Sources

NERACOOS Buoy Data
http://www.neracoos.org/

USGS Bathymetry Data
USGS Coastal and Marine Geology Program

Jurisdictional Boundary Data
Maine Department of Marine Resources (DMR)
http://www.maine.gov/dmr/rm/lobster/

Marine Conservation Agreements Toolkit

Temperature-Molt Relationships in Lobsters near Boothbay Harbor, Maine
Maine DMR 1993

eMOLT Program Information
http://www.nefsc.noaa.gov/epd/ocean/MainPage/lob/mission.html
http://www.emolt.org/

NOAA Charts