

# Sea Level Affecting Marshes Model (SLAMM) for Coastal Long Island Sound:

Using a Web Mapping Application Data Viewer to Examine Predicted Land Cover for **2025**, **2055**, **2085**, and **2100**

---

AUTHOR: KEVIN O'BRIEN

CONNECTICUT DEPARTMENT OF ENERGY AND ENVIRONMENTAL PROTECTION (CTDEEP)

1. Project Background
2. Use Considerations
  - SLAMM Data
  - Web Mapping Application
3. About the SLAMM Data Viewer Application
4. Using the SLAMM Data Viewer Application
5. Analysis with the LIS SLAMM Data Viewer Application

## Project Background

Tidal marshes are dynamic ecosystems that provide significant ecological and economic value. They are also among the most susceptible ecosystems to climate change, especially sea level rise (SLR). To help identify potential responses to such change, the Connecticut Department of Energy and Environmental Protection (CTDEEP), the New England Interstate Water Pollution Control Commission (NEIWPCC), the New York State Department of Environmental Conservation (NYSDEC), EPA's Long Island Sound Study (LISS), and the New York State Energy Research and Development Authority (NYSERDA) contracted with Warren Pinnacle Consulting, Inc., (WPC) to apply the Sea Level Affecting Marshes Model (SLAMM) to the Connecticut and New York coasts of Long Island Sound.

A variety of factors affect a marsh's fate, including its elevation relative to the tides, frequency of inundation, salinity of tidal flood waters, amount of vegetation on the marsh surface, land subsidence, marsh substrate, and the settling rate of suspended sediment on the marsh surface. Therefore, a simple comparison of current marsh elevations to future projections of sea level does not adequately predict wetland vulnerability to accelerated rates of sea level rise. SLAMM considers many of these factors to predict the response of marshes and other intertidal resources to predicted rates of SLR. SLAMM is not a hydrodynamic model designed to consider variables such as three-dimensional water flow, channel scour, sediment transport, or flow-velocity reductions due to irregular seafloor topography and tidal

flow constrictions such as tide gates. Rather, SLAMM is a two-dimensional model in which long-term shoreline and habitat changes are predicted as a function of elevation, tide range, and sea level rise. A fundamental assumption used is that individual wetland types inhabit a range of vertical elevations that is a function of local tide range. SLAMM computes relative sea level rise for each area subject to analysis at different time steps that is offset by both observed and modeled marsh accretion and other factors affecting marsh surface elevation.

When the model is applied, the change from one land-cover class to another (e.g., irregularly flooded marsh to regularly flooded marsh) is determined by comparing the new tidal water elevation and inundation frequency resulting from a future SLR value to the existing land-cover class and then applying a decision-tree and land-cover conversion rules. To better inform users of the SLAMM model about the confidence or reliability of these results, an uncertainty analysis was also applied using a "what-if" type analysis, called a Monte-Carlo simulation, to account for model input uncertainties or variation.

The investigation's final reports and outputs are available at: <http://warrenpinnacle.com/prof/SLAMM/LISS/> and <http://warrenpinnacle.com/prof/SLAMM/NYSERDA/>

# Use Considerations

## SLAMM Data

As with any modeling exercise, the quality of its predictions is governed by the data used and the performance of the model itself. Accordingly, the project team has attempted to use and report the best available information. Some specific considerations are noted below:

- SLAMM is widely recognized as an effective model to study and predict wetland response to long-term sea level rise (Park et al. 1991) and has been applied in every coastal US state.
- Elevation, land cover, tide range, and accretion/erosion data for coastal Connecticut and New York come from reliable sources that have been researched and vetted by the project team as well as external project advisers. The resulting output was reviewed both internally and by external experts who provided comments and suggestions to improve and clarify the final products.
- SLR presents the most complicated component. Although there is general agreement within the scientific community that sea levels have been and will continue to increase over this century, there is no consensus on the rate or range of rates expected by location. As a result, the project team used the recommendations from a recent review and analysis of sea level rise projections by NYSERDA. This approach provided consistency for comparison of SLAMM results for areas of LIS, and incorporated both lower-end and higher-end projections for short, mid-range, and long-term time-steps previously presented in peer-reviewed scientific literature.

A more detailed description of SLAMM model processes, underlying assumptions, and equations for this effort can be found in the SLAMM 6.2 Technical Documentation (<http://warrenpinnacle.com/prof/SLAMM>). Information on the NYSERDA approach, including the specific SLR cases, can be found at: <http://www.nyserda.ny.gov/climaid>

*Park, R. A., Lee, J. K., Mausel, P. W., and Howe, R. C. (1991). "Using remote sensing for modeling the impacts of sea level rise." World Resources Review, 3, 184-220.*

# Use Considerations

## Web Mapping Application

The web mapping application was built from an Environmental Systems Research Institute (ESRI) ArcGIS Online template using Mozilla Firefox 31.0 and is freely available to the public. It has been opened and used in desktop versions of Internet Explorer (11.0.9600.17801). Access through other browsers or mobile devices may or may not respect the full functionality of the desktop versions.

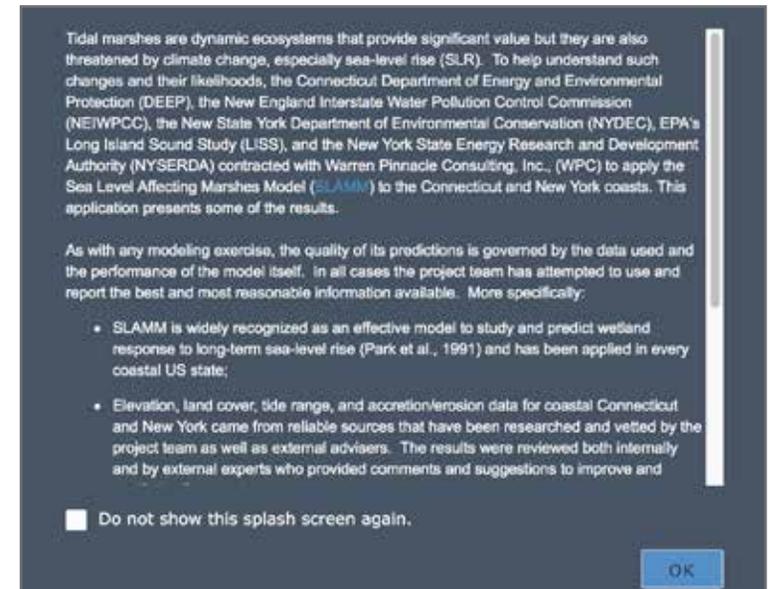
The application can be accessed from the following locations:

The CTDEEP mapping site: <http://tinyurl.com/CTNYSLAMM-DataViewer>

The ESRI ArcGIS Online website ([www.arcgis.com/home](http://www.arcgis.com/home)) by searching for "CT NY SLAMM"

The EPA LISS website SLAMM page: [www.longislandsoundstudy.net/slam](http://www.longislandsoundstudy.net/slam)

**NOTE:** when the application first opens, a splash screen with a general review of the project background and some use considerations will be automatically displayed.



# About the SLAMM Comparison Application

## About

The application is designed to allow users to view and compare the following SLAMM data sets for the coastal areas of Long Island Sound in both Connecticut and New York.\*

### 1. Land cover changes prior to any future sea-level rise predictions (i.e., initial conditions circa 2010)

These data were generated from SLAMM with current environmental input data and calibrating the results against the most recent wetlands mapping data (National Wetlands Inventory data for CT and NY) and aerial photography. Where needed, corrective adjustments were made to ensure consistency with known land cover.

### 2. Land cover changes from sea-level rise

The amount of SLR (in both meters and feet) applied by 16 combinations of models and time steps is shown below:

Scenario	2025 (meters / feet)	2055 (meters / feet)	2085 (meters / feet)	2100 (meters / feet)
Global Climate Model Maximum	0.13 / 0.4	0.31 / 1.0	0.58 / 1.9	0.72 / 2.4
1 m by 2100	0.13 / 0.4	0.43 / 1.4	0.81 / 2.7	1.0 / 3.3
Rapid Ice Melt Minimum	0.13 / 0.4	0.48 / 1.6	1.0 / 3.3	1.3 / 4.3
Rapid Ice Melt Maximum	0.25 / 0.8	0.74 / 2.4	1.4 / 4.6	1.72 / 5.6

### 3. The likelihood of coastal marsh by 2025, 2055, 2085, and 2100

The likelihood layer depicts how we might expect coastal marsh to be distributed at a given time. (Here, coastal marsh is any of the following land-cover classes: regularly flooded marsh, irregularly flooded marsh, transitional marsh, and tidal-fresh marshes.) Rather than displaying results for a particular set of assumptions from any of the specific SLR scenarios listed above, this layer depicts the results from multiple model runs using different combinations of various environmental variables. *These results can then be analyzed to illustrate the distribution of how likely coastal marsh may be present at a given time, regardless of any specific SLR assumption or variation in the value of other model input variables.*

\* The SLAMM modeling process generated a variety of predictions based on several scenarios of SLR. For more information on these and the overall SLAMM development effort for LIS, please consult the final reports available at:

<http://warrenpinnacle.com/prof/SLAMM/LISS/> and <http://warrenpinnacle.com/prof/SLAMM/NYSERDA/>

or the NYSERDA ClimAID report at <http://www.nyserderda.ny.gov/climaid>

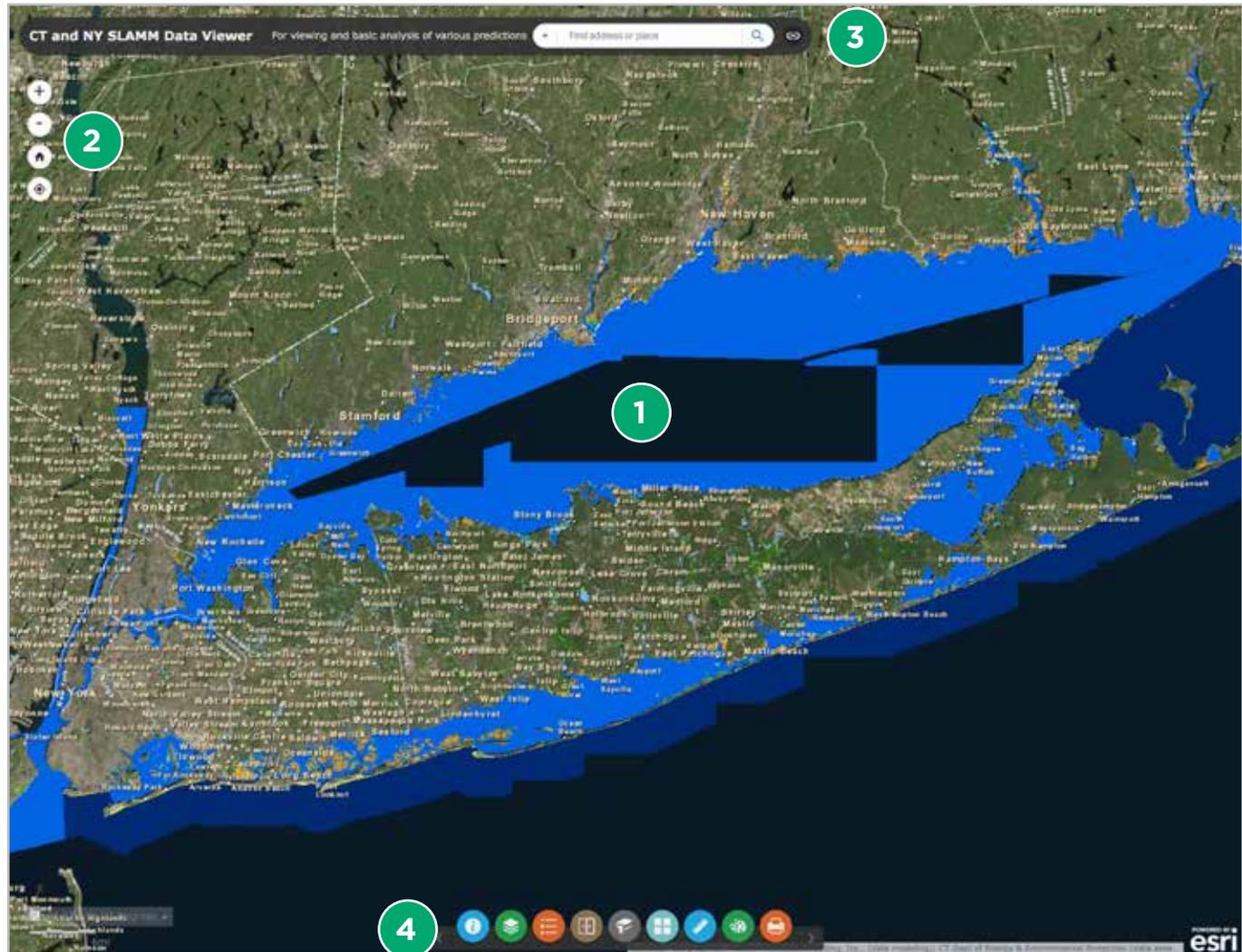
## SECTION 4

# Using LIS SLAMM Comparison Application

## Application layout

The application has four functional components:

- 1 The Map View window
- 2 The Navigation Control toolbar
- 3 The Title Bar / Search box
- 4 The Main toolbar



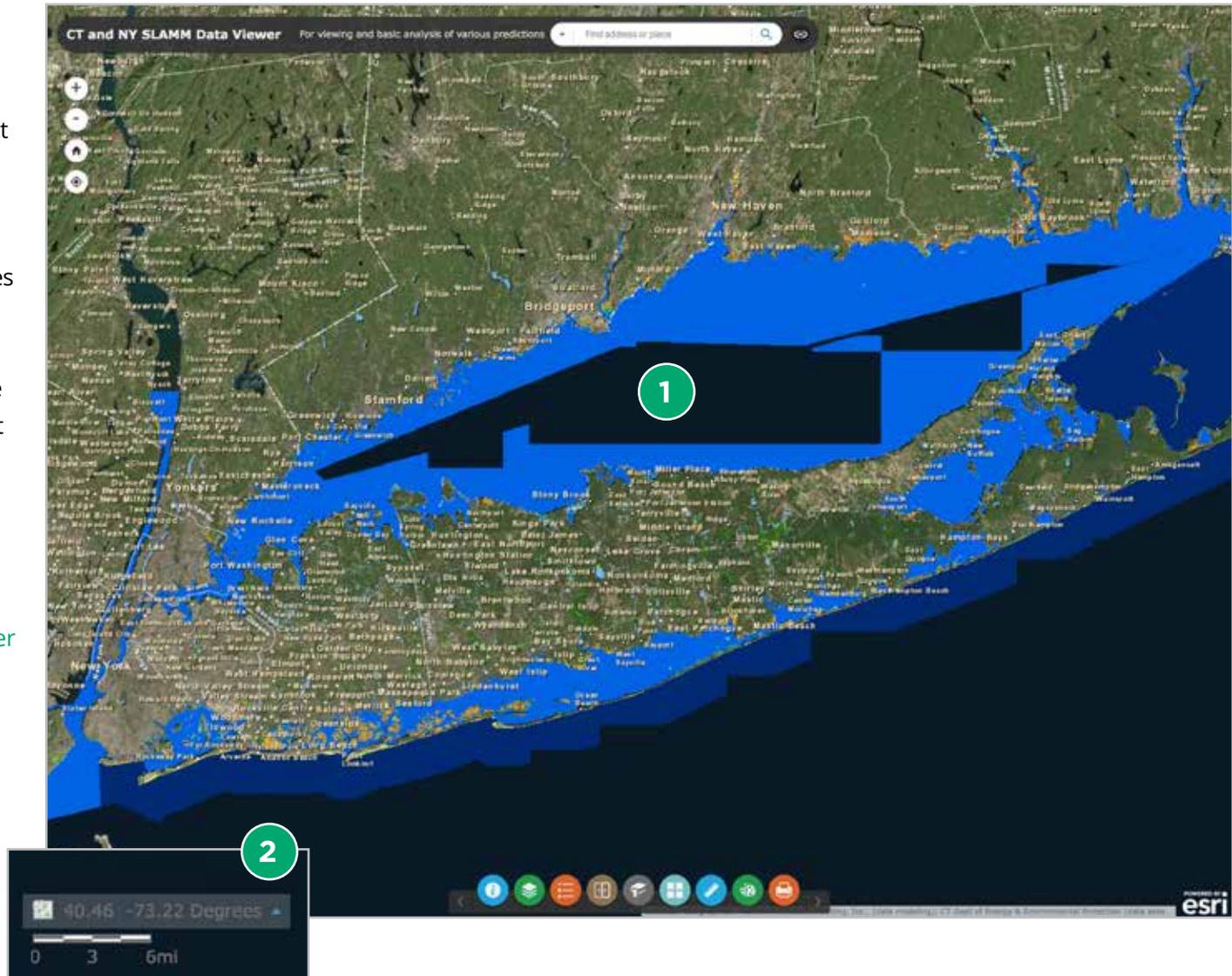
## SECTION 4

# Using LIS SLAMM Comparison Application

## Map View Window

The Map View window is the area that displays the SLAMM data and basemap background and where users can open and interact with many of the tools within the application. In the lower left-hand corner of the map, a scale bar is provided as well as the coordinates of any single click of the cursor. However, depending on the style of basemap selected or color style of data layer, these can be difficult to see.

- 1 Map view centered on Long Island Sound
- 2 Example of scale bar and location data found in the lower left corner of the map view. Clicking on the blue triangle next to the coordinates will allow different coordinates to be used. Decimal degrees are displayed by default



# Using LIS SLAMM Comparison Application

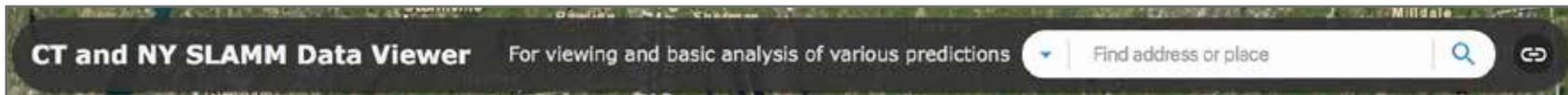
## Navigation Control Toolbar

In the upper left corner of each map there are four control buttons:

-  **Zoom In:** Clicking on this button will zoom the map in by a preset factor, allowing you to see smaller areas in greater detail.
-  **Default Extent:** Clicking on this button will return the map out to a predefined extent, showing the entire study area for Long Island Sound. (This is a good way to reset things if you get lost.)
-  **Zoom Out:** Clicking on this button will zoom the map out by a preset factor, allowing you to see larger areas but in less detail.
-  **Sync:** Click on this button in any map view to control how the other maps sync. By default this is set for the Initial Conditions map. A map view with a **black** sync symbol (as opposed to a greyed-out symbol) indicates that particular view is the primary view controlling the other three.
-  **Search:** Clicking on this button will open a box where you can enter an address or place-based name to locate.

In addition to these controls, using your mouse by holding down the left mouse button and dragging your cursor will allow you to pan around the map (i.e., drag the map view around to reposition the extent).

## Using the Title Bar / Search Box



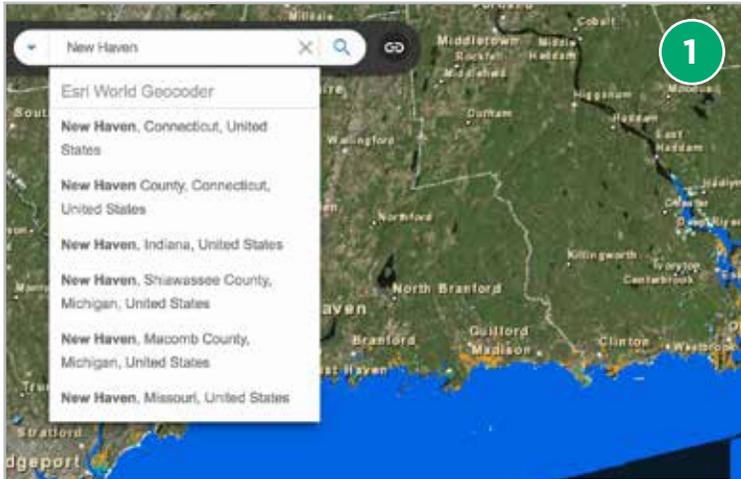
Using combinations of the panning and zooming controls will allow you to manually move around the extent of the map at varying scales.

The title bar provides the name and a brief description of the application's function. It also provides a search box to locate and go to an address or place. In the area labeled "Find address or place," enter some location information. This could be a specific address or a more general place name. As you enter your information, a drop-down list of potential options will be generated. If appropriate, you can select an option from this list by clicking on it, or hit enter to apply the search term you entered.

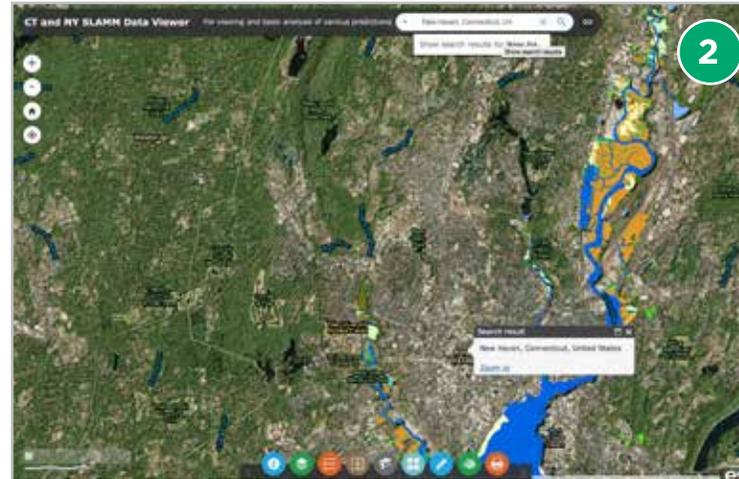
## SECTION 4

# Using LIS SLAMM Comparison Application

## Using the Title Bar / Search Box (ct'd:)



- 1 Entering “New Haven” into the search box generates a list of options that can be selected.

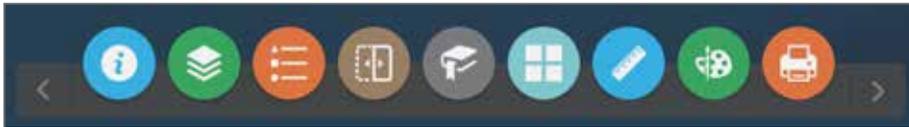


- 2 Selecting the “New Haven, Connecticut, United States” option adds a small point and a result window (white box) to the map view and zooms in to the location. Clicking on “Zoom to” in the lower left of the result window will zoom in further. (You can also use the standard zooming tools described earlier.) The result window can be expanded and contracted with the “maximize” icon to the left of the “X” in the upper right. You can close the result window by clicking its “X” icon in the upper right. (The point, however, will remain on the map.)

To clear out the result of a search entirely (i.e., remove points and result windows from the map view), click the “X” on the right side of the search box.

# Using LIS SLAMM Comparison Application

## Using the Main Toolbar



The main toolbar provides a variety of functionality to interact with the data and the map view. From left to right the tools are:

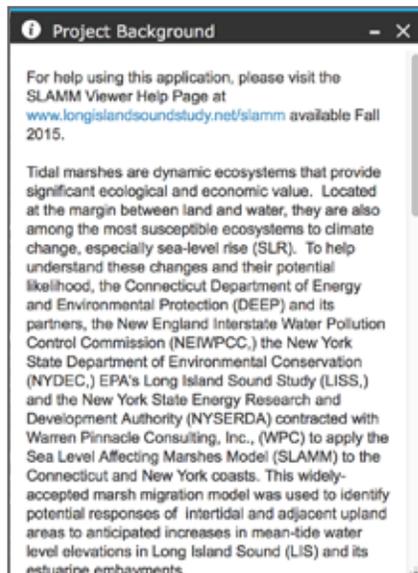
-  **Project Background:** Opens a window that contains an overview of the SLAMM project and access to external sources of additional reference material and information.
-  **Layer List:** Allows the user to turn on or off any of the data layers generated (predicted land cover and likelihood analyses). By default, the layer showing the initial conditions in 2010 is turned on when the application opens.
-  **Legend:** Opens a window to display the legend for visible data layers.
-  **Swipe:** Allows the user to manually drag or “swipe” a layer that is on top of another and interactively show or hide the layer underneath. (Requires at least two layers to be turned on.)
-  **Bookmark:** Saves a series of map bookmarks capturing the location and extent of particular areas on the map for easy access and display.
-  **Change Basemap:** Offers a series of maps that can be used as the background in the map viewer window.
-  **Measure:** Opens a window where users can calculate and display areas, lengths, or point locations when interacting with the maps.
-  **Draw:** Offers a variety of options to mark up the map view with text and/or graphics.
-  **Print:** Provides options to print hard-copy versions of the map view.

Any tool window can be *moved around* in the map view by placing the cursor on the title bar, clicking, and dragging. It can be resized by placing the cursor in the lower right-hand corner, clicking, and dragging. From the right side of the title bar, it can be minimized and expanded by clicking on the up or down symbols, or closed by clicking the X.

# Using LIS SLAMM Comparison Application

## Project background

Opens a window that contains an overview of SLAMM and access to external sources of additional reference material and information.



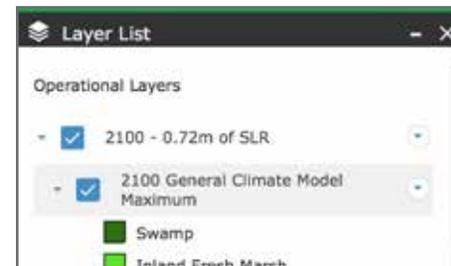
## Layer list

Users can selectively turn on and off layers of data to display in the map view. The data are organized as a hierarchy first in descending order by year from 2100 to 2010. Within each year, the least to most severe SLR scenarios are then listed, followed by the likelihood of coastal marsh. By default, the layer showing the initial conditions in 2010 is turned on when elicitation opens.

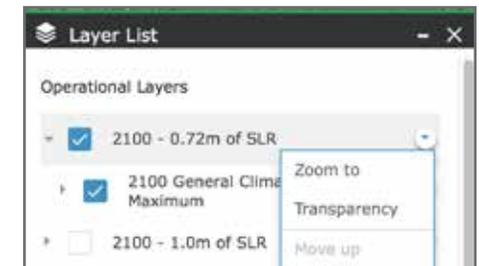


To turn on or off layers, click on the box to the left of a layer name. A blue box denotes an active layer. Most layers are nested as a group (see example to the right). In order to be visible on the map, both levels must be checked. Lower nested levels are automatically on by default, so the user only needs to use the highest level.

The order of the layers in the list is the same as how they are displayed on the map. Layers that are turned on may be hidden or obscured if they are underneath others.



Clicking on any small arrow to the left of a check box expands the layer group to show more information. Clicking the arrow next to “2100 – 0.72 m of SLR” shows that the layer uses the 2100 version of the General Climate Model Maximum scenario. Clicking on the arrow next to that displays the legend. Clicking the arrow again will collapse any expanded information. The arrows allow the user to see nested levels of information as needed



Clicking on the drop-down symbol on the right side of the window opens an option menu for any layer. Users can click on any of these options:

- Automatically zoom to the extent of the layer
- Adjust the transparency of a layer (to help display layers stacked on top of each other)
- Move the layer up or down in the list (and by association, within the map view)
- Open new web page with detailed description about the layer

To remove this option menu, simply click the drop-down symbol again.

## SECTION 4

# Using LIS SLAMM Comparison Application

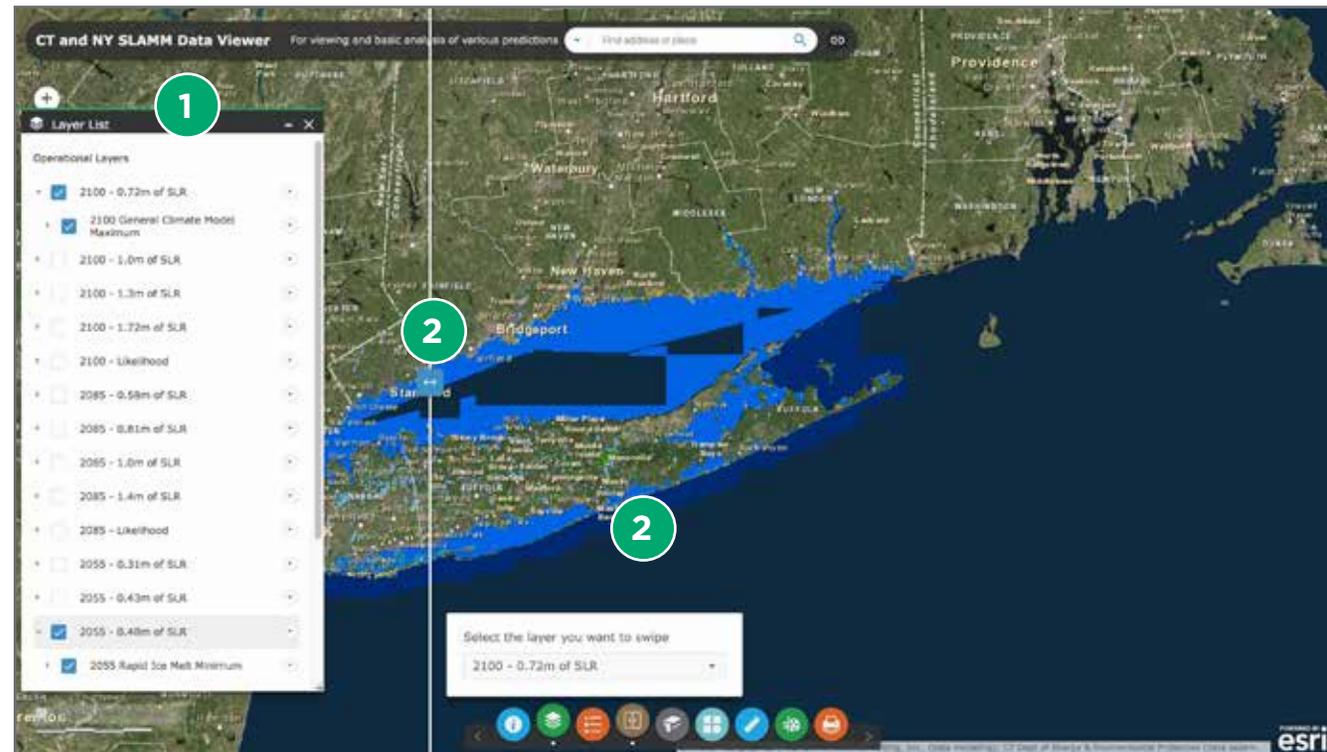
## Legend

Opens a window to display the legend for visible data layers. If more than one layer is visible, users may need to use the scrollbar on the right to move up and down to see the values.



## Swipe

Allows the user to manually drag or “swipe” a layer that is on top of another and interactively show or hide the layer underneath. In order for this tool to work, there must be two or more layers turned on.

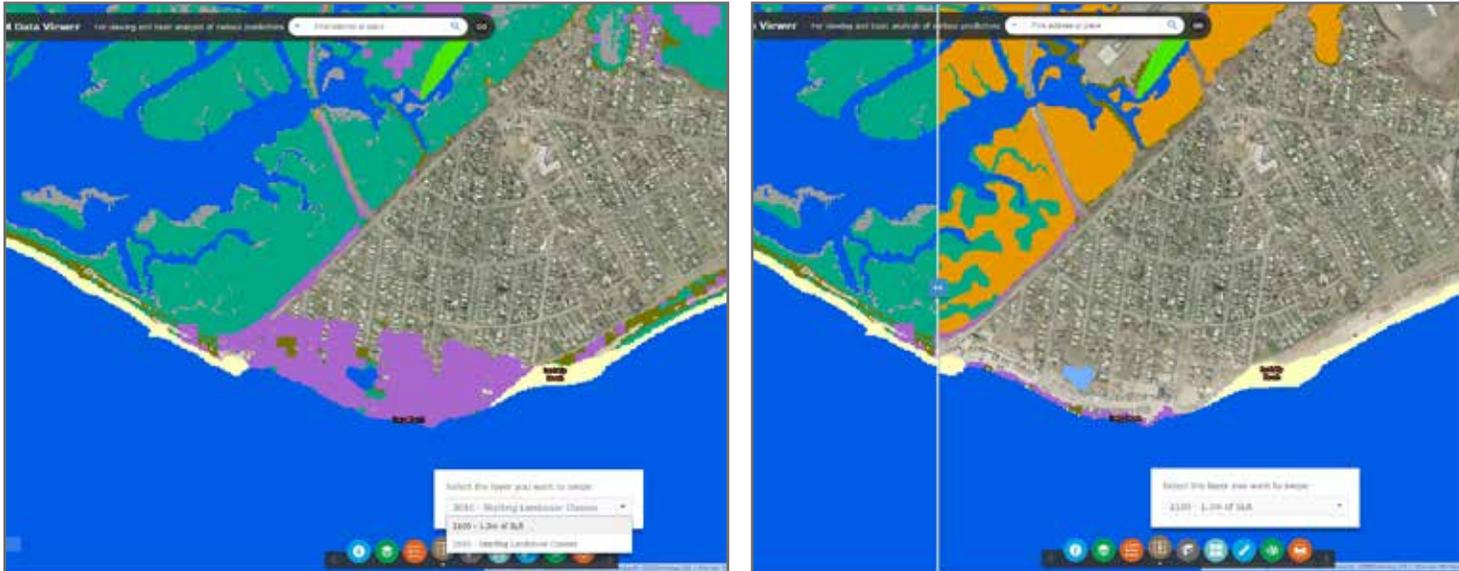


**Step 1:** Ensure there are at least two layers turned on. To do this, use the Layer List tool and select any two or more layers. Here, the Rapid Ice Melt Minimum examples for 2100 and 2055 are activated.

**Step 2:** In order to more easily see the difference between layers, it may be helpful to first zoom in for a more detailed view before swiping. Once you have an area, click on the Swipe tool. You should see two things appear in the map view: an option window that prompts you to choose the layer to swipe, and a vertical bar with a button showing right and left arrows.

# Using LIS SLAMM Comparison Application

## Swipe (ct'd)



**Step 3:** From the option menu, click the drop-down arrow on the right-hand side to see a list of available layers. Similar to the layer list, they are displayed to reflect the order they are drawn (i.e., layers on the bottom are covered by layers on top). To choose one, simply click on it. (Only layers that are turned on are options here. If you don't see any layer names to pick from, use the Layer List tool to activate at least two layers—one that will remain on and one that will swipe on and off.) The above examples reflect a choice of “2100 – 1.3 m of SLR” as the swipe layer.

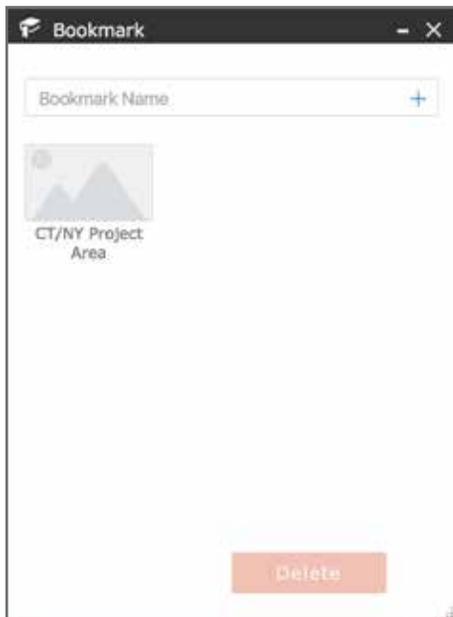
The swipe layer will then be displayed in the option menu. Depending on where the vertical swipe bar is, you may also see the map view display change. Note that the image on the right is different. This is because the vertical swipe bar is now controlling the display. Part of the map view on the left of the bar has “2100 – 1.3 m of SLR” visible on top of the other data. Part of the map view on the right of the bar has it turned off so the next visible layer underneath is showing. Clicking and holding anywhere on the bar itself allows the user to drag it right or left to reveal what is under the swipe layer.

**Step 4:** To turn off the Swipe function, click on the Swipe tool on the main toolbar.

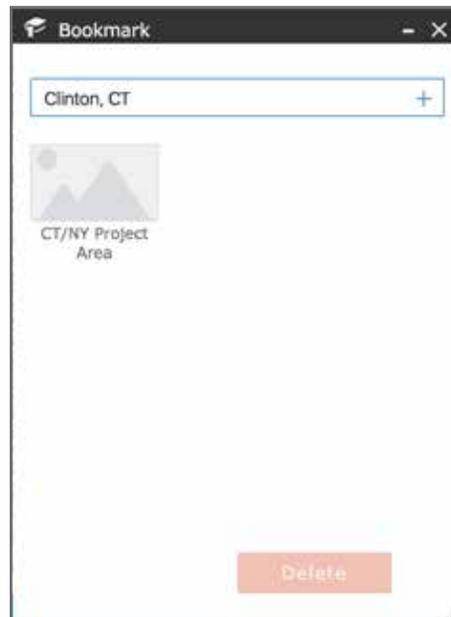
# Using LIS SLAMM Comparison Application

## Bookmark

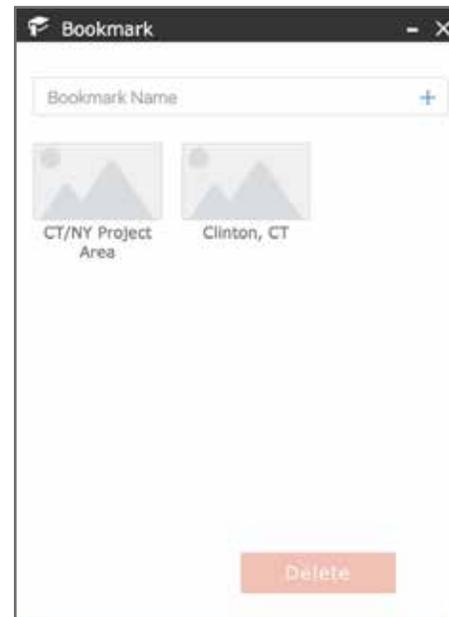
Saves a series of map bookmarks capturing the location and extent of particular areas for easy access and display.



**Step 1:** If you have a location that you want to return to regularly (e.g., a municipality, county, address), zoom the map view to the extent you wish to save, then click the Bookmark tool.



**Step 2:** Enter a name and then click the "+" symbol on the right of the entry box.



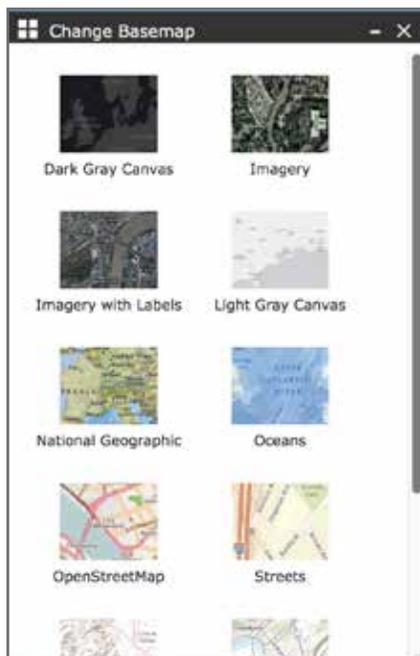
**Step 3:** The new bookmark has been added. You can access these in the future by simply opening the Bookmark tool and clicking on a bookmark. If you don't wish to keep one any longer, click on it to select it, then click Delete.

# Using LIS SLAMM Comparison Application

## Change Basemap

Offers a series of maps that can be used as the background for the map viewer window. These are provided by ESRI and may change over time.

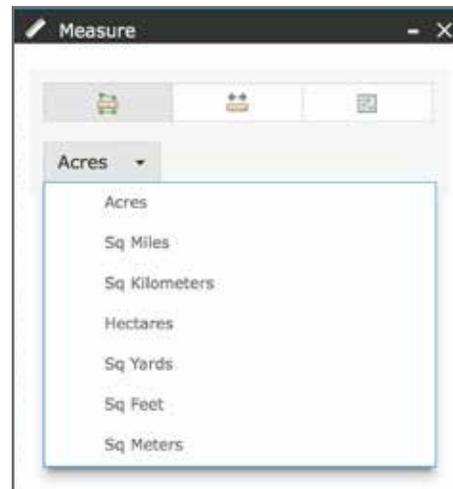
Click the Basemap tool to open the Change Basemap window. From here, select any of the options. By default, the web application uses the "Imagery with Labels" version.



## Measure

Provides users the ability to calculate and display areas, lengths, or point locations when interacting with the maps. Click the Measure tool to open a dialog window. Across the top are 3 options: from left to right they are Area, Distance, and Location. Clicking on each will enable you to select the units of your measurement.

## Measuring an Area



**Area – Step 1:** Once you have the Measure window open, select the "Area" measurement option and then the unit of measurement.

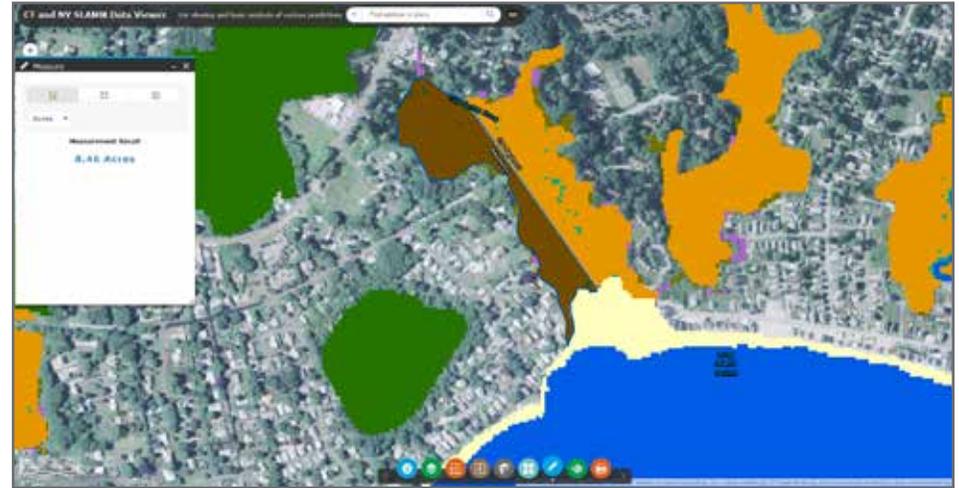
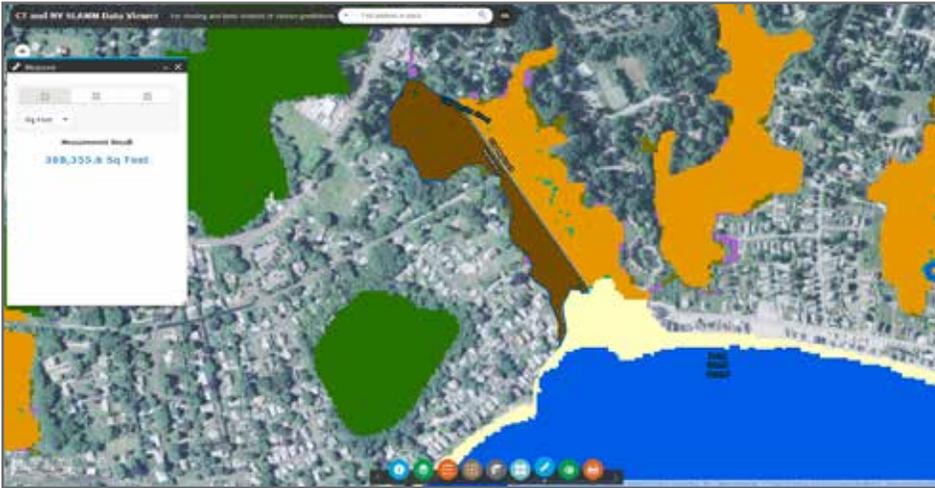


**Area – Step 2:** To measure an area, click the cursor once to begin drawing by creating a starting point (vertex). Then move the cursor to another location and click again to add a vertex. As you continue to add vertices, an area will be drawn on the map, and you will notice the Measure dialog begin to calculate the area in the units you selected. When you are done adding vertices and want to stop drawing, place the last vertex with a double-click. The image above on the left shows a marsh site crossing two towns. The image on the right shows the beginning of a drawing to calculate how much of the marsh is in one of the towns.

## SECTION 4

# Using LIS SLAMM Comparison Application

## Measuring an Area (ct'd)

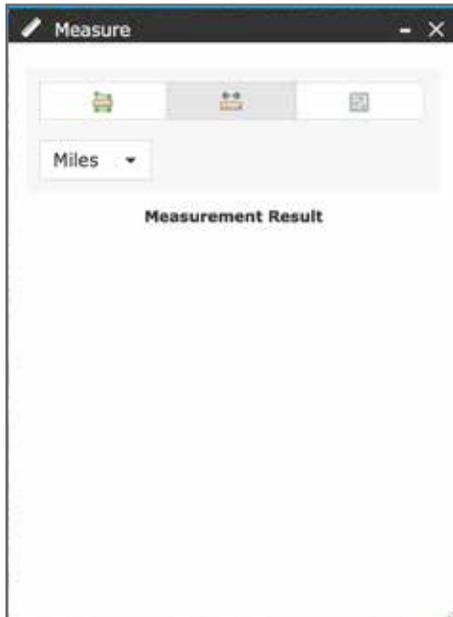


**Step 3:** The upper-left image shows a completed area for the part of the marsh in one of the towns with its calculated value. If you want to display the area in different units, simply use the Measure window to pick a different unit. The lower-right image shows the same area in acres instead of square feet without having to re-draw it.

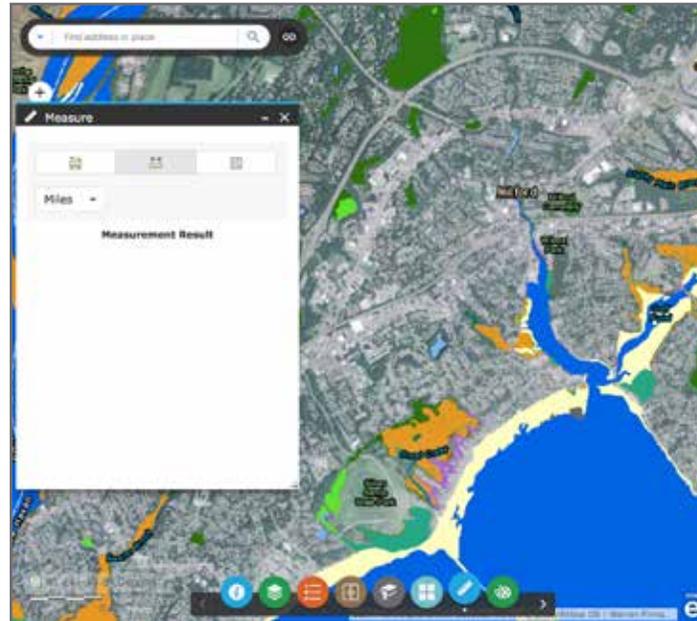
**NOTE:** To delete any area measurement info from the map or the dialog window, simply close the Measure dialog window or click on any of the three measurement options.

# Using LIS SLAMM Comparison Application

## Measuring Distances

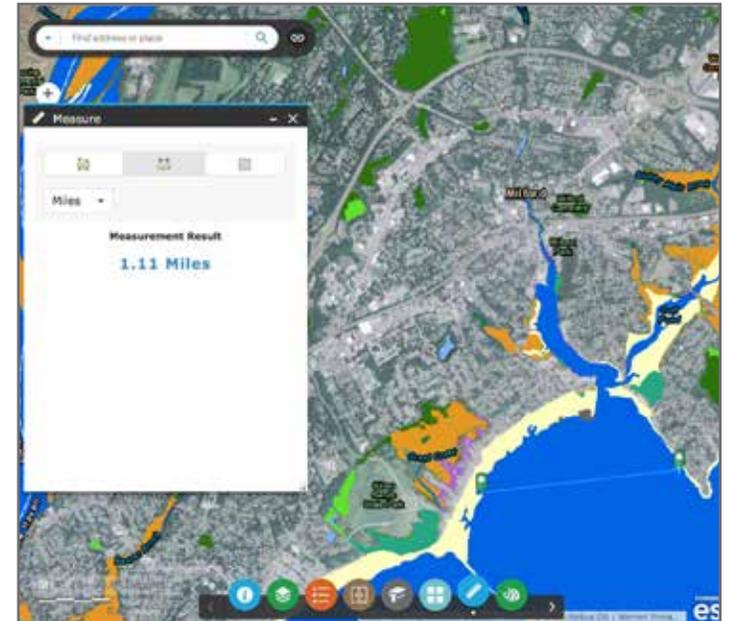


**Distance – Step 1:** Once you have the Measure window open, select the “Distance” measurement option and then the unit of measurement.



**Distance – Step 2:** Select a starting point on the map and click once. This will anchor a line. Moving the cursor and clicking will add additional points to draw a line and update the measurement result. You can add a straight line with two points or a more complex line with many points. To complete your drawing, end the last point with a double-click. The image above right shows a distance in feet ready to be calculated. The image below right shows a line measuring the length of the marsh in feet.

Just like in the area example, you can switch the units of a distance result by selecting a different unit from the option list.

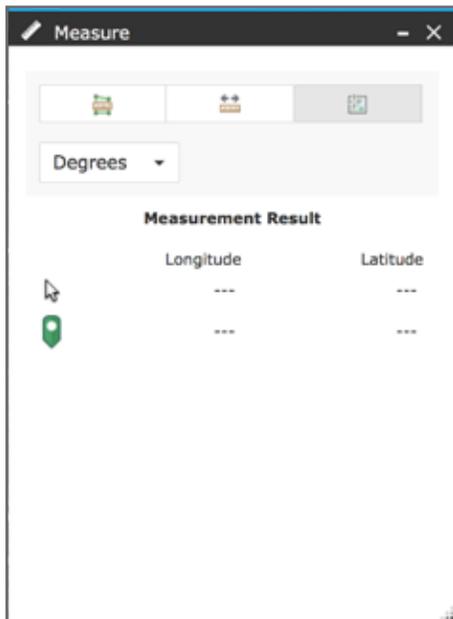


**NOTE:** To delete any area measurement info from the map or the dialog window, simply close the Measure dialog window or click on any of the three measurement options.

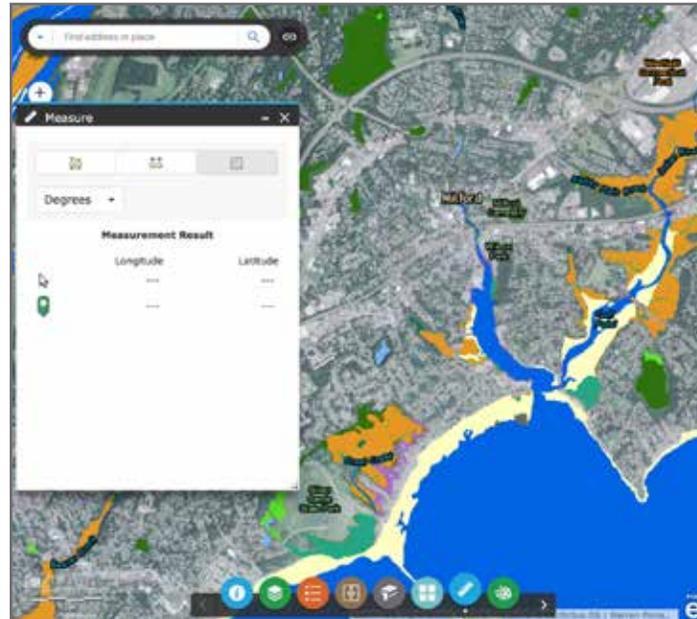
## SECTION 4

# Using LIS SLAMM Comparison Application

## Finding a Location

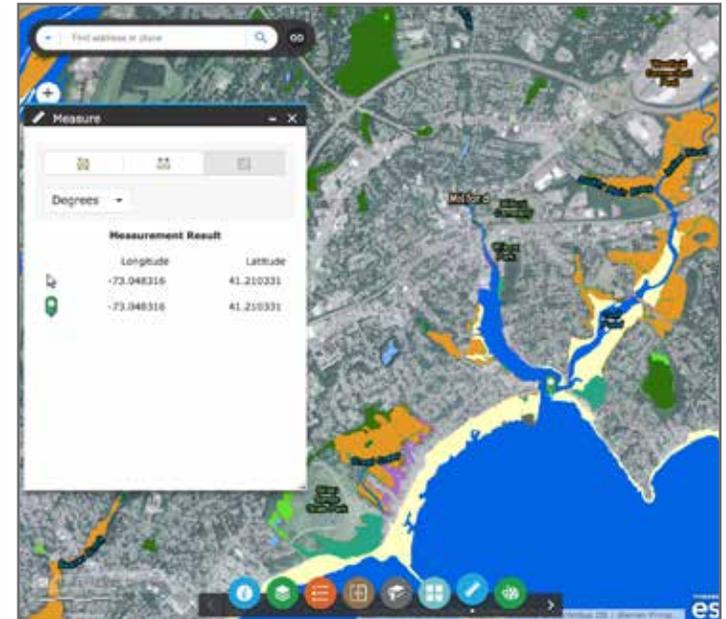


**Location – Step 1:** Once you have the Measure window open, select the “Location” measurement option and then the unit of measurement. Here you are limited to either decimal degrees or degrees/minutes/seconds.



**Location – Step 2:** Select a point on the map and click once. This will add a marker to the map and a specific location value in the Measurement Results. As you move the cursor, the Measurement Results will also return an interactive location value based on the cursor location. The image above right shows a location in decimal degrees ready to be calculated. The image below right shows fixed marker placed on the map. The Measure window shows location values for both the marker and the cursor.

Just like in the area and distance examples, you can switch the units of a location result by selecting a different unit from the option list.



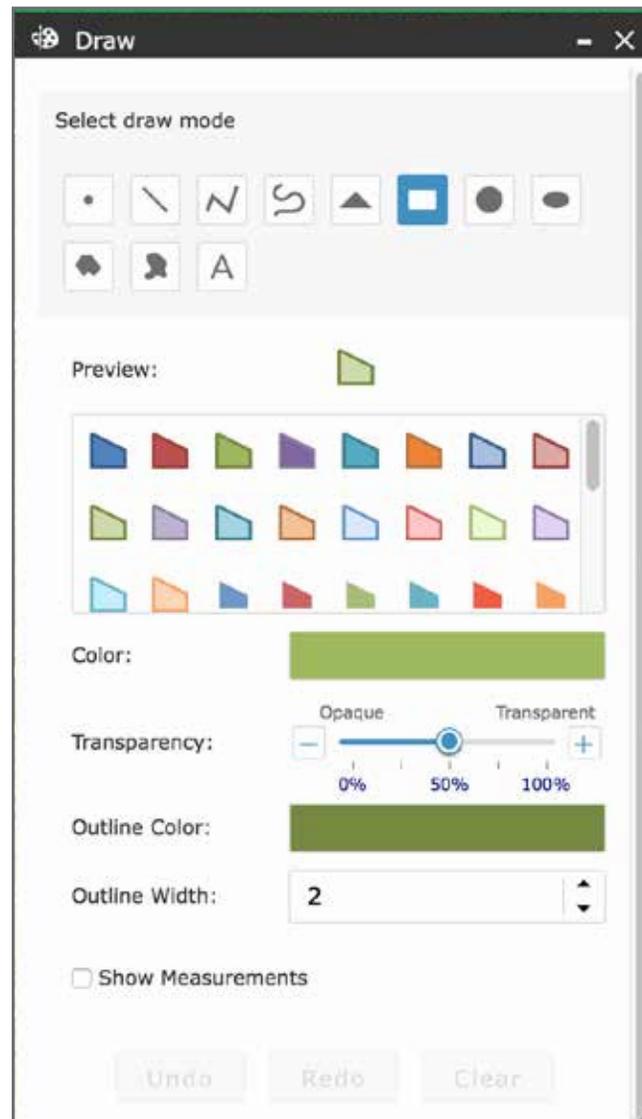
**NOTE:** To delete any location info from the map or the window, simply close the Measure dialog window or click on any of the three measurement options.

# Using LIS SLAMM Comparison Application

## Draw

The Draw tool offers a variety of ways the user can mark up or annotate the map using symbols, text, or both. To draw on the map, the general order of events is as follows:

1. Select the draw mode (points, lines, shapes, or text).
2. Choose from a series of drawing options specific to the selected mode (e.g., the style of the symbols used, the size, the colors, the level of transparency).
3. Depending on the draw mode, optionally include measurement information for lines and shapes.
4. Interact with the map by using the cursor to click and add the drawing.
5. Repeat as needed using the same or different draw modes to add additional elements.
6. Control the results as needed with the UNDO, REDO, or CLEAR commands.



### Draw Modes:

Options include points, straight lines, polylines, freehand lines, triangles, rectangles, circles, ovals, polygons, and freehand polygons. (Polylines and polygons are created with a series of points and lines; freehand versions are similar to drawing with a pen or pencil and creating a smooth curve or shape.)

### Drawing Options:

Depending on the drawing mode selected, this will change to offer choices of how to display a drawing. A preview of the selections is provided to help refine the choices.

### Measure Options:

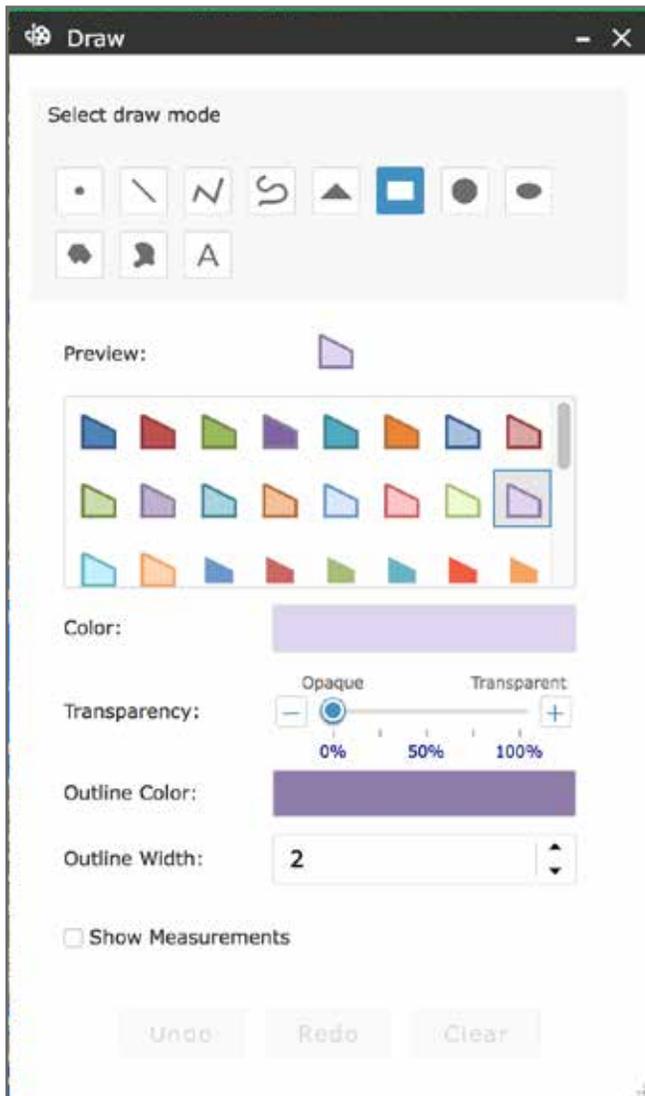
If lines or areas are chosen from the draw mode, clicking the checkbox will enable users to select the appropriate units.

### Drawing Controls:

Undo will remove the last drawing. Redo will repeat the last drawing. Clear will remove all drawings.

# Using LIS SLAMM Comparison Application

## Adding a polygon with Area and Perimeter info



Within the Draw Tool window, make the following selections:

1. Select the draw mode option for POLYGON. (The selected mode will be highlighted in blue.)
2. Choose your preferred color configuration for the polygon by selecting one of the sample choices. (You can change the colors for both the interior of the polygon and the outline by clicking on the "Color" and/or "Outline Color" bars and then choosing different colors from the range of options presented.)
3. Select a transparency setting. 0% (opaque) will not show anything under the drawing; approaching 100% (transparent) will allow more of the area under the drawing to be visible.
4. Adjusting the outline width changes the thickness of the outline.
5. Click on the Show Measurement checkbox and set the area units to acres and the distance units to meters.

# Using LIS SLAMM Comparison Application

## Draw (ct'd)



Begin to draw an area by clicking on the map. Note that the tool prompts you to do this.



Add more points to draw an area by clicking and moving the cursor. Note that the tool continues to guide you.



Once you've almost finished an area, double-click to finish it. As above, the on-screen prompts will help guide you.



A finished polygon with area and perimeter data.

**NOTE:** At any point in the drawing process, if you make a mistake and need to start over, the Undo command on the Draw Tool window will remove the last (or current) drawing.

# Using LIS SLAMM Comparison Application

## Draw (ct'd)

There are too many drawing options to provide an example for each, so here is a general guide that covers the fundamentals of any option:

1. Select the draw mode (points, lines, shapes, or text).
2. Choose from a series of drawing options specific to the selected mode (e.g., the style of the symbols used, the size, the colors, the level of transparency). As you move through the options, note the preview that will allow you to see what the effects of your changes will look like.
3. Optionally include measurement information for lines and shapes. (NOTE: Unlike the Measurement tools described previously, you cannot update measurement values of a drawing by selecting a different area or distance unit option from the Draw tools. If you create a drawing and decide the units are not what you want, you can either:
  - Click Undo and start from scratch, or
  - Click Undo, change the area and/or distance units, then click Redo. This will re-create the same drawing you had previously and add the new unit values.
4. Interact with the map by using the cursor to click and add the drawings. Note that cursor on the screen will prompt you on how to proceed based on the drawing you select.
5. Repeat as needed using the same or different draw modes to add additional elements. For example you can first trace out some areas, then add cross-sections showing lengths, then add some descriptive text.
6. Control the results as needed with the following command options: UNDO (*removes the current/last drawing*), REDO (*repeat the last drawing*), or CLEAR (*remove all drawings*).

# Using LIS SLAMM Comparison Application

## Print

Provides options to print hard-copy versions of the map view. Most users will only need to work with the basic options presented; however, added advanced options are also available for special cases.

The screenshot shows a 'Print' dialog box with the following fields and options:

- Map Title:** Text input field containing 'SLAMM Web Map'.
- Layout:** Dropdown menu set to 'MAP\_ONLY'.
- Format:** Dropdown menu set to 'PDF'.
- Advanced:** A gear icon and a dropdown menu.
- Print:** A printer icon and a 'Print' button.

The right-hand pane of the dialog contains the following sections:

- Map scale/extent:**
  - Preserve:** Radio buttons for 'map scale' (selected) and 'map extent'.
  - Force scale:** Radio button (unselected) and a text input field containing 'current'.
- Layout metadata:**
  - Author:** Text input field.
  - Copyright:** Text input field.
  - Include legend:** Checked checkbox.
- MAP\_ONLY size:**
  - Width (px):** Text input field containing '670'.
  - Height (px):** Text input field containing '500'.
- Print quality:**
  - DPI:** Text input field containing '96'.

### Basic options:

Users can add a specific map title and subtitle, choose a layout size, and select from many common printing formats (e.g., PDF, JPG, BMP).

### Advanced options:

Allow users to more finely control the output in terms of scale and extent, include any legends automatically, and specify map size and resolution (DPI – dots per inch). In most cases, the general user will not need to change these. However, if your printout isn't looking like you want, adjusting settings here may help.

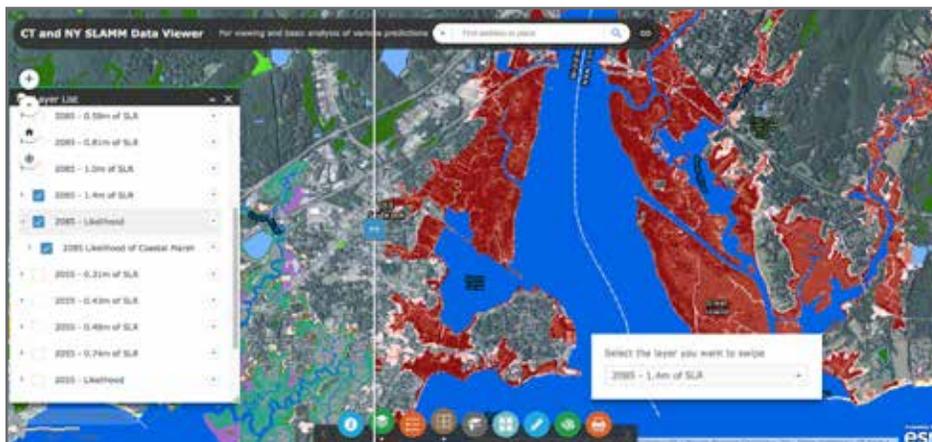
## SECTION 5

# Analysis with the LIS SLAMM Data Viewer Application

Below is an example of how one could use the application to examine the worst predicted case of SLR by 2085 and its effect on the likelihood of coastal marsh. The descriptions here are abbreviated; if you need a refresher on how a particular tool works, consult the earlier sections of this manual

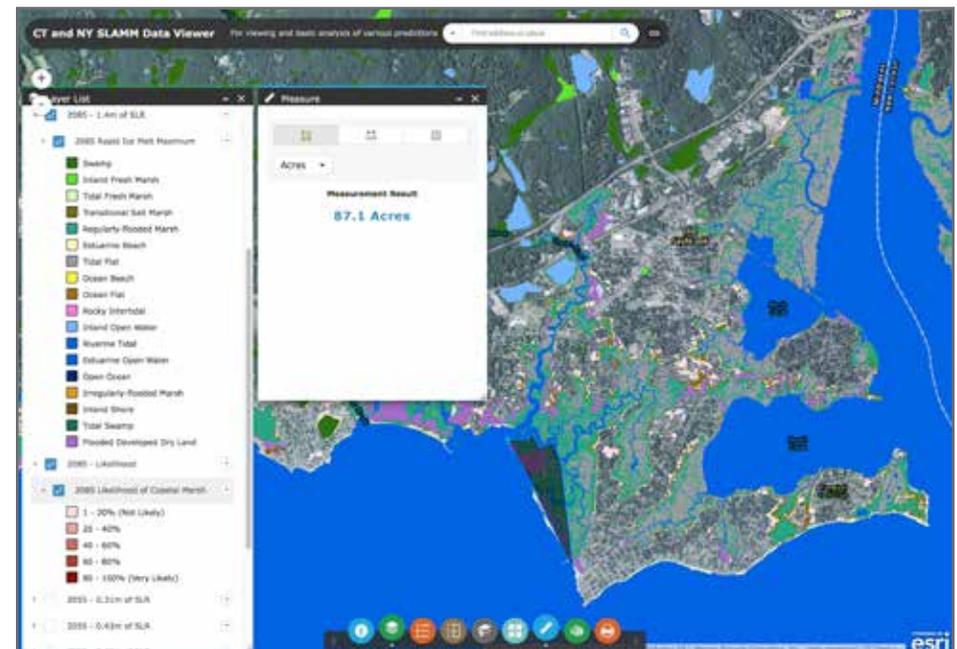
1. Use the Layer Tools to turn on the “2085 – 1.4m of SLR” and the “2085 Likelihood of Coastal Marsh” layers.
2. Navigate to a particular area of interest in the map window. (Recall that you can use the Navigation Control toolbar options, the Search box, or a combination thereof.)
3. Turn on the Swipe tool and set the swipe layer to “2085 – 1.4m of SLR”

At this point, the application should look similar to the image to the below. Recall that by setting the swipe layer to “2085 – 1.4m of SLR,” moving the vertical swipe bar left or right will either cover or expose the Likelihood layer.



4. From the Layer List, expand the layers that are turned on to display the symbology used for the color schemes. (Alternatively, use the Legend tool.)
5. Activate the Measure tool, select the Area option, and set the measurement value option to acres.
6. On the map, select an area of interest and draw a polygon that calculates its area.

At this point, the application should look similar to the image below. Here we have used various layers to identify an area of concern or interest and then calculated an area of potential impact.



## Analysis with the LIS SLAMM Data Viewer Application

Here are some general examples of functions that managers or scientists might use the application for:

- How large are certain areas of marsh?
- How different in composition or extent are the various predicted future states?
- For any future state or states, how do explicit predictions of a marsh response compare to the likelihood analyses?

Here are some examples of activities that managers or scientists might explore now to prepare for the future:

**Can we design studies or collect observations to confirm or deny:**

- Predicted marsh transgressions extents and/or rates?
- Predicted marsh land-cover composition?

**Are there land management assessments or studies to:**

- Determine the implication of the ecological effects of certain marshes transitioning between different land cover states?
- Explore the possibility of certain areas even supporting marsh transition?
- Explore the potential for conservation easements, land purchases, or other protective measures where it may be likely to help ensure healthy coastal marsh ecosystems?

## ACKNOWLEDGMENTS

This document was prepared by the Long Island Sound Study, with significant support from the New England Interstate Water Pollution Control Commission. This support was funded under cooperative agreement LI-96144501 between the United States Environmental Protection Agency and NEIWPCC.

This document has not undergone the EPA's publications review process. Accordingly, it may not necessarily reflect the views or official positions of the Agency, and no official endorsement should be inferred. Mention of trade names or commercial products, services, or enterprises does not constitute endorsement or recommendation for use by EPA, NEIWPCC, or the Long Island Sound Study.

The manual and SLAMM mapping application website is a collaborative project of the Long Island Sound Study, through the assistance of CTDEEP, NEIWPCC, the New York State Department of Environmental Conservation, and the New York State Energy Research and Development Authority.

