

ESI Toolkit

There are a series of ESI tools that allow easier query and summarization of the ESI geodatabase files. These tools require at a minimum ArcMap 10, service pack 2. They are designed to work on a pre-packaged ESI geodatabase, where the necessary relates are already established. To use these tools, only one geodatabase can be loaded*.

Questions and/or suggestions regarding these tools may be sent to orr.esi@noaa.gov. Updates or additional tools may be found at: <http://response.restoration.noaa.gov/maps-and-spatial-data/esi-toolkit.html>



Select a Layer to Query by Location: (LayerSelect.dll, vs. 2)

This tool provides a drop-down list of the available biology and human use layers. You are limited to querying one layer at a time. Once a layer has been selected using this tool, you may use the ArcMap “Select Features” tool or the Selection Menu items to view what species are present in a particular area.



SQL Query a Biology Layer by Attribute: (BiologyQuery.dll, vs. 2)

This tool lets you select a biology layer and construct a query based on species, state and federal status, and monthly presence and/or breeding status. You have the option to limit the query to presently selected points or polygons. This gives you the option to select species matching your criteria that occur in a previously selected area of interest. An example might be where a spill trajectory tells you to expect heavy oiling, then querying for species occurring during the month of the spill.



Generate Seasonal Map, Resource Summary & Geodatabase

(SeasonalSummary.dll vs. 2)

This tool creates a new geodatabase for a selected area and a specified seasonality, generates a summary text report of the resources included, and creates a map layout for an 8.5 x 11 map page. The layers and tables of the newly created geodatabase have the same symbology and relates as the original layers. If the original ESI geodatabase is removed, the new layers and data tables can be saved to a new map document (.mxd) that will function with the ESI tools like any of the pre-packaged ESI map documents.

The text summary report lists the species found in the selected area, along with seasonality and status information. ESI lines will be summarized both in meters and as a percentage relative to the resultant ESI layer.

The map layout is designed to work with python scripts that generate a legend, and a formatted version of the text summary. At this point in time, those scripts are only available through the Seattle office.



Generate a Resource at Risk Report: (RARReport.dll vs. 2)

This tool is a subset of the functions of the SeasonalReport.dll. It exports any selected records in the biology table to a text file, either as a unique species list, or a list that includes all the selected records and all of the fields that are currently visible. There is also an option to export a summary of the ESI shoreline types selected.



Open an Associated Metadata File: (MetadataView.dll, vs. 1)

This tool launches your PDF viewer software and opens the atlas metadata data file that is included in the ESI geodatabase directory.

*To work with more than one ESI geodatabase at the same time, use the data management tool *Append* to add the features and data records from one geodatabase to the a corresponding feature class/table in the target ESI geodatabase. To avoid duplicate features or table entries, use the data management tool *Delete Identical*, using the *Select All* field option (requires ArcInfo license). The ESI .mxd for the target geodatabase should maintain all symbology and relates, allowing the ESI tools to be used.

Related Tools and Products:



GNOME Trajectory Import Tool:

This tool may be useful for investigating potential impact areas on your ESI map. It requires that an oil spill trajectory be generated using GNOME or GNOME Analyst. Additional information about this tool and the GNOME product may be found at:

<http://response.restoration.noaa.gov/index.php> under the heading of featured software and datasets.

ESI Styles – symbol sets for ArcMap

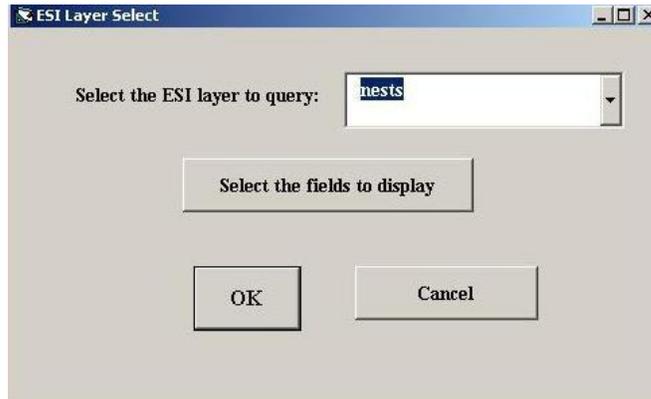
Included with each pre-packaged ESI map document and geodatabase is an ArcMap Style. These Styles contain all the symbolization used within the map document. It also includes multi-colored line symbols for symbolization of ESI lines with multiple shoreline types. Styles can be added to your ArcMap document using the *Customize* menu. Select *Customize*, then choose *Style Manager...* From that dialog box, click on the *Styles...* button, then click the button *Add Styles to List*. Navigate to the directory holding the ESI map document, and select the style set (it will be xxESI.style, where xx is the name of the ESI atlas). To utilize the multi-colored shoreline option, modify the map legend for the ESI layer by importing the legend from the xx_carto.lyr, where xx again represents the name of the ESI atlas. This file can be found in the LayerFiles directory inside the ESI directory housing the map document and ESI geodatabase. Choose **ESI** as the value field on which to base the symbolization.

Using the ESI Tools

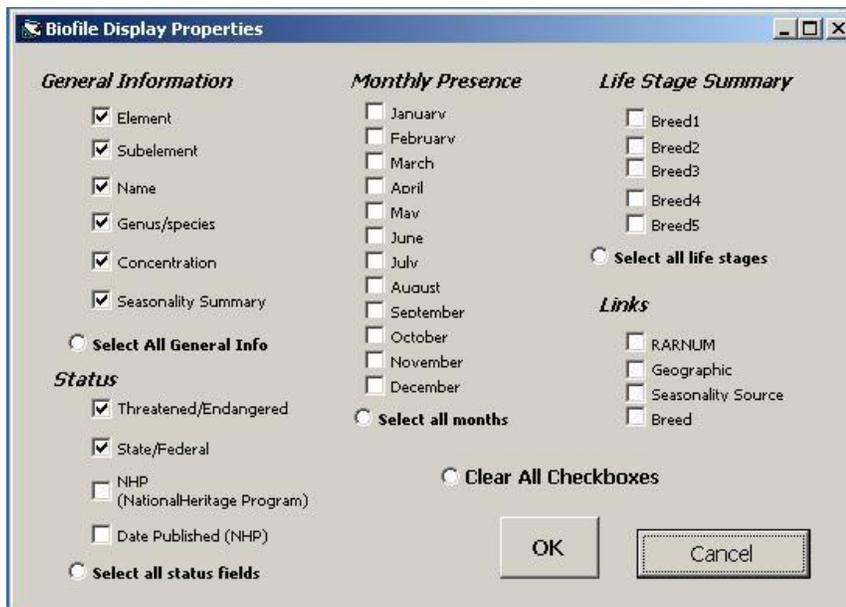
Select a Layer to Query by Location:



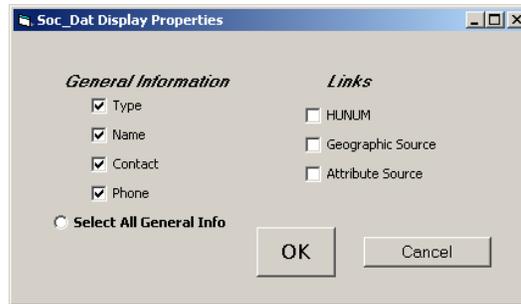
Click on the icon depicting a fish and two map layers. A dialog box with a drop down menu will be displayed. Select the biology or human use layer of your choice (you can query only one layer at a time). In the example below, the layer “nests” is selected.



In the same dialog box, there is a button, “Select the fields to display”. Clicking this will invoke a 2nd dialog box where you can select the fields of the *biofile* table you want to view. In the example below, the “Select All General Info” option was chosen, turning on the Element, Subelement, Name, Genus/species, Concentration, Seasonality Summary and State/Federal Threatened/Endangered status fields. Other options include viewing individual months for presence or absence of a species, as well as life stage summaries for species in a particular location.



If a human use layer was selected from the drop down list, the “Select the fields to display” dialog box will let you choose the fields in the *soc_dat* table that you want to view. Below, once again, the “Select All General Info” option was chosen, making the fields Type, Name, Contact and Phone visible in the soc_dat window.

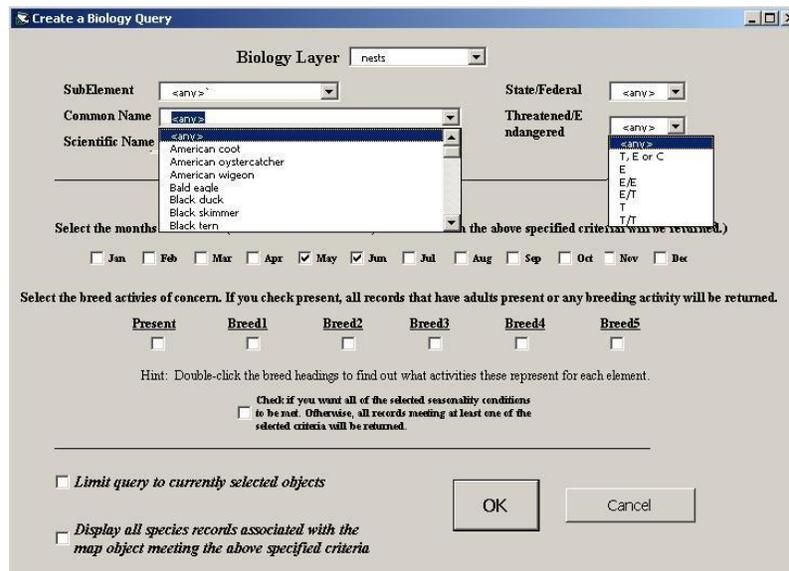


Once a layer has been chosen, and OK is clicked in the original dialog box, you may query objects on that layer using either the ArcMap “Select Features” tool or the selection menu items. The Biofile table (or the Soc_dat table if querying a human use layer) will then highlight (select) the records corresponding to the map objects that are selected.

Query a Biology Layer by Attribute: SQL

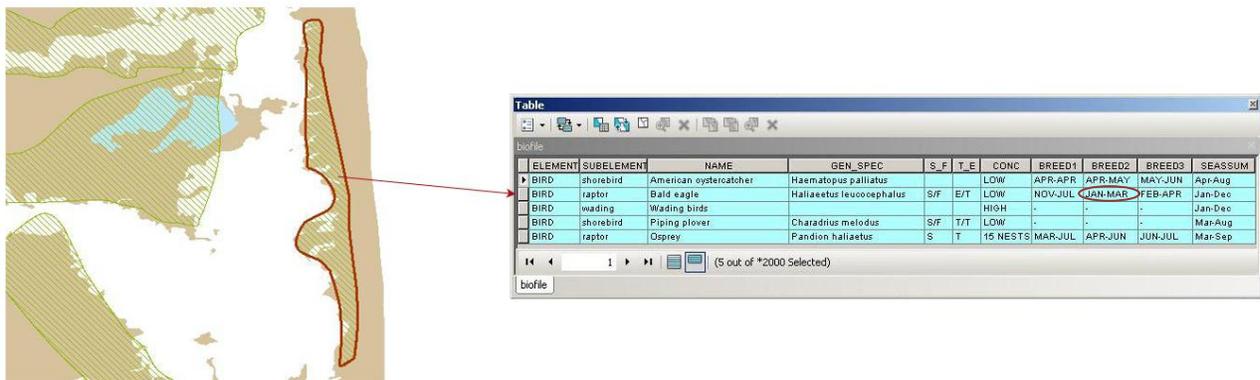
Selecting this tool launches a dialog box where you create a query on a particular biology layer. The drop-down menu choices are limited to the values available for the element represented on the selected layer. For example, below the layer “nests” is chosen, so all of the species of the element Bird will be available in the drop down menu “Common Name”.

The query below returns all nest points where birds of any type are present in May or June. You could restrict this query to show only nest points where a particular species or subelement is found in the specified months, or only birds that are listed in some way, such as Threatened, Endangered or a species of Concern. You could further restrict the query by looking at only nests where laying occurs during the specified time (Breed 1). Double click on the breed headings to see a list of the activities they represent for each element.



At the bottom of the Query dialog, there are two additional options. The first lets you limit a query to only the currently selected objects. This is very useful if you are only interested in a particular region of the atlas, for example the area of impact indicated by a spill trajectory. If you have already selected the nests inside the spill trajectory, you may now want to limit that to nests where birds are present during the month the spill occurred. If you select nests as the layer, check March in the seasonality section, and then check the limit option, you will only see the species records of the birds, present in March, found in the nest points previously selected.

The second check box at the bottom of the dialog asks that for points or polygons where there is at least one record matching the query criteria, all species found in that polygon or point also be shown. The following example shows a polygon that is selected when the query for “birds, laying or migrating (breed 2) occurs in February”. This polygon represents an area where the Bald Eagle’s breed activities meet these criteria. If the second check box is NOT checked, the record for the Bald Eagle would be the only record shown for this polygon. On the other hand, if the box to show the other species records associated with this polygon is checked, you would get the records shown in the biofile selection below. The additional species are not listed as laying or migrating in February, but they are found at some point in time within this polygon’s extent.



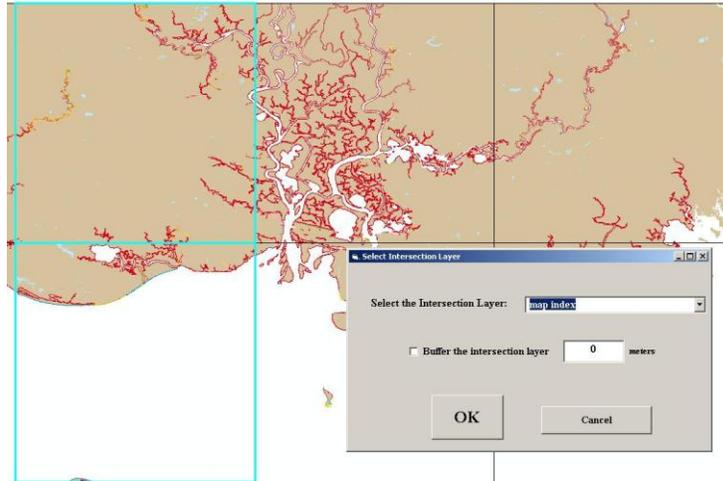
Query for birds laying in February (Bald Eagle), shown with the other species associated with the selected map

Generate Resource Summary, Seasonal Map & new Geodatabase Σ

The SeasonalSummary.dll is a multi-function tool. It creates a textual resource report for a specified region and seasonality, generates a new geodatabase for that area and season, and creates a map layout of the summarized area. It is fairly complex, and there are some key considerations for the user, particularly in defining the area to be summarized. These, as well as the basics of the tool, are described below.

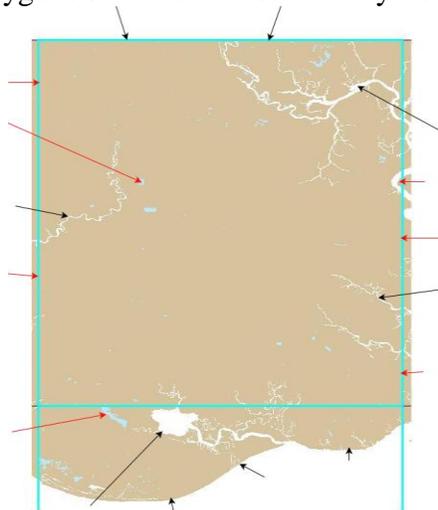
When you launch the seasonal tool, the first dialog box will ask you what feature class you wish to use for the intersection layer. The area of interest may be selected from any polygon feature class loaded in the map document; it does not have to be contained within the ESI geodatabase. Usable polygon layers will show up in the drop down menu. If you want to use only a portion of the selected layer, select the polygon(s) to be summarized before launching the tool; up to 99 distinct polygons can be selected. The summary will not differentiate between these polygons, but rather give a summary of all resources falling within any of the selected bounding features. If no polygons are selected, all polygons in the selected layer will be used. In this case, if the

feature class has more than 99 polygons, a message will be displayed, indicating that there is a 99 polygon limit for the tool.



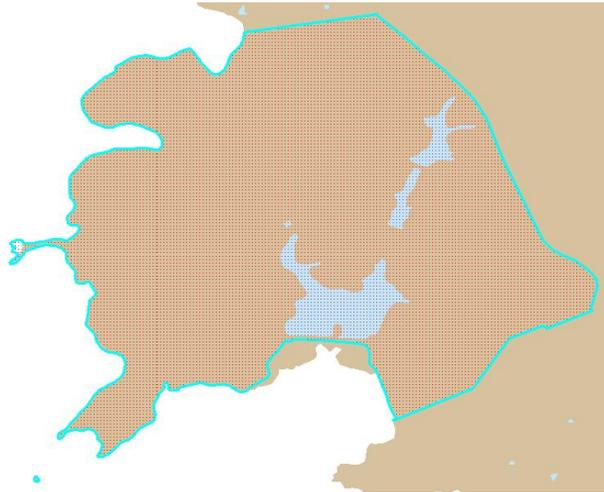
Select Intersection Layer dialog – in this example, two polygons in the map index layer will be summarized

In the above example, the user has chosen two polygons in the map index layer to be summarized. There is a potential “problem” in this particular map selection. If you look at the top boundary of the selected polygons, you will see that the map index box is flush with the underlying hydro layer. Among other things, the resource summary includes an overall shoreline length. This length is a summation of the perimeter of all hydro features that border on the universal (outside) polygon, before the area clipping occurs. In the diagram that follows, the black arrows point to hydro edges that are included in the shoreline length calculation. Edges that result from the clipping are recognized as land, and are excluded from the shoreline calculation. These are indicated by red arrows in the diagram below. To eliminate the inclusion of land edges as shoreline, make sure the polygons selected intersect the hydro layer.



Black arrows point to edges that are included in the shoreline length calculation; red arrows point to edges that will result from clipping the area of interest and are not included

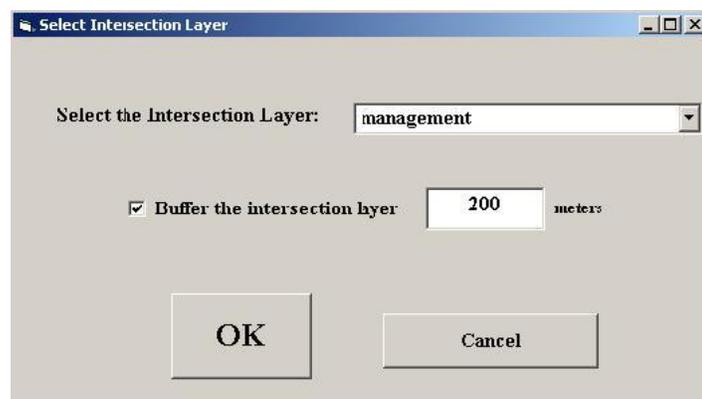
Another option in the select intersection layer dialog is to buffer the map object(s) you have specified as the area of interest. This is useful if you are using polygons that are coincident (or near coincident) to the hydro and/or ESI layers. Buffering will ensure that all of the shoreline features are included.



Two polygons showing the extent of the Great Bay National Wildlife Refuge

In the Delaware Bay ESI atlas, two polygons are used to define the area for the Great Bay National Wildlife Refuge. Both are, for the most part, coincident with the shoreline. A relatively small buffer distance, for example 30 meters, would be sufficient to include all of the shoreline except the small area on the south side. If you wanted to include that area in your summarization, you would need to specify a larger buffer distance.

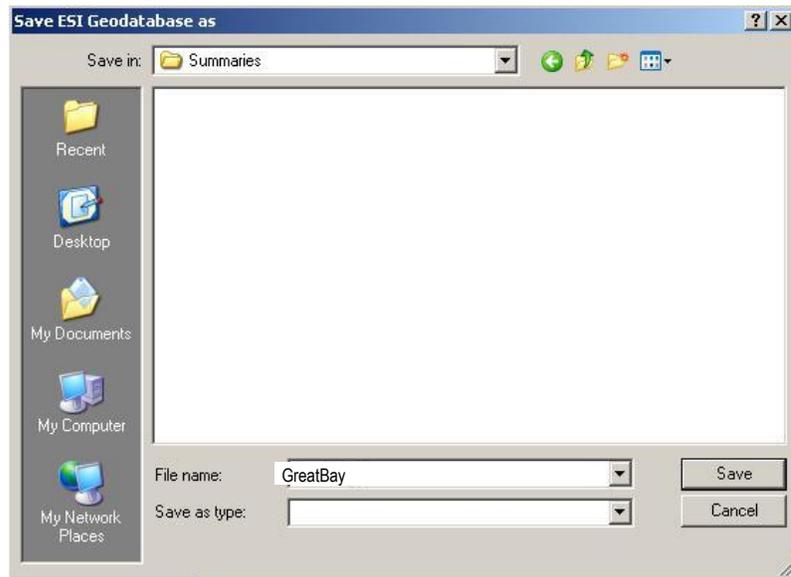
We will now step through the dialog boxes and output of the tool using this Great Bay Wildlife Refuge sample. Below we specify a buffer distance of 200 meters, to include the area that is to the south of the large management polygon. The initial dialog box looks like this:



After clicking OK, a dialog box asking for seasonality and caption preference will appear. Below we have specified that we want to name the map “Great Bay National Wildlife Refuge”, and that we want the summary to include biological resources that are present in April or May. We have also provided a textual description of the seasonality and given the name and date of the ESI atlas that is being used. These captions will be used on the map and in the resource summary.



Next you will need to specify the name of the geodatabase to be created. This name and location will also be used for the summary text file. In this case, we have named the output “GreatBay”.



Clicking “Save” initiates the summary process. All layers that are contained by the source geodatabase will be clipped to the area of interest. The biology, human use and shoreline information will be summarized and written to the text file. When the process is completed, you will see the following message box, explaining what has been done, and giving information about how to use the new ESI geodatabase.



In some cases, you may get another message box, as shown below.



This happens when, within the area of interest, a particular species is present in multiple polygons that have differing breeding seasonality. For example, if the Piping Plover was found in the north nesting from April to June, and in the south end of the area it is nesting between May and July, a line will be included for each of these cases in the final text summary. Lines that represent duplicate species are preceded by an asterisk.

As mentioned, the output from this tool run is three-fold. First, a new geodatabase is created which includes a feature class corresponding to each feature class in the original ESI geodatabase that had map objects falling within the clipping region. The symbology for each of these feature layers replicates that from the original map document. If any of the output feature layers are biology layers, the *biofile*, *sources* and *breed_dt* tables will also be part of the new geodatabase. Likewise, if any of the layers are human use, the *soc_dat* file is included. All of the ESI relates are set up between the new ESI feature layers and the tables, so if the original geodatabase is removed, the ESI tools will function with the new data. This may be particularly useful if you need to summarize a number of regions within a particular portion of an ESI atlas. Starting with a smaller data set can speed the summarization process, sometimes considerably. Saving the map document with the newly created geodatabase (once the original geodatabase has been removed) yields a map document “equivalent” to the pre-packaged ESI map documents in symbology, established relates and the ability to work with the ESI tool set.

A text file, with the same name as the new geodatabase, will be written to the directory specified for the new geodatabase. This file lists all of the biological resources present during the months specified. In addition to the species and subelement names, if any breeding activity occurs during the specified months, a summary of that activity is listed. Threatened and endangered status is given when it applies. All socio-economic resources are listed. A summary of the ESI shoreline and polygon types is provided in meters and as a percentage of the shoreline summarized. An excerpt from the Great Bay text file is shown on the next page. The summary in its entirety is included as Appendix A.

Great Bay National Wildlife Refuge
New Hampshire - 2004

Species of particular concern present April-May

BIRD	diving	Common loon	State threatened
BIRD	diving	Pied-billed grebe	State endangered; Nesting APR-OCT
BIRD	raptor	Bald eagle	State endangered; Federally threatened
BIRD	raptor	Osprey	State threatened; Nesting APR-OCT
BIRD	raptor	Peregrine falcon	State endangered
BIRD	shorebird	Black-bellied plover	Laying JUL-MAY*
BIRD	shorebird	Greater yellowlegs	Laying JUL-MAY*
FISH	diadromous	American shad	Juvenile JUL-FEB; Adults MAY-JUL
FISH	diadromous	Atlantic salmon	Juvenile JAN-DEC; Adults MAY-MAR
FISH	diadromous	Blueback herring	Juvenile JAN-DEC; Adults JAN-DEC
INVERT	bivalve	Atlantic jackknife clam	Juvenile JAN-DEC; Adults JAN-DEC
INVERT	crab	Horseshoe crab	Spawning MAY-JUL; Eggs MAY-JUL; Juvenile JAN-DEC; Adults JAN-DEC
INVERT	shrimp	Daggerblade grass shrimp	Juvenile JAN-DEC; Adults JAN-DEC
INVERT	shrimp	Sevenspine bay shrimp	Juvenile JAN-DEC; Adults JAN-DEC

Additional species present in area: Double-crested cormorant, Great black-backed gull, Herring gull, Solitary sandpiper, Spotted sandpiper, American bittern, Black-crowned night-heron, Glossy ibis, Great blue heron, Green heron, Snowy egret, Sora, American wigeon, Blue-winged teal, Bufflehead, Canvasback, Common goldeneye, Common merganser, Gadwall, Greater scaup, Green-winged teal, Hooded merganser, Northern pintail, Red-breasted merganser, Ring-necked duck, Scoters, Atlantic menhaden, Bluefish, Eelgrass, Beaver, Muskrat, Northern river otter

HISTORICAL SITE MARGESON, RICHMAN, ESTATE
WELL PEASE DEVELOPMENT AUTHORITY
WILDLIFE REFUGE GREAT BAY NATIONAL WILDLIFE REFUGE JIMMIE REYNOLDS 603/431-7511

ESI Polygon Type Area in square meters

9A: Sheltered tidal flats	486,194
10A: Salt- and brackish-water marshes	103,672
10D: Scrub-shrub wetlands	19,958

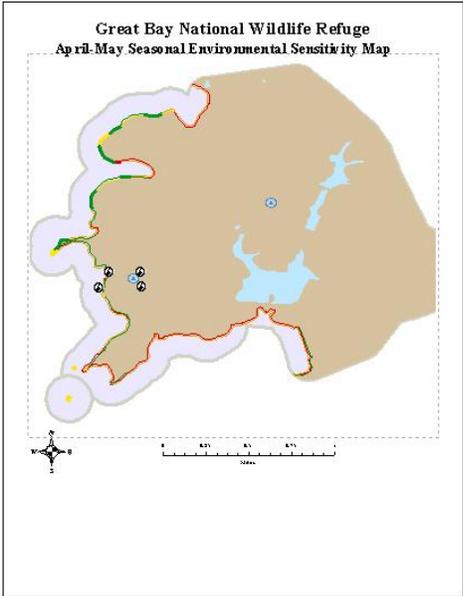
ESI Line Type Length in meters Percentage of ESI Shoreline

6A: Gravel beaches	4,216	51
8A: Sheltered scarps in bedrock, mud or clay	1,104	13
9A: Sheltered tidal flats	6,183	76
10A: Salt- and brackish-water marshes	4,692	57

*Total ESI shoreline length: 8,129

Approximate shoreline length: 8,130 meters

Finally, the tool creates a map layout for an 8.5x11 ESI summary map. The map is zoomed to the area of interest, and initially displays the hydro, socecon, ESI line and ESI poly layers. Of course you may choose to turn any of these off, other layers on, reorder the layers, etc. The reference scale (set under document properties) defaults to 1:24,000 as this is generally a good scale for displaying the ESI shoreline. You may want to adapt this to a more appropriate reference scale based on the actual map scale and/or the layers you choose to show. Space is reserved at the bottom of the map layout for a legend that may be added later. The layout created for our Great Bay example is shown below. The ESI shoreline in this sample is using the “carto” layer symbology. This utilizes a symbol set that enables symbolization of multiple shoreline types. This symbolset is distributed as a “style” with each ESI geodatabase.

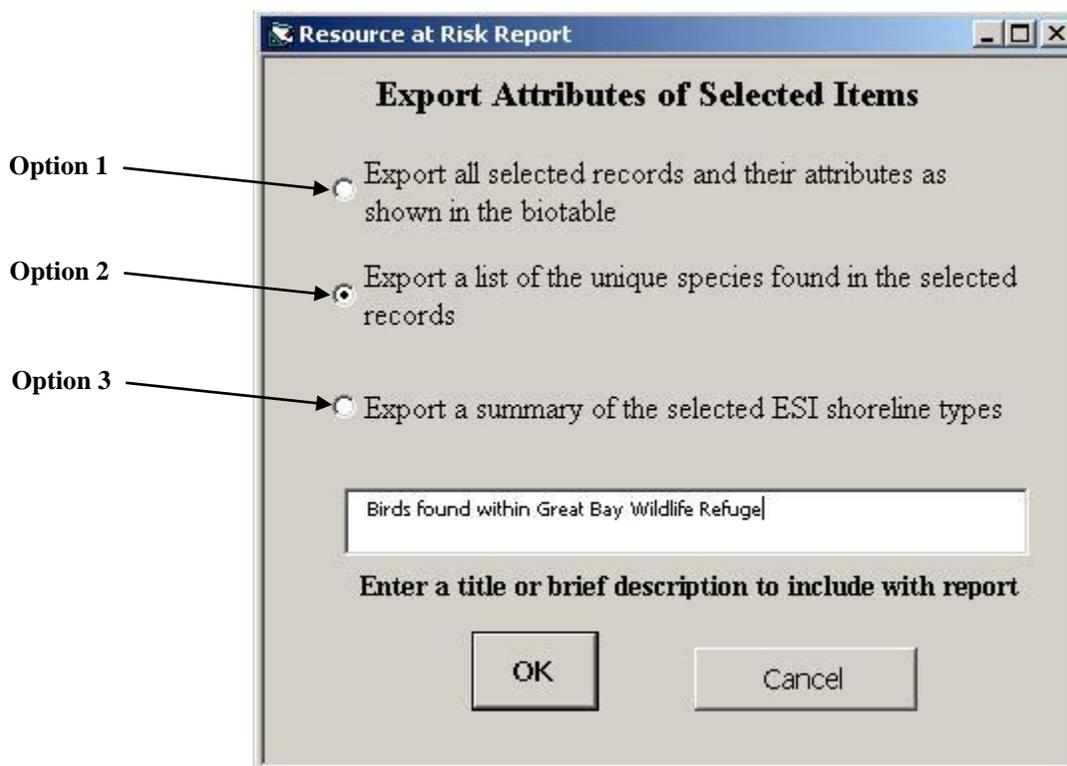


At this time there isn't an ArcMap tool to assist with creating the legend or generating an easy to read "back of the map". Within NOAA there are some standalone scripts that accomplish these last steps. At some point, it may be possible to integrate this code as a separate ArcMap ESI tool. An example of a typical ESI summary map product is shown in Appendix B.

Generate a Simple Report

In some ways, this tool is a subset of the Seasonal Summary tool discussed above. With this tool, you can generate a tab delimited text file listing the records currently selected in the *biofile*. You may choose to export all of the selected records or a list of the unique species selected. You also have the option to export a summary of the ESI shoreline types that are currently selected.

Launching the tool brings up the following dialog box:



Option 1 will export a tab delimited list of all the records currently selected in the *biofile*. This option includes all the fields visible in that table. In the following example, the species found on the bird layer, within the Great Bay Wildlife Refuge, are selected. The selection consists of 140 records. All of these are written to the specified text file, *BirdsInGreatBay.txt*. An excerpt from this text file is shown. Notice that this export includes the Concentration and Seasonality Summary values since they were visible in the *biotable* at the time of the export. These fields may vary from polygon to polygon, so are only valid when looking at individual polygons, or as, in the case, when you look at all the selected records. For example, in this excerpt you can find 3 entries for the Bald Eagle. (The records

are sorted alphabetically on the Name field, and are grouped by resource at risk number). There are two different values for concentration.

Birds found within Great Bay Wildlife Refuge							
ELEMENT	SUBELEMENT	NAME	GEN_SPEC	S_F	T_E	CONC	SEASSUM
BIRD	waterfowl	American black duck	Anas rubripes			MED	Jan-Dec
BIRD	waterfowl	American wigeon	Anas americana			>100	Oct-Apr
BIRD	raptor	Bald eagle	Haliaeetus leucocephalus	S/F	E/T	LOW	Dec-Apr
BIRD	waterfowl	Blue-winged teal	Anas discors			LOW	Nov-Apr
BIRD	waterfowl	Bufflehead	Bucephala albeola			LOW	Nov-Apr
BIRD	waterfowl	Common goldeneye	Bucephala clangula			LOW	Nov-Apr
BIRD	waterfowl	Gadwall	Anas strepera			LOW	Nov-Apr
BIRD	wading	Great blue heron	Ardea herodias			LOW	Apr-Oct
BIRD	waterfowl	Greater scaup	Aythya marila			LOW	Oct-Apr
BIRD	shorebird	Greater yellowlegs	Tringa melanoleuca			LOW	Jul-May*
BIRD	wading	Green heron	Butorides virescens			LOW	Apr-Oct
BIRD	waterfowl	Green-winged teal	Anas crecca			150	Sep-Oct
BIRD	waterfowl	Hooded merganser	Lophodytes cucullatus			-	Jan-Dec
BIRD	wading	Least bittern	Ixobrychus exilis			LOW	May-Sep
BIRD	shorebird	Least sandpiper	Calidris minutilla			LOW	Jul-May*
BIRD	shorebird	Lesser yellowlegs	Tringa flavipes			LOW	Jul-May*
BIRD	waterfowl	Mallard	Anas platyrhynchos			MED	Jan-Dec
BIRD	waterfowl	Northern pintail	Anas acuta			LOW	Nov-Apr
BIRD	raptor	Osprey	Pandion haliaetus	S	T	LOW	Apr-Oct
BIRD	raptor	Peregrine falcon	Falco peregrinus	S	E	LOW	Jan-Dec
BIRD	diving	Pied-billed grebe	Podilymbus podiceps	S	E	LOW	Apr-Oct
BIRD	waterfowl	Ring-necked duck	Aythya collaris			LOW	Nov-Apr
BIRD	shorebird	Semipalmated sandpiper	Calidris pusilla			50	Jul-May*
BIRD	wading	Snowy egret	Egretta thula			LOW	Apr-Oct
BIRD	shorebird	Solitary sandpiper	Tringa solitaria			LOW	Jul-May*
BIRD	wading	Sora	Porzana carolina			LOW	Apr-Sep
BIRD	shorebird	Spotted sandpiper	Actitis macularia			LOW	Jul-May*
BIRD	wading	Virginia rail	Rallus limicola			LOW	May-Aug
BIRD	waterfowl	Wood duck	Aix sponsa			200	Sep-Apr
BIRD	raptor	Bald eagle	Haliaeetus leucocephalus	S/F	E/T	15-25	Dec-Apr
BIRD	diving	Double-crested cormorant	Phalacrocorax auritus			LOW	May-Oct
BIRD	gull_tern	Great black-backed gull	Larus marinus			HIGH	Jan-Dec
BIRD	gull_tern	Herring gull	Larus argentatus			HIGH	Jan-Dec
BIRD	raptor	Bald eagle	Haliaeetus leucocephalus	S/F	E/T	15-25	Dec-Apr
BIRD	waterfowl	Bufflehead	Bucephala albeola			<100	Nov-Apr
BIRD	waterfowl	Canvasback	Aythya valisineria			LOW	Nov-Apr

Using option 2, on the same selection, results in the export of 45 entries, each representing a unique list of species. In this case it does not make sense to include concentration and seasonality, as you would get only one version. The following example shows the first part of this file.

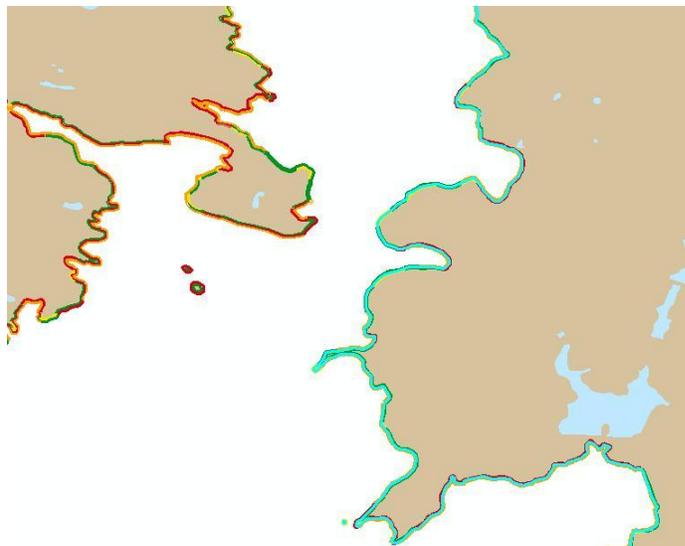
Element	Subelement	Name	Gen_Spec	S_F/T_E
BIRD	wading	American bittern	Botaurus lentiginosus	
BIRD	waterfowl	American black duck	Anas rubripes	
BIRD	waterfowl	American wigeon	Anas americana	
BIRD	raptor	Bald eagle	Haliaeetus leucocephalus	S/F/E/T
BIRD	shorebird	Black-bellied plover	Pluvialis squatarola	
BIRD	wading	Black-crowned night-heron	Nycticorax nycticorax	
BIRD	waterfowl	Blue-winged teal	Anas discors	
BIRD	waterfowl	Bufflehead	Bucephala albeola	
BIRD	waterfowl	Canada goose	Branta canadensis	
BIRD	waterfowl	Canvasback	Aythya valisineria	
BIRD	waterfowl	Common goldeneye	Bucephala clangula	
BIRD	diving	Common loon	Gavia immer	S/T
BIRD	waterfowl	Common merganser	Mergus merganser	
BIRD	diving	Double-crested cormorant	Phalacrocorax auritus	
BIRD	waterfowl	Gadwall	Anas strepera	
BIRD	wading	Glossy ibis	Plegadis falcinellus	
BIRD	gull_tern	Great black-backed gull	Larus marinus	
BIRD	wading	Great blue heron	Ardea herodias	
BIRD	wading	Great egret	Ardea alba	
BIRD	waterfowl	Greater scaup	Aythya marila	

When specifying the file name to use for the output, you can choose a unique name, or choose an existing text file. In that case you will see the following message:



At times, it may be appropriate to append additional records to an existing file. For example, if you want to summarize different layers within a specified area, or if you want to export a series of seasonalities from the same layer, keeping that output together in the same file may be useful. You can enter identifying information in the text box on the startup dialog.

Option 3 allows you to export a summary of the selected ESI lines. Below is an example showing the selected shoreline within the Great Bay area, and the summary report that is generated.



```
*ESI Type:      Length in meters
6A: Gravel beaches: 5866
8A: Sheltered scarps in bedrock, mud or clay: 1289
8B: Sheltered, solid man-made structures: 44
8C: Sheltered riprap: 77
9A: Sheltered tidal flats: 7998
10A: Salt- and brackish-water marshes: 6880
*Total length of selected shoreline: 10490

*These shoreline descriptors represent the standardized Estuarine definitions found in the ESI Guidelines. Please compare with the shoreline values for your area found in the atlas specific metadata and modify as necessary,

**The sum of the lengths of the shoreline types may, and likely will, be greater than the total length of selected shoreline. This is because some shoreline segments represent multiple shoreline types. As an example, if a 10 meter shoreline segment has an esi type of 10A/1C, that ten meters will be added both to the sum of the 10A segments and the sum of the 1C segments but will be counted only once in the overall shoreline length.
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The summary includes an explanation about ESI lines with multiple shoreline types are calculated, and how that differs from the overall shoreline calculation. In this case that value is simply the summation of the lengths of each of the selected ESI lines.

Appendix A

Sample output from the Seasonal Summary tool

Great Bay National Wildlife Refuge
New Hampshire - 2004

Species of particular concern present April-May

BIRD	diving	Common loon	State threatened
BIRD	diving	Pied-billed grebe	State endangered; Nesting APR-OCT
BIRD	raptor	Bald eagle	State endangered; Federally threatened
BIRD	raptor	Osprey	State threatened; Nesting APR-OCT
BIRD	raptor	Peregrine falcon	State endangered
BIRD	shorebird	Black-bellied plover	Laying JUL-MAY*
BIRD	shorebird	Greater yellowlegs	Laying JUL-MAY*
BIRD	shorebird	Least sandpiper	Laying JUL-MAY*
BIRD	shorebird	Lesser yellowlegs	Laying JUL-MAY*
BIRD	shorebird	Semipalmated plover	Laying JUL-MAY*
BIRD	shorebird	Semipalmated sandpiper	Laying JUL-MAY*
BIRD	shorebird	Short-billed dowitcher	Laying JUL-MAY*
BIRD	wading	Least bittern	Nesting MAY-SEP
BIRD	wading	Virginia rail	Nesting MAY-AUG
BIRD	waterfowl	American black duck	Nesting APR-AUG
BIRD	waterfowl	Canada goose	Nesting APR-AUG
BIRD	waterfowl	Mallard	Nesting APR-AUG
BIRD	waterfowl	Wood duck	Nesting OCT-OCT
FISH	diadromous	Alewife	Juvenile APR-DEC; Adults APR-JUL
FISH	diadromous	American eel	Adults MAR-OCT
FISH	diadromous	American shad	Juvenile JUL-FEB; Adults MAY-JUL
FISH	diadromous	Atlantic salmon	Juvenile JAN-DEC; Adults MAY-MAR
FISH	diadromous	Blueback herring	Juvenile JAN-DEC; Adults JAN-DEC
FISH	diadromous	Ninespine stickleback	Spawning MAY-JUL; Eggs MAY-JUL; Larvae MAY-JUL; Juvenile JAN-DEC; Adults JAN-DEC
FISH	diadromous	Sea lamprey	Juvenile APR-DEC; Adults APR-JUL
FISH	diadromous	Striped bass	Juvenile JAN-DEC; Adults JAN-DEC
FISH	e_nursery	Smooth flounder	Juvenile JAN-DEC; Adults JAN-DEC
FISH	e_nursery	White perch	Spawning APR-JUN; Eggs APR-JUN; Larvae APR-JUN; Juvenile JAN-DEC; Adults JAN-DEC
FISH	e_nursery	Windowpane flounder	Juvenile JAN-DEC; Adults JAN-DEC
FISH	e_nursery	Winter flounder	Spawning FEB-MAY; Juvenile JAN-DEC; Adults JAN-DEC
FISH	e_resident	Atlantic silverside	Spawning APR-JUN; Eggs APR-JUN; Larvae APR-JUL; Juvenile APR-DEC; Adults JAN-DEC
FISH	e_resident	Fourspine stickleback	Spawning APR-JUN; Eggs APR-JUN; Larvae APR-JUN; Juvenile JAN-DEC; Adults JAN-DEC
FISH	e_resident	Grubby	Spawning DEC-MAR; Eggs DEC-APR; Larvae JAN-JUN; Juvenile JAN-DEC; Adults JAN-DEC
FISH	e_resident	Mummichog	Spawning JUN-AUG; Eggs JUN-AUG; Larvae JUN-SEP; Juvenile JAN-DEC; Adults JAN-DEC
FISH	e_resident	Northern pipefish	Spawning APR-AUG; Larvae APR-OCT; Juvenile JAN-DEC; Adults JAN-DEC
FISH	e_resident	Striped killifish	Spawning JUN-AUG; Eggs JUN-AUG; Larvae JUN-SEP; Juvenile JAN-DEC; Adults JAN-DEC
FISH	e_resident	Threespine stickleback	Spawning MAY-AUG; Eggs MAY-AUG; Larvae MAY-AUG; Juvenile JAN-DEC; Adults JAN-DEC
FISH	freshwater	Rainbow smelt	Juvenile MAR-SEP; Adults OCT-APR
FISH	m_benthic	American sand lance	Larvae DEC-JUN; Juvenile MAR-NOV; Adults MAR-NOV
FISH	m_benthic	Atlantic tomcod	Spawning DEC-FEB; Juvenile JAN-DEC; Adults JAN-DEC
FISH	m_benthic	Cunner	Spawning MAR-AUG; Eggs MAR-AUG; Larvae MAR-SEP; Juvenile JAN-DEC; Adults JAN-DEC

FISH m_benthic Longhorn sculpin Spawning DEC-APR; Eggs DEC-APR; Larvae JAN-JUN;
 Juvenile JAN-DEC; Adults JAN-DEC
 FISH m_benthic Pollock Eggs NOV-FEB; Larvae NOV-MAR; Juvenile JAN-DEC
 FISH m_benthic Red hake Eggs JUN-OCT; Larvae JUN-OCT; Juvenile MAY-NOV; Adults
 MAY-NOV
 FISH m_benthic Rock gunnel Spawning DEC-MAR; Eggs DEC-APR; Larvae JAN-MAY; Juvenile
 JAN-DEC; Adults JAN-DEC
 FISH m_benthic Skates Juvenile JAN-DEC; Adults JAN-DEC
 FISH m_benthic White hake Eggs JUL-OCT; Larvae JUL-OCT; Juvenile MAY-NOV; Adults
 MAY-NOV
 FISH m_pelagic Atlantic mackerel Juvenile MAY-OCT; Adults MAY-OCT
 INVERT bivalve Atlantic jackknife clam Juvenile JAN-DEC; Adults JAN-DEC
 INVERT bivalve Eastern oyster Spawning JUN-AUG; Eggs JUN-AUG; Larvae JUN-
 AUG; Juvenile JAN-DEC; Adults JAN-DEC
 INVERT bivalve Softshell clam Spawning MAY-OCT; Eggs MAY-OCT; Larvae MAY-
 OCT; Juvenile JAN-DEC; Adults JAN-DEC
 INVERT crab Horseshoe crab Spawning MAY-JUL; Eggs MAY-JUL; Juvenile JAN-DEC;
 Adults JAN-DEC
 INVERT lobster American lobster Spawning JUN-OCT; Eggs JUN-OCT; Larvae JUN-
 OCT; Juvenile JAN-DEC; Adults MAY-NOV
 INVERT shrimp Daggerblade grass shrimp Juvenile JAN-DEC; Adults JAN-DEC
 INVERT shrimp Sevenspine bay shrimp Juvenile JAN-DEC; Adults JAN-DEC

Additional species present in area: Double-crested cormorant, Great black-backed gull,
 Herring gull, Solitary sandpiper, Spotted sandpiper, American bittern, Black-crowned
 night-heron, Glossy ibis, Great blue heron, Green heron, Snowy egret, Sora, American
 wigeon, Blue-winged teal, Bufflehead, Canvasback, Common goldeneye, Common merganser,
 Gadwall, Greater scaup, Green-winged teal, Hooded merganser, Northern pintail, Red-
 breasted merganser, Ring-necked duck, Scoters, Atlantic menhaden, Bluefish, Eelgrass,
 Beaver, Muskrat, Northern river otter

HISTORICAL SITE MARGESON, RICHMAN, ESTATE
 WELL PEASE DEVELOPMENT AUTHORITY
 WILDLIFE REFUGE GREAT BAY NATIONAL WILDLIFE REFUGE JIMMIE REYNOLDS 603/431-7511

ESI Polygon Type Area in square meters
 9A: Sheltered tidal flats 486,194
 10A: Salt- and brackish-water marshes 103,672
 10D: Scrub-shrub wetlands 19,958

ESI Line Type Length in meters Percentage of ESI Shoreline
 6A: Gravel beaches 4,216 51
 8A: Sheltered scarps in bedrock, mud or clay 1,104 13
 9A: Sheltered tidal flats 6,183 76
 10A: Salt- and brackish-water marshes 4,692 57
 *Total ESI shoreline length: 8,129

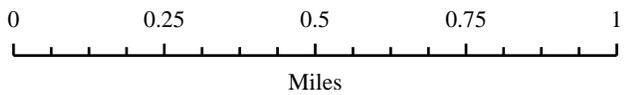
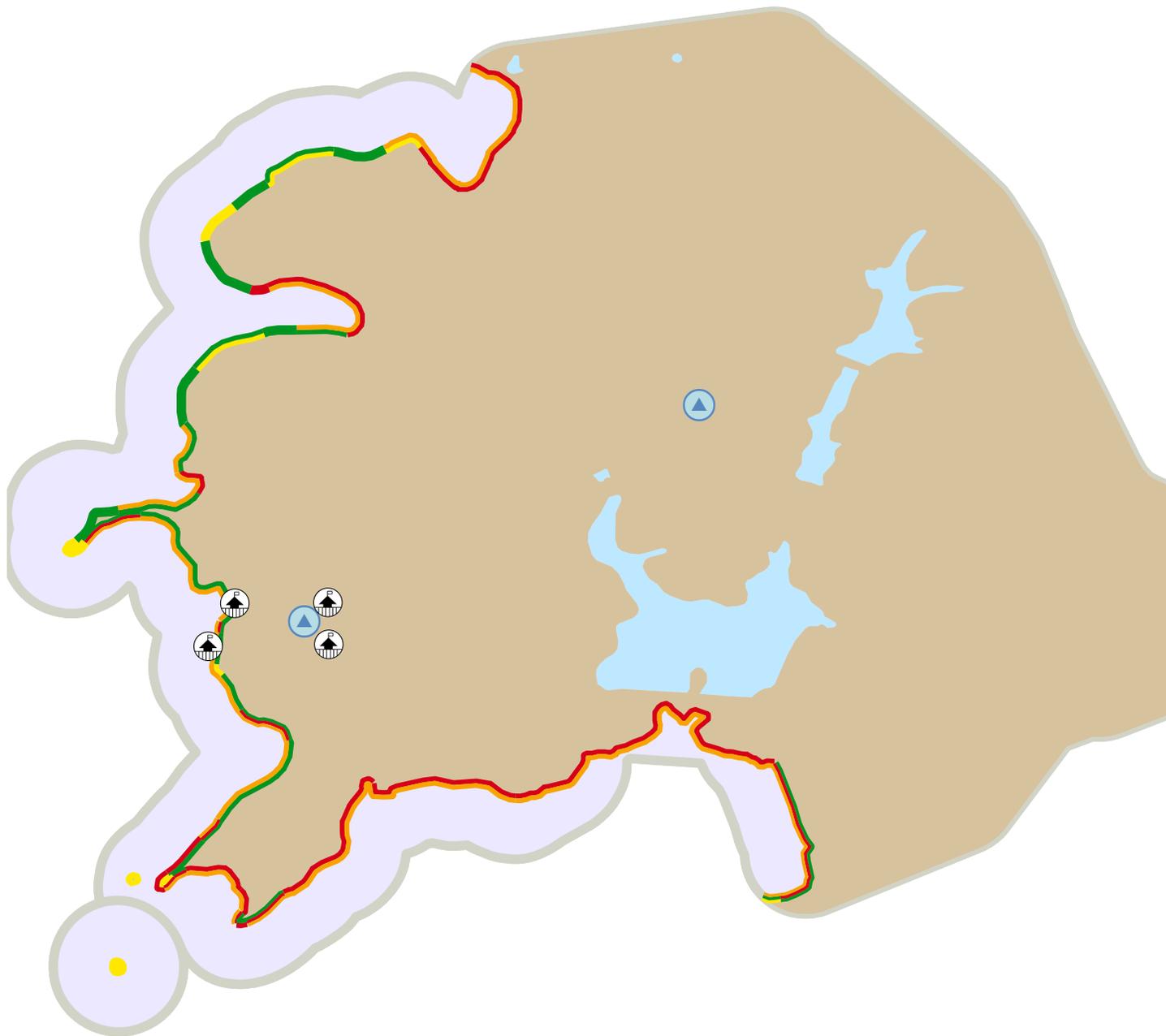
Approximate shoreline length: 8,130 meters

Appendix B

A sample ESI summary map

Great Bay National Wildlife Refuge

April-May Seasonal Environmental Sensitivity Map



Legend (More details on back of map)

<p>Species Present in Area</p>	<p>Shoreline Types on Map</p> <ul style="list-style-type: none"> 10A Salt- and brackish-water marshes 9A Sheltered tidal flats 8A Sheltered scarps in bedrock, mud or clay 6A Gravel beaches 	<p>Content from New Hampshire - 2004</p>
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Great Bay National Wildlife Refuge

Biological Resources (Species Of Particular Concern Present April-may)

Birds 	
 Diving	Common loon (<i>State threatened</i>); Pied-billed grebe (<i>State endangered; Nesting Apr-Oct</i>)
 Raptor	Bald eagle (<i>State endangered; Federally threatened</i>); Osprey (<i>State threatened; Nesting Apr-Oct</i>); Peregrine falcon (<i>State endangered</i>)
 Shorebird	Black-bellied plover (<i>Laying Jul-May*</i>); Greater yellowlegs (<i>Laying Jul-May*</i>); Least sandpiper (<i>Laying Jul-May*</i>); Lesser yellowlegs (<i>Laying Jul-May*</i>); Semipalmated plover (<i>Laying Jul-May*</i>); Semipalmated sandpiper (<i>Laying Jul-May*</i>); Short-billed dowitcher (<i>Laying Jul-May*</i>)
 Wading	Least bittern (<i>Nesting May-Sep</i>); Virginia rail (<i>Nesting May-Aug</i>)
 Waterfowl	American black duck (<i>Nesting Apr-Aug</i>); Canada goose (<i>Nesting Apr-Aug</i>); Mallard (<i>Nesting Apr-Aug</i>); Wood duck (<i>Nesting Oct-Oct</i>)
Fish 	
 Diadromous	Alewife (<i>Juvenile Apr-Dec; Adults Apr-Jul</i>); American eel (<i>Adults Mar-Oct</i>); American shad (<i>Juvenile Jul-Feb; Adults May-Jul</i>); Atlantic salmon (<i>Juvenile Jan-Dec; Adults May-Mar</i>); Blueback herring (<i>Juvenile Jan-Dec; Adults Jan-Dec</i>); Ninespine stickleback (<i>Spawning May-Jul; Eggs May-Jul; Larvae May-Jul; Juvenile Jan-Dec; Adults Jan-Dec</i>); Sea lamprey (<i>Juvenile Apr-Dec; Adults Apr-Jul</i>); Striped bass (<i>Juvenile Jan-Dec; Adults Jan-Dec</i>)
 Estuarine Nursery	Smooth flounder (<i>Juvenile Jan-Dec; Adults Jan-Dec</i>); White perch (<i>Spawning Apr-Jun; Eggs Apr-Jun; Larvae Apr-Jun; Juvenile Jan-Dec; Adults Jan-Dec</i>); Windowpane flounder (<i>Juvenile Jan-Dec; Adults Jan-Dec</i>); Winter flounder (<i>Spawning Feb-May; Juvenile Jan-Dec; Adults Jan-Dec</i>)
 Estuarine Resident	Atlantic silverside (<i>Spawning Apr-Jun; Eggs Apr-Jun; Larvae Apr-Jul; Juvenile Apr-Dec; Adults Jan-Dec</i>); Fourspine stickleback (<i>Spawning Apr-Jun; Eggs Apr-Jun; Larvae Apr-Jun; Juvenile Jan-Dec; Adults Jan-Dec</i>); Grubby (<i>Spawning Dec-Mar; Eggs Dec-Apr; Larvae Jan-Jun; Juvenile Jan-Dec; Adults Jan-Dec</i>); Mummichog (<i>Spawning Jun-Aug; Eggs Jun-Aug; Larvae Jun-Sep; Juvenile Jan-Dec; Adults Jan-Dec</i>); Northern pipefish (<i>Spawning Apr-Aug; Larvae Apr-Oct; Juvenile Jan-Dec; Adults Jan-Dec</i>); Striped killifish (<i>Spawning Jun-Aug; Eggs Jun-Aug; Larvae Jun-Sep; Juvenile Jan-Dec; Adults Jan-Dec</i>); Threespine stickleback (<i>Spawning May-Aug; Eggs May-Aug; Larvae May-Aug; Juvenile Jan-Dec; Adults Jan-Dec</i>)
 Freshwater	Rainbow smelt (<i>Juvenile Mar-Sep; Adults Oct-Apr</i>)
 Marine Benthic	American sand lance (<i>Larvae Dec-Jun; Juvenile Mar-Nov; Adults Mar-Nov</i>); Atlantic tomcod (<i>Spawning Dec-Feb; Juvenile Jan-Dec; Adults Jan-Dec</i>); Cunner (<i>Spawning Mar-Aug; Eggs Mar-Aug; Larvae Mar-Sep; Juvenile Jan-Dec; Adults Jan-Dec</i>); Longhorn sculpin (<i>Spawning Dec-Apr; Eggs Dec-Apr; Larvae Jan-Jun; Juvenile Jan-Dec; Adults Jan-Dec</i>); Pollock (<i>Eggs Nov-Feb; Larvae Nov-Mar; Juvenile Jan-Dec</i>); Red hake (<i>Eggs Jun-Oct; Larvae Jun-Oct; Juvenile May-Nov; Adults May-Nov</i>); Rock gunnel (<i>Spawning Dec-Mar; Eggs Dec-Apr; Larvae Jan-May; Juvenile Jan-Dec; Adults Jan-Dec</i>); Skates (<i>Juvenile Jan-Dec; Adults Jan-Dec</i>); White hake (<i>Eggs Jul-Oct; Larvae Jul-Oct; Juvenile May-Nov; Adults May-Nov</i>)
 Marine Pelagic	Atlantic mackerel (<i>Juvenile May-Oct; Adults May-Oct</i>)
Shellfish 	
 Bivalve	Atlantic jackknife clam (<i>Juvenile Jan-Dec; Adults Jan-Dec</i>); Eastern oyster (<i>Spawning Jun-Aug; Eggs Jun-Aug; Larvae Jun-Aug; Juvenile Jan-Dec; Adults Jan-Dec</i>); Softshell clam (<i>Spawning May-Oct; Eggs May-Oct; Larvae May-Oct; Juvenile Jan-Dec; Adults Jan-Dec</i>)
 Crab	Horseshoe crab (<i>Spawning May-Jul; Eggs May-Jul; Juvenile Jan-Dec; Adults Jan-Dec</i>)
 Lobster	American lobster (<i>Spawning Jun-Oct; Eggs Jun-Oct; Larvae Jun-Oct; Juvenile Jan-Dec; Adults May-Nov</i>)
 Shrimp	Daggerblade grass shrimp (<i>Juvenile Jan-Dec; Adults Jan-Dec</i>); Sevenspine bay shrimp (<i>Juvenile Jan-Dec; Adults Jan-Dec</i>)

(*) = This life stage occurs during the months listed, but not continuously.

Additional Species (No Life Stage Noted, but Present April-may)
Double-crested cormorant; Great black-backed gull; Herring gull; Solitary sandpiper; Spotted sandpiper; American bittern; Black-crowned night-heron; Glossy ibis; Great blue heron; Green heron; Snowy egret; Sora; American wigeon; Blue-winged teal; Bufflehead; Canvasback; Common goldeneye; Common merganser; Gadwall; Greater scaup; Green-winged teal; Hooded merganser; Northern pintail; Red-breasted merganser; Ring-necked duck; Scoters; Atlantic menhaden; Bluefish; Eelgrass; Beaver; Muskrat; Northern river otter

Great Bay National Wildlife Refuge (continued)

Socioeconomic Resources

Icon	Type	Name	Contact	Phone
	Historical Site	Margeson, Richman, Estate		
	Well	Pease Development Authori		
	Wildlife Refuge	Great Bay National Wildlife Refuge	JIMMIE REYNOLDS	603/431-7511

ESI Polygon Habitats

Pattern	ESI Rank	Habitat	Area (meters ²)
	10A	Salt- and brackish-water marshes	103,672
	10D	Scrub-shrub wetlands	19,958
	9A	Sheltered tidal flats	486,194

Shoreline Types (Length of ESI Shoreline on Map = 8,129 meters; Length of Shoreline on Map = 8,130 meters)

Color	ESI Rank	Shoreline Habitat	Length (meters)	% of ESI Shoreline
	10A	Salt- and brackish-water marshes	4,692	57
	9A	Sheltered tidal flats	6,183	76
	8A	Sheltered scarps in bedrock, mud or clay	1,104	13
	6A	Gravel beaches	4,216	51

Note: A shoreline segment may include multiple shoreline habitats. If any segments include multiple habitats, the combined length of all habitats will exceed the length of the mapped ESI shoreline, and the percent of ESI shoreline values will sum to greater than 100%.

