Assessment of Existing Information on Atlantic Coastal Fish Habitats: Development of a web-based spatial bibliography, query tools, and data summaries

NOAA/NOS National Centers for Coastal Ocean Science
Center for Coastal Monitoring and Assessment
Biogeography Branch

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NOAA Technical Memorandum NOS NCCOS 103

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EXECUTIVE SUMMARY

The primary objective of this project, "the *Assessment of Existing Information on Atlantic Coastal Fish Habitat*", is to inform conservation planning for the Atlantic Coastal Fish Habitat Partnership (ACFHP). ACFHP is recognized as a Partnership by the National Fish Habitat Action Plan (NFHAP), whose overall mission is to protect, restore, and enhance the nation's fish and aquatic communities through partnerships that foster fish habitat conservation.

This project is a cooperative effort of NOAA/NOS Center for Coastal Monitoring and Assessment (CCMA) Biogeography Branch and ACFHP. The Assessment includes three components; 1. a representative bibliographic and assessment database, 2. a Geographical Information System (GIS) spatial framework, and 3. a summary document with description of methods, analyses of habitat assessment information, and recommendations for further work.

The spatial bibliography was created by linking the bibliographic table developed in *Microsoft Excel* and exported to *SQL Server*, with the spatial framework developed in *ArcGIS* and exported to *GoogleMaps*. The bibliography is a comprehensive, searchable database of over 500 selected documents and data sources on Atlantic coastal fish species and habitats. Key information captured for each entry includes basic bibliographic data, spatial footprint (e.g. waterbody or watershed), species and habitats covered, and electronic availability. Information on habitat condition indicators, threats, and conservation recommendations are extracted from each entry and recorded in a separate linked table.

The spatial framework is a functional digital map based on polygon layers of watersheds, estuarine and marine waterbodies derived from NOAA's Coastal Assessment Framework, MMS/NOAA's Multipurpose Marine Cadastre, and other sources, providing spatial reference for all of the documents cited in the bibliography.

Together, the bibliography and assessment tables and their spatial framework provide a powerful tool to query and assess available information through a publicly available web interface. They were designed to support the development of priorities for ACFHP's conservation efforts within a geographic area extending from Maine to Florida, and from coastal watersheds seaward to the edge of the continental shelf. The Atlantic Coastal Fish Habitat Partnership has made initial use of the *Assessment of Existing Information*. Though it has not yet applied the AEI in a systematic or structured manner, it expects to find further uses as the draft conservation strategic plan is refined, and as regional action plans are developed. It also provides a means to move beyond an "*assessment of existing information*" towards an "*assessment of fish habitat*", and is being applied towards the National Fish Habitat Action Plan (NFHAP) 2010 Assessment. Beyond the scope of the current project, there may be application to broader initiatives such as Integrated Ecosystem Assessments (IEAs), Ecosystem Based Management (EBM), and Marine Spatial Planning (MSP).

INTRODUCTION

The National Fish Habitat Action Plan (NFHAP) was launched in 2006 with the mission to protect, restore, and enhance the nation's fish and aquatic communities through partnerships that foster fish habitat conservation (AFWA 2006). On the regional scale, several partnerships have been launched, with participation from federal and state agencies, non-governmental organizations, and local citizens, including the *Atlantic Coastal Fish Habitat Partnership* (ACFHP), recognized as a Partnership by the NFHAP Board (NFHAP 2009). Synthesis of existing information into a comprehensive and useable database and synoptic document has been identified as a crucial need at both the national and regional levels.

The goal of this project is to assist the Atlantic Coastal Fish Habitat Partnership (ACFHP) in developing a strategy to conserve, protect, restore, and enhance aquatic habitats along the U.S. Atlantic Coast from Maine to Florida. To meet this goal, this project has developed and delivered a comprehensive database of Atlantic coastal habitat condition indicators, threats and stressors, as well as conservation actions and recommendations. This database is presented as a web-based tool to inform conservation planning by the Partnership. This report describes the development of the database and web-based tool, and summarizes results derived from information compiled on indicators, threats, and conservation actions. This Assessment of Existing Information (AEI) has three components:

Database: A comprehensive database of bibliographic and assessment information, developed in Microsoft Excel and exported to other applications (SQL Server). Bibliographic information and spatial footprint are recorded for each entry, and relevant assessment information is extracted and recorded in a separate linked table. The database is served via the web with a user query interface developed in ASP.net.

GIS: An ArcGIS project using NOAA's Coastal Assessment Framework and MMS/NOAA's Multipurpose Marine Cadastre provided a starting point for spatial organization of information. The base layer of watershed and waterbody polygons and their centroid points was exported to GoogleMaps for web development. Indicator data were imported back into ArcGIS for analysis and display together with the polygon base layer.

Document: A project summary report, with a narrative description of the project, analyses of habitat assessment information, and recommendations for further work

The *Spatial Bibliography* approach provides a powerful means of organizing existing information by placing it within a geographic context, while tracking it back to its original source. Standard bibliographies may include place names as keywords, but this approach tags each reference to a specific place within a defined spatial framework. Most standard bibliographic search engines are limited to either library holdings or to peer-reviewed literature, but this approach allows the addition of "gray literature" or other lesser-known sources that would otherwise not be found by a standard literature search. Spatial bibliographies have proven useful in previous literature reviews of biological information for the Main Hawaiian Islands (Coleman et al. 2002), Southern

California Coastal Waters (SDNP 2003), and the Northwestern Hawaiian Islands (Taylor and Nelson 2006, PMNM 2009). The *ACFHP Assessment of Existing Information* takes the additional step of extracting policy-relevant information on habitat condition indicators, threats, and conservation actions from the assembled literature, and compiling it within the same spatial framework. This added value provides a means to move beyond an "*assessment of existing information*" towards an "*assessment of fish habitat*", and may be useful in broader initiatives such as Integrated Ecosystem Assessments (IEAs), Ecosystem Based Management (EBM), and Marine Spatial Planning (MSP).

THE WORK PLAN

The original work plan, completed in August 2008 (NOAA/CCMA 2008) outlined a series of objectives and tasks following an aggressive timeline.

Objectives to achieve this project's goal include:

1. With guidance from ACFHP, craft a work plan with specific tasks and "deliverables" that can be feasibly completed by January 2009.

2. Using the best available search methods, assemble a comprehensive bibliography of existing information on Atlantic Coast habitats and species.

3. Using the best available bibliographic methods, design and create a useable database to capture all of the compiled information.

4. Develop the database as a "spatial bibliography" by linking the spatial footprint of each entry with a suitable framework in ArcGIS.

5. Through close coordination with ACFHP, develop a set of topics and questions which can be analyzed using the database.

6. Communicate results in a timely manner to ACFHP and NFHAP through written reporting, oral presentation, and live demonstration.

7. To the extent possible, collect publicly-available versions of the entries (.pdf, database, GIS, and metadata files) to develop an electronic library.

8. Explore the feasibility of future work such as deploying the Assessment Database with web-based platforms such as ArcIMS or SQL Server.

Six specific tasks were identified to achieve these objectives:

Task I. Database Development

Create a comprehensive, searchable, bibliographic database of selected documents, data sets, and analyses – including spatial and tabular data – relevant to the ACFHP priority habitats. Example database components include relevant species and associated habitats, identified threats, recommendations, and partners.

Task II. Cooperatively Develop Assessment Criteria

Work with the ACFHP Assessment Subgroup and ACFHP Coordinator to develop and apply objective criteria for the summary and analysis of habitat status, threat type and severity, conservation goals, and existing strategies to be applied in assessment analyses.

Task III. Develop spatial framework in a Geographical Information System

Develop a map of priority habitats across the range of ACFHP, and a map of ACFHP project sites.

Task IV. Apply spatial analysis to habitat assessment criteria

Conduct a spatial analysis of the status of priority habitats, the distribution and severity of threats to priority habitats, and the spatial distribution of existing conservation plan (i.e., protection, restoration, and enhancement) implementation.

Task V. Identify data gaps

Identify, assess, and map appropriate gaps in knowledge and actions represented in this existing set of information that relate to types and occurrences of habitats, threats, goals, and strategies to support the identification of conservation priorities across the Atlantic coast.

Task VI. Deliver final report and useable data base

Compile a final report with a complete bibliography and electronic examples of references, base maps, the Microsoft Access database, and ESRI compatible GIS layers based on occurrences of priority habitats, key threats, and current conservation strategies across the ACFHP region. In addition, document trends and data gaps found in the assessment of existing information.

Revisions to the Work Plan

Since the project began in the summer of 2008, the work plan has evolved, with some course corrections and valuable lessons learned along the way:

1. An October 2008 meeting of the ACFHP Steering Committee in Rehoboth, Delaware, generally concurred that the database itself would have more utility as a web application than as a desktop module. In addition, it would be not much more difficult to develop as a web application in SQL Server than in Microsoft Access. Availability via the web would make updates and maintenance of the database itself easier to distribute.

2. The GIS base layer was developed in ArcGIS, but then exported as a KML file to GoogleMaps for web development. GoogleMaps is freely available to any user via the internet, whereas GoogleEarth requires a user to install the application on their computer.

3. The project team recognized that capturing assessment information must be on a per-waterbody basis, not on a per-document basis, so the team designed and

built a separate table for “assessment information as reported”. In addition, we realized that “assessment information as reported” doesn’t readily fit into predetermined assessment indices of habitat condition.

4. Although the collection of disparate raw data sets and GIS layers was beyond the original scope of the project, the team acquired several processed data sets on water quality, contaminant, and habitat condition indicators which directly contributed to the table of assessment information.

5. Some tasks, especially the development of a robust bibliographic table, and extraction of assessment information, took longer than expected to reach a workable state. The original six-month timeline may have been unrealistic to complete all of the tasks as originally conceived.

6. The bibliography of 500+ references is robust and representative, but by no means exhaustive. It is recognized that there are documents and information sources that were not captured, and that new information sources are being continually published.

DATABASE DEVELOPMENT

Tasks necessary to develop the database were:

1. Identify relevant documents and data sources, and record bibliographic information and “spatial footprint” within a robust bibliographic table.

2. Extract information on indicators, threats, and actions from source documents, and record in a separate assessment table

3. Develop GIS base layers to serve as a geospatial framework for organizing the bibliographic and assessment information.

4. Link the bibliographic, assessment, and geospatial tables via appropriate common fields, creating “many-to-many relationship” sub-tables as needed.

5. Develop a web interface for querying the database and displaying results.

6. Develop metadata to describe the database content for interested users.

Each of these tasks is described in more detail below.

Bibliographic Information

The bibliographic database table was developed to a fully functional state in May 2009, with records completed for 527 reference documents and data sources. Useful reference documents were suggested by the ACFHP Steering Committee, in addition to other known documents and data sources with relevant information – e.g. recent synoptic assessment documents from National Estuary Programs, National Estuarine

Research Reserves, State Wildlife Action Plans, stressor-specific assessments (eutrophication, contaminants), online data portals and IMS sites, etc.

These sources were tagged to their "spatial footprint" by region, state, and waterbody (e.g. estuary and/or watershed). Relevant habitat types (e.g. wetlands, SAV) and fish species considered in each document were recorded, and documents which provide information on habitat assessment, threats and stressors, or conservation recommendations were flagged for extraction of pertinent information. The bibliographic database was developed in Microsoft Excel and exported to SQL Server, ASP.net, and GoogleMaps for web development (see GIS discussion below). Table 1 provides a graphic description of the fields within the bibliographic table, color-coded by the type of information captured by each field, with notes on how the bibliographic table is linked to the assessment and geospatial tables.

Table 1. Field names for each entry in the ACFHP Bibliographic Table. Fields are color-coded by the type of information that they capture: yellow = standard bibliographic information, red = electronic availability, dark blue = spatial footprint, and light blue = species and habitat types.

Field Name	Notes
bibID	link to assessment table
Title	
Author(s)	
Year	
Organization	
Type of Document	
Publication Info	
Web Location	"click here" to access website and/or pdf
Filename	not for inclusion on web version
pdf available?	
electronic data available?	
Spatial Data? Rank: (0-1-2; no data-metadata-map)	
ACFHP Region(s)	link to geodatabase
State(s)	link to geodatabase
Waterbody(s)	link to geodatabase and assessment table
Type of Information	
ACFHP Species	link to species info
ACFHP Habitat Types	link to habitat info

Each field in the bibliographic table is described below

bibID – unique identification number for each record. This is also used to link to information sources cited in the Assessment Criteria table.

Title – title of report or information source (text string).

Author(s) – as a text string in standardized format.

Year – publication year of document or data.

Organization – primary organization of lead author or sponsor.

Type of document – journal article, technical report, management plan, etc.

Publication Info – journal information, publisher, etc.

Web location – in web version, a "click here" link is provided to access pdf or website from original source.

Filename – provided in Excel version of table to keep track of documents, but not included in web version.

Electronic and Spatial Data – to find original data sources for further study.

ACFHP Region(s) – North Atlantic, Mid-Atlantic, South Atlantic, and/or South Florida.

State(s) – ME, NH, MA, RI, CT, NY, NJ, PA, DE, MD, DC, VA, NC, SC, GA, FL.

Waterbodies – reported as a unique number, and linked to geospatial table.

Type of Information – type of information included in document or data source. Entries in the bibliographic database were selected because they were relevant to Atlantic coastal fish habitat, and were classified as to the type of information that they contain:

Habitat Assessment – documents which specifically assess the quality or condition of specific habitat parameters, with information on indicators and threats.

Habitat Characterization – descriptive studies of specific habitat types or parameters, or mapping of specific areas.

Habitat Data – online data portals and mapping services which provide necessary raw or processed data for further study.
Species Characterization – field studies or stock assessments of fish or other species, not specifically linked to their habitats.

Species/Habitat Association – life history or quantitative modeling studies which describe the association between species and habitat parameters.

Conservation Plan – documents which recommend actions to manage and conserve species and habitats.

Science Plan – including monitoring, research plans, etc.

Reference – useful reference information, not pertaining to a particular location.

ACFHP Species – common name of a species is recorded if document pertains to them, left blank if the source is not species-specific.

ACFHP Habitat Types – one or more habitat types as identified in previous ACFHP documentation, plus additional classes to capture the water column and terrestrial watershed components of the ACFHP study area:

Shellfish Beds – includes oyster and mussel beds.

Other Sessile Fauna - includes corals, deep corals, and *Sabellaria* beds.

Macroalgae – includes rockweeds and kelp.

Submerged Aquatic Vegetation – SAV, includes seagrasses.

Tidal Vegetation – wetlands.

Coastal Inert Substrate – generally unconsolidated sediment.

Riverine – freshwater above head of tide.

Estuarine Waters – water column within estuaries.

Marine Waters – in State or Federal waters, and not within estuaries.

Watersheds – terrestrial component draining to rivers, estuaries, or ocean.

The 500-plus entries in the bibliography provide a robust base of information on the characterization and assessment of Atlantic coastal fish habitat. In addition, since we have focused on assessment and synthesis documents, and not peer-reviewed scientific journal articles, we have identified many sources of information that would otherwise be missed by a standard bibliographic search. However, the bibliography is by no means exhaustive. There is room for growth with older peer-reviewed and “gray” literature, and with newly published entries.

Assessment Information

Of all of the types of information sources, *Habitat Assessments* and *Conservation Plans* provided the most pertinent information for this project. Documents and sources were carefully reviewed, and policy-relevant habitat assessment information (indicators, threats, and actions) was recorded "as reported" in a separate table, linked via waterbody number and reference number.

Assessment information was captured in a separate table using these fields:

Reference Number : links to bibID in bibliographic table.

Waterbody Number : links to same "uniqueid" in geodatabase (digital map).

Indicator/Threat/Action : information classified as indicator, threat, or action:
Indicator – any measurement or assessment of a relevant parameter.
Threat - anything adversely affecting quality of fish habitat.
Action – any conservation action recommended or already occurring.

Parameter : What is being measured or reported (e.g. "status of eelgrass").

Value : What value is reported for the parameter (e.g. "increasing").

In addition, digital estuarine assessment data were acquired by special request or downloaded from several sources, including:
EPA's National Coastal Conditions Report III (U.S. EPA 2008)
NOAA's National Status and Trends Program (Kimbrough et al. 2008)
NOAA's Eutrophication Project (Bricker et al. 2007)
USGS Coastal Vulnerability Index (Hammar-Klose and Thieler 2001)
NMFS' Impacts to Marine Fisheries Habitat report (Johnson et al. 2008)
These proved to be especially valuable sources of assessment information because they report results at a local spatial scale, but use consistent methods across regions.

To the extent feasible, these data were incorporated directly into the Assessment Table. Table 2 provides a visual subset of indicator, threat, and action information captured "as reported" from several sources for Delaware Bay. In some cases, point data were not aggregated to a spatial scale readily compatible with ACFHP's polygon-based spatial framework. This suggests an opportunity for further work beyond the scope of this immediate project (see *The Way Forward*, p. 33).

Approximately half (258/527) of the sources contributed information to the Assessment Table. This leaves many sources (269) which are included in the Bibliographic Table, but did not contribute information to the Assessment Table primarily because they are reference documents, species characterization, or raw data not readily interpretable as indicators, threats, and conservation recommendations. As of May 31, 2009, the Assessment Table consisted of 4785 rows of information, including 1642 indicators, 1260 threats, and 1869 actions.

Table 2. Subset of assessment information "as reported" for one waterbody (Delaware Bay) from several sources. Information is linked to the bibliographic table via "Reference Number", and to the base map via "Waterbody Number."

Waterbody Name	Reference Number	Waterbody Number	Indicator/Threat/Action	Parameter	Value
Delaware Bay	152	26	indicator	Water Quality Index	1 = Poor
Delaware Bay	143	26	indicator	Overall Eutrophic Condition	moderate
Delaware Bay	143	26	indicator	Chlorophyll a - Overall Expression	high
Delaware Bay	143	26	indicator	Dissolved Oxygen - Overall Expression	low
Delaware Bay	143	26	indicator	Secchi Depth - Overall Expression	high
Delaware Bay	143	26	indicator	Macroalgae - Overall Expression	no problem
Delaware Bay	143	26	indicator	Algal Blooms - Overall Expression	no problem
Delaware Bay	143	26	indicator	Eutrophication - Impact to SAV	no problem
Delaware Bay	143	26	indicator	Eutrophication - Impact to Living Resources	no impact
Delaware Bay	152	26	indicator	Sediment Quality Index	4 = Good/Fair
Delaware Bay	152	26	indicator	Benthic Index	1 = Poor
Delaware Bay	152	26	indicator	Fish Tissue Contaminants Index	1 = Poor
Delaware Bay	152	26	indicator	Dissolved Inorganic Nitrogen (DIN)	Poor
Delaware Bay	152	26	indicator	Dissolved Inorganic Phosphorus (DIP)	Fair
Delaware Bay	152	26	indicator	Chlorophyll a	Fair
Delaware Bay	152	26	indicator	Water Clarity	Fair
Delaware Bay	152	26	indicator	Dissolved Oxygen	Good
Delaware Bay	152	26	indicator	Sediment Toxicity	Poor
Delaware Bay	152	26	indicator	Sediment Contamination	Good
Delaware Bay	152	26	indicator	Sediment Total Organic Carbon (TOC)	Good
Delaware Bay	152	26	indicator	Overall Condition	1.75 = Poor/Fair
Delaware Bay	157	26	indicator	Contaminants - Metals Status in Oysters	Medium
Delaware Bay	157	26	indicator	Contaminants - Metals Trends in Oysters	Stable
Delaware Bay	157	26	indicator	Contaminants - Organics Status in Oysters	Low
Delaware Bay	157	26	indicator	Contaminants - Organics Trends in Oysters	Stable

Geospatial Framework

The GIS base layer was developed in ArcGIS as proposed in the original work plan, and is subdivided into four zones: watersheds, estuaries, nearshore marine, and offshore marine. It is based on NOAA's Coastal Assessment Framework (NOAA 2007), including estuarine waterbodies and their associated watersheds. The Coastal Assessment Framework is a set of digital GIS layers, with lineage back to an earlier data atlas known as the National Estuarine Inventory (NEI) (NOAA 1985). The NEI and CAF further subdivide estuarine waters into salinity zones (tidal fresh, mixing, and seawater), but these subdivisions were not used for the ACFHP spatial framework. The CAF does not extend into marine waters, so the scheme had to be modified to meet ACFHP's purposes.

Note that there are two different types of watersheds designated within the Coastal Assessment Framework. An Estuarine Drainage Area (EDA) is that component of an estuary's entire watershed that empties directly into the estuary and is affected by tides. EDAs may be composed of all or part of a single or several USGS hydrologic units and include all or part of the USGS cataloging unit (HUC-8) containing the most upstream extent of tidal influence (head-of-tide). A Coastal Drainage Area (CDA) is defined as that component of an entire watershed that meets the following three criteria: 1) it is not part of any EDA; 2) it drains directly into an ocean, an estuary, or the Great Lakes; and 3) it is composed only of the downstream-most HUC in which the head-of-tide is found.

In other words, CDAs are land areas that do not drain to a particular estuary, and in some cases are represented as multiple polygons within a state.

Additional polygons were added for both State and Federal marine waters, based on legally-vetted boundary layers in the Multipurpose Marine Cadastre, a joint project of the U.S. Minerals Management Service, NOAA's Coastal Services Center, and other partners (MMS 2008, NOAA/CSC 2008). State waters extend to the 3 nautical mile limit, and Federal waters extend to the 200 nmi Exclusive Economic Zone (EEZ).

Regional breaks were selected at Cape Cod, Cape Hatteras, and Cape Canaveral, creating four regions: North Atlantic, Mid-Atlantic, South Atlantic, and South Florida, consistent with generally accepted biogeographic classifications (Briggs 1974, NOAA 2004, Cook and Auster 2007, Spalding et al. 2007). The estuarine, watershed, and marine polygons were merged into a single polygon layer, 195 polygons in total, preserving their attributes for region, state, zone (watershed, estuarine, marine), and waterbody name. Figure 1 illustrates the overall spatial framework, emphasizing the four zones:

Coastal watersheds - include Estuarine Drainage Areas (EDAs, n=74), and Coastal Drainage Areas (CDAs, n=19), based on USGS HUC-8s.

Estuarine Waterbodies - based on NOAA's Coastal Assessment Framework (n=78).

Nearshore Marine - waters within 3 nmi, using boundaries from MMS/NOAA's Multipurpose Marine Cadastre (n=15).

Offshore Marine – Federal waters of EEZ, separated into four marine biogeographic regions (n=4).

Figures 2, 3, and 4 depict the estuarine, watershed, and marine polygons for the four regions. Along the latitudinal gradient, the study area extends over 2000 miles from Passamaquoddy Bay, Maine, to the Dry Tortugas, Florida. Along the inshore-offshore gradient, it extends from summit-to-sea, "whitewater to blue water", from terrestrial watersheds seaward to the Continental Shelf. Overall, the spatial framework provides a means of organizing information for a vast and diverse region into a finite number of spatial units.

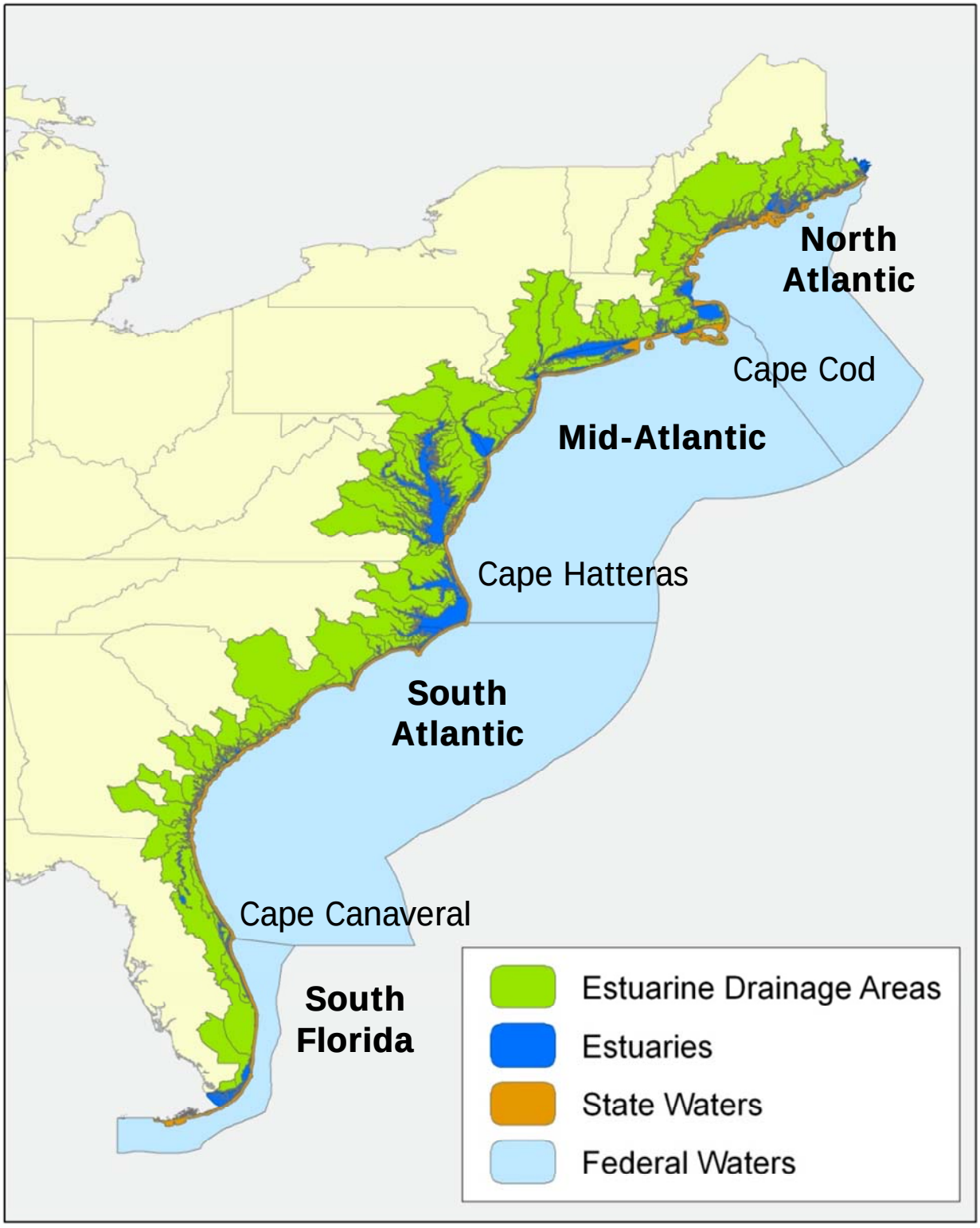


Figure 1. GIS Framework Overview. The "summit-to-sea" study area is divided into four zones: watersheds, estuaries, nearshore, and offshore. Coastal watersheds include both Estuarine Drainage Areas (EDAs) and Coastal Drainage Areas (CDAs) from the Coastal Assessment Framework.

Note that the scale of the spatial framework designates an individual waterbody, rather than a finer-scale habitat classification, as the fundamental spatial unit for organizing information. This is primarily because most of the information sources report indicators, threats, or conservation actions on a per-waterbody basis, e.g. “status of seagrass in Narragansett Bay”. Beyond the scope of this current project, data layers such as salinity zones from the Coastal Assessment Framework and spatial habitat classification schemes such as CMECS (Madden et al. 2008) can be used in a finer scale regional habitat characterization.

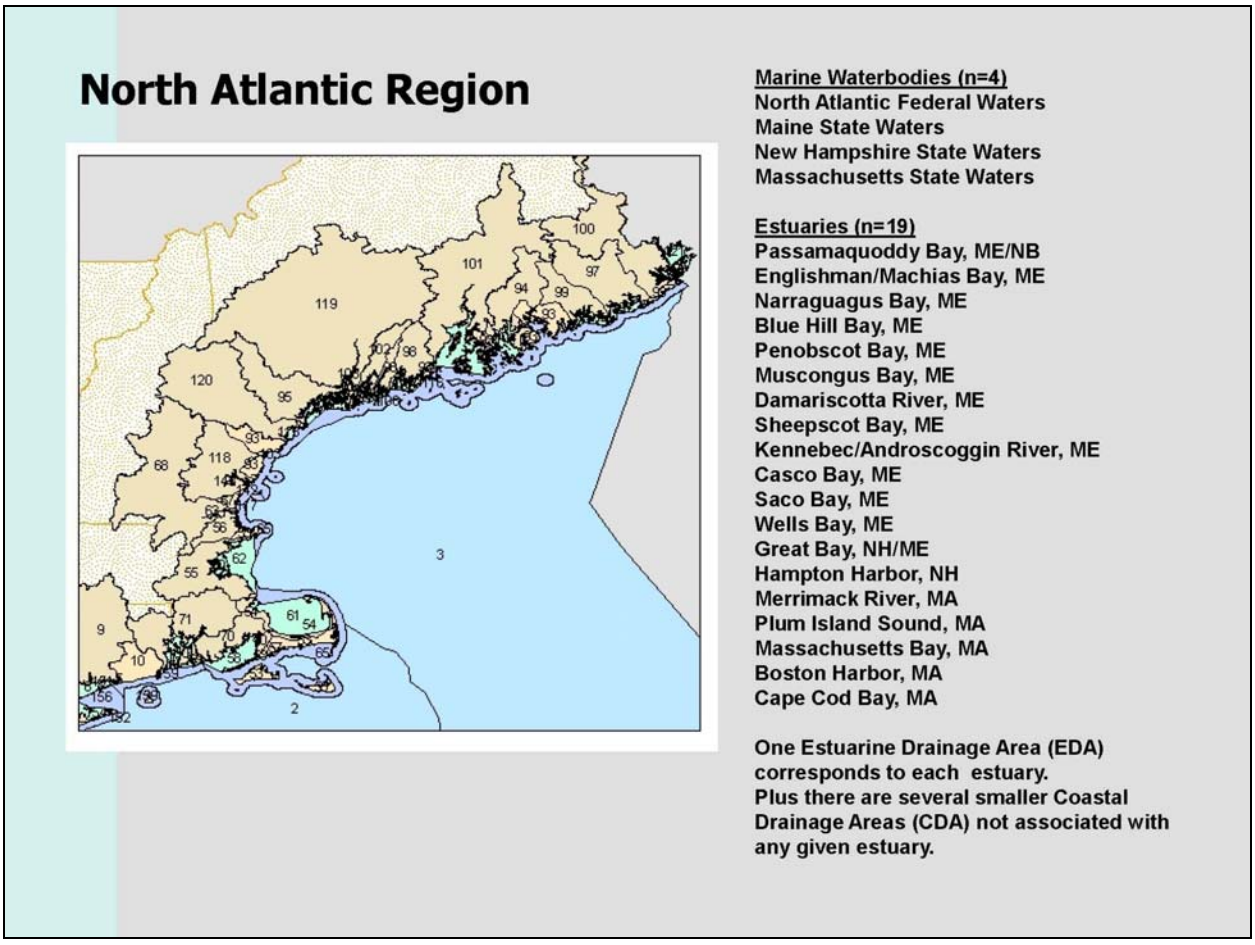


Figure 2. North Atlantic Waterbodies and Watersheds. Polygons are color-coded by zone: tan = watersheds (EDAs or CDAs), greenish blue = estuaries, darker blue = nearshore (state) marine waters, and lighter blue = offshore (federal) marine waters. Note that some large marine embayments such as Cape Cod Bay and Massachusetts Bay are considered “estuaries” for the purposes of the ACFHP spatial framework, and that Passamaquoddy Bay includes Cobscook Bay.

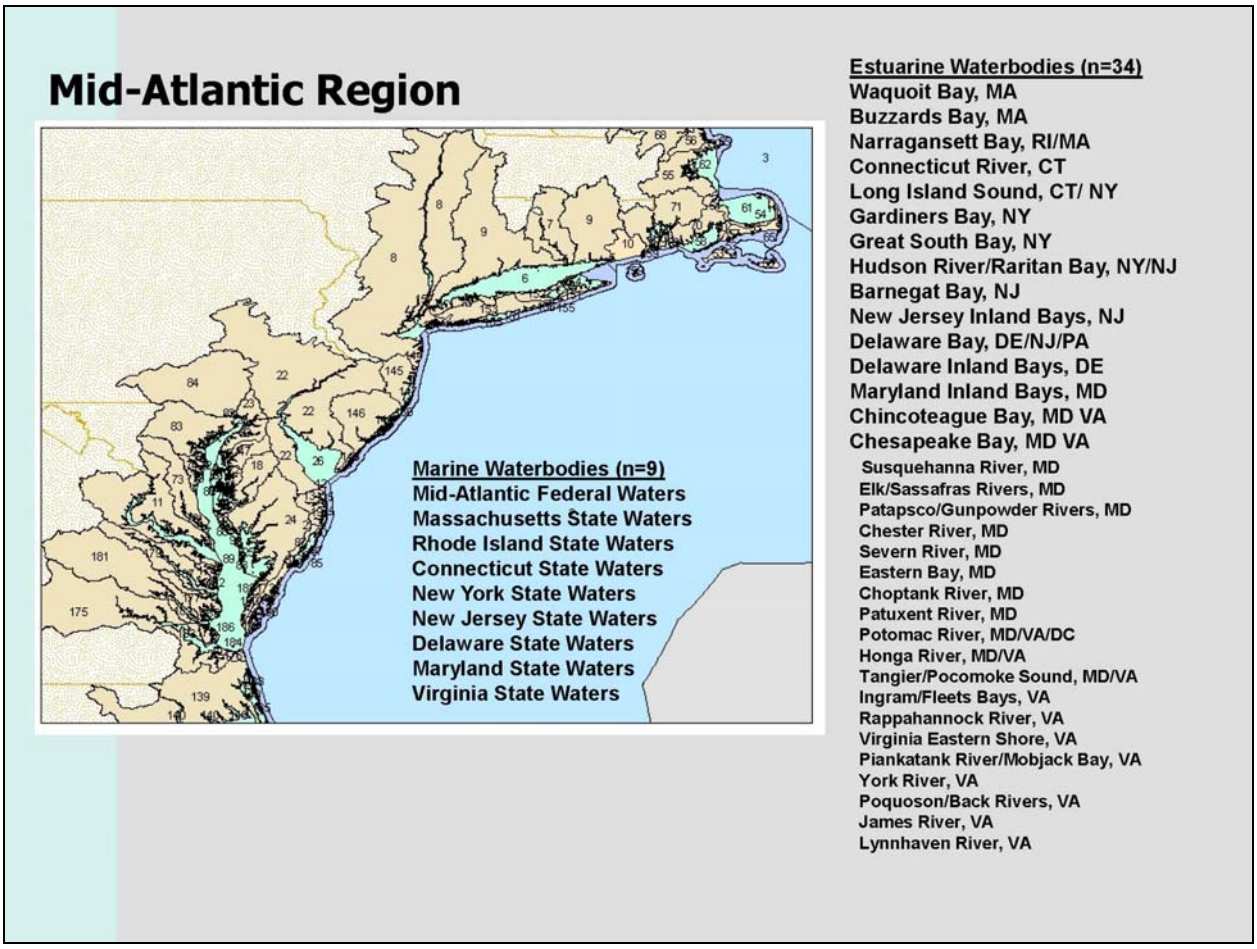


Figure 3. Mid-Atlantic Waterbodies and Watersheds. Polygons are color-coded by zone: tan = watersheds (EDAs or CDAs), greenish blue = estuaries, darker blue = nearshore (state) marine waters, and lighter blue = offshore (federal) marine waters. Chesapeake Bay has been subdivided into 19 sub-estuaries, whereas most other large estuaries are considered single units. Gardiners Bay, NY includes Peconic Bay.

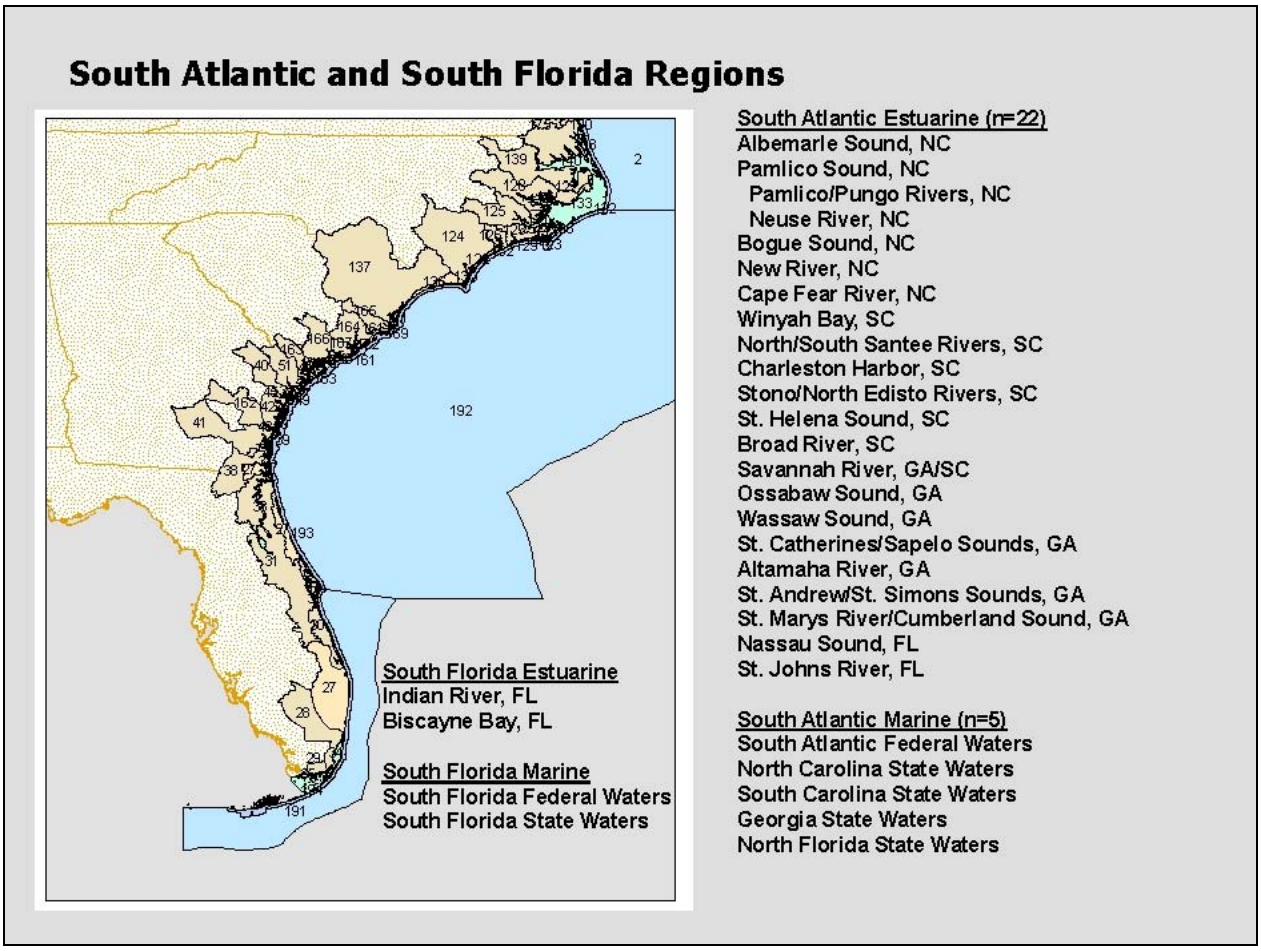


Figure 4. South Atlantic and South Florida Waterbodies and Watersheds. Polygons are color-coded by zone: tan = watersheds (EDAs or CDAs), greenish blue = estuaries, darker blue = nearshore (state) marine waters, and lighter blue = offshore (federal) marine waters. Note that in South Florida, the U.S. Exclusive Economic Zone (EEZ) does not extend to 200 nautical miles, but to a boundary between the adjacent EEZs of the Bahamas and Cuba.

WEB-BASED TOOL DEVELOPMENT

Project Home Page

Figure 15 illustrates a project page entitled *Assessment of Existing Information on Atlantic Coastal Fish Habitats* , launched in October 2008 on CCMA's website at http://ccma.nos.noaa.gov/ecosystems/estuaries/coastalfish.html . This page provides links to the workplan and other products, including the bibliographic, assessment, and spatial queries. This page is descriptive, providing a means to publicize the project, serve pdf documents, such as the original work plan and final report, and direct an interested user to additional sources of information.

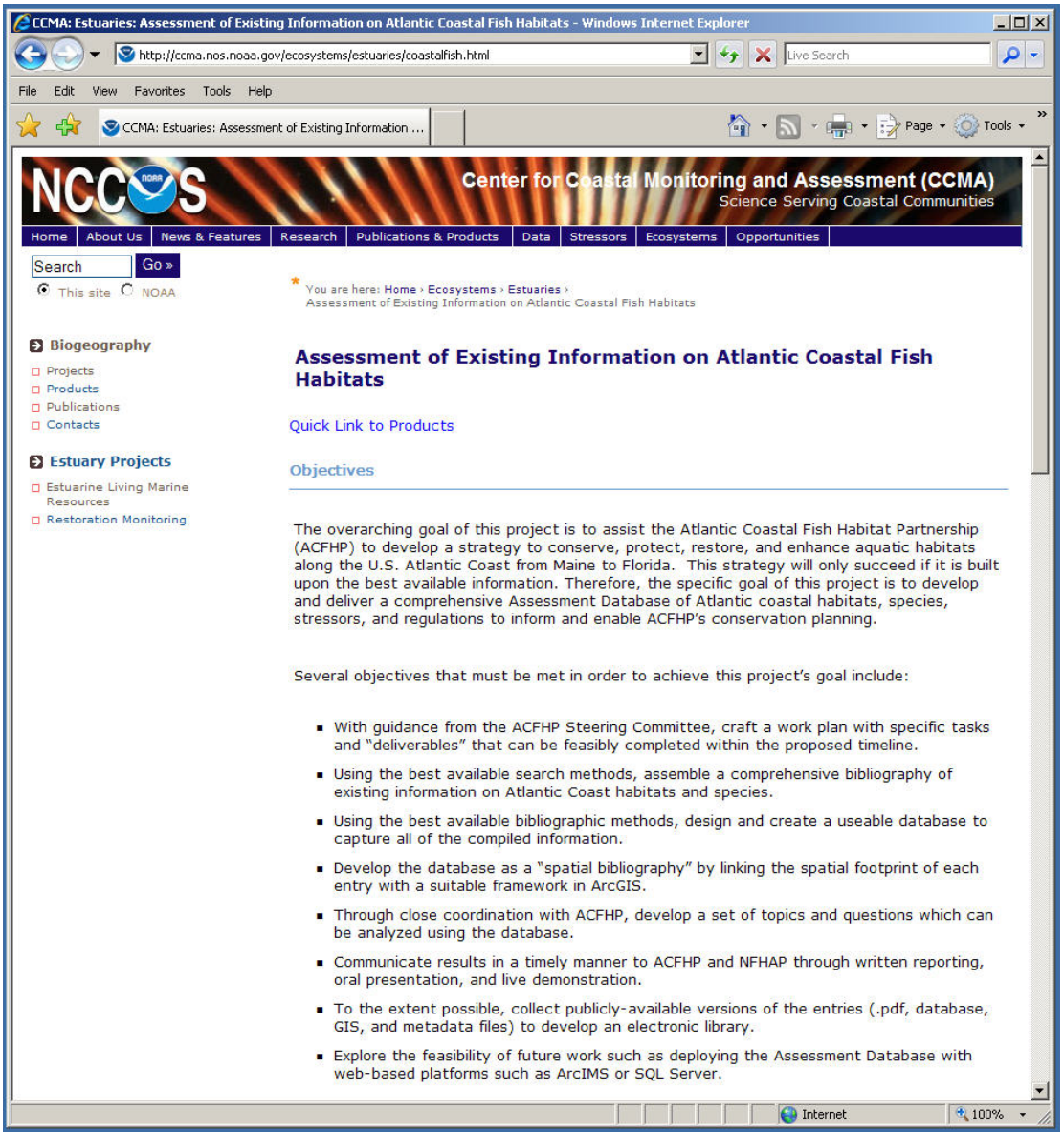


Figure 5. Descriptive project page for *Assessment of Existing Information on Atlantic Coastal Fish Habitats*, http://ccma.nos.noaa.gov/ecosystems/estuaries/coastalfish.html .

Development of the SQL Server Relational Database

The component tables (Bibliographic, Assessment, and Geospatial) were designed from the start so that they could be linked within a relational database application such as Microsoft Access, SQL Server, or Oracle, using fields that were shared between the tables. For example, entries in both the Bibliographic and Assessment Tables are tagged to specific polygon(s) in the Geospatial table. All of the tables were imported into SQL Server so that they could be developed into a web-based query application. Separate index tables were created to enable the "many-to-many" relationship between some fields. For example, a single document may refer to many different waterbodies, and vice versa. The relationships between the Bibliographic, Assessment, and Geospatial Tables are depicted in Figure 6.

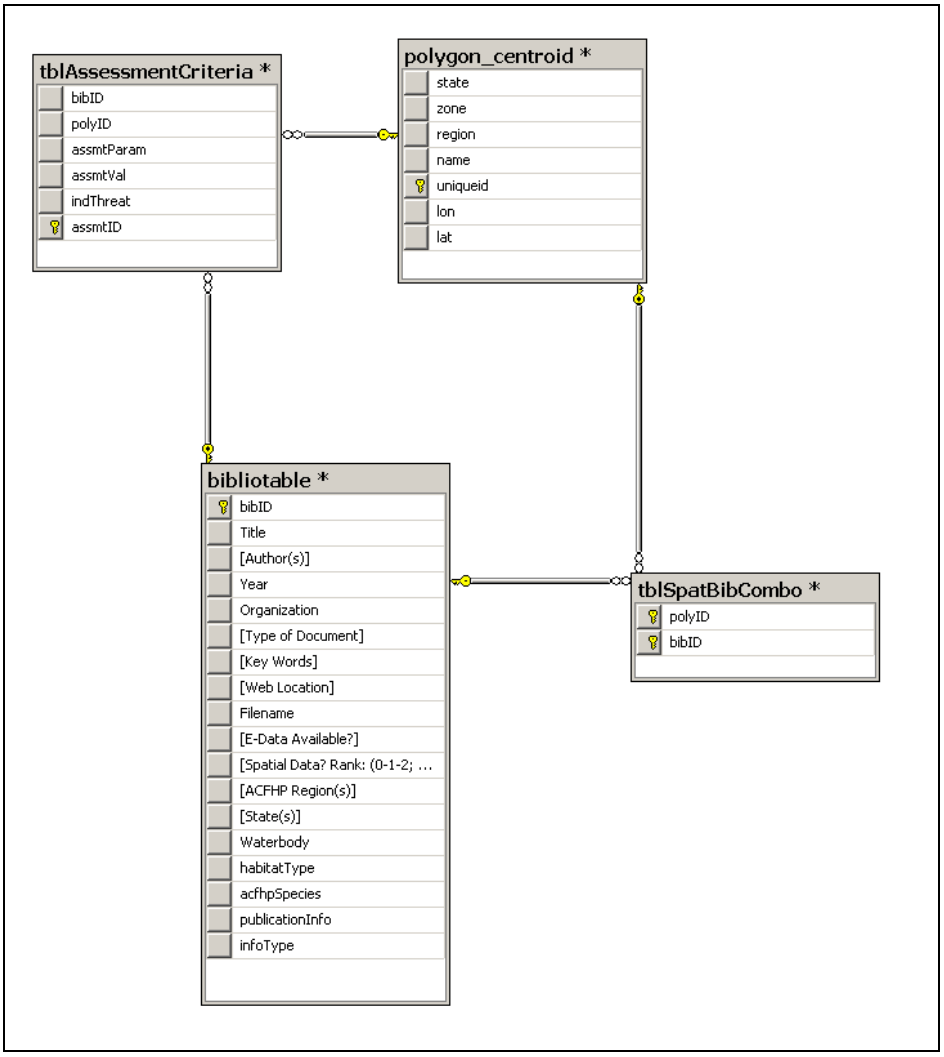


Figure 6. Database design (v.6.4.09). The Assessment table is linked to the Bibliographic Table by the bibID field. The two are also linked by a many-to-many relationship of Waterbody Number (uniqueid). The AssessmentTable is also linked to the Geospatial Table by the uniqueid (Waterbody Number) field.

Web-based ACFHP Query Tools

The web based ACFHP Query Tool includes a front page and three query modules, developed as subroutines within NOAA's Benthic Habitat Viewer web tool (NOAA/CCMA 2007). To enable the development as a web application, the ArcGIS base layer was exported as a KML file to import into GoogleMaps However, we encountered difficulty displaying the polygon layer as-is, so we simplified it as a point layer by deriving a centroid lat/lon from each polygon. Using the centroid point layer, we developed a query module that links GoogleMaps with an ASP.Net query interface. Additional menu-driven query modules enable access to either the Bibliographic or Assessment data.

Front Page. The front page (http://www8.nos.noaa.gov/bhv/spatbibindex.html), as illustrated in Figure 7, titled "*Atlantic Coastal Fish Habitat Database: A Tool for Geospatial Assessment of Existing Information*", provides a brief explanation of content, and links for the three query modules under the heading "ACFHP Data Links": Bibliographic Query, Assessment Query, and Geospatial Query. This page also provides links to related sources of information:

1. Assessment of Existing Information on Atlantic Coastal Fish Habitats (hosted by CCMA)
2. National Fish Habitat Action Plan (NFHAP)
3. Atlantic Coastal Fish Habitat Partnership (ACFHP)

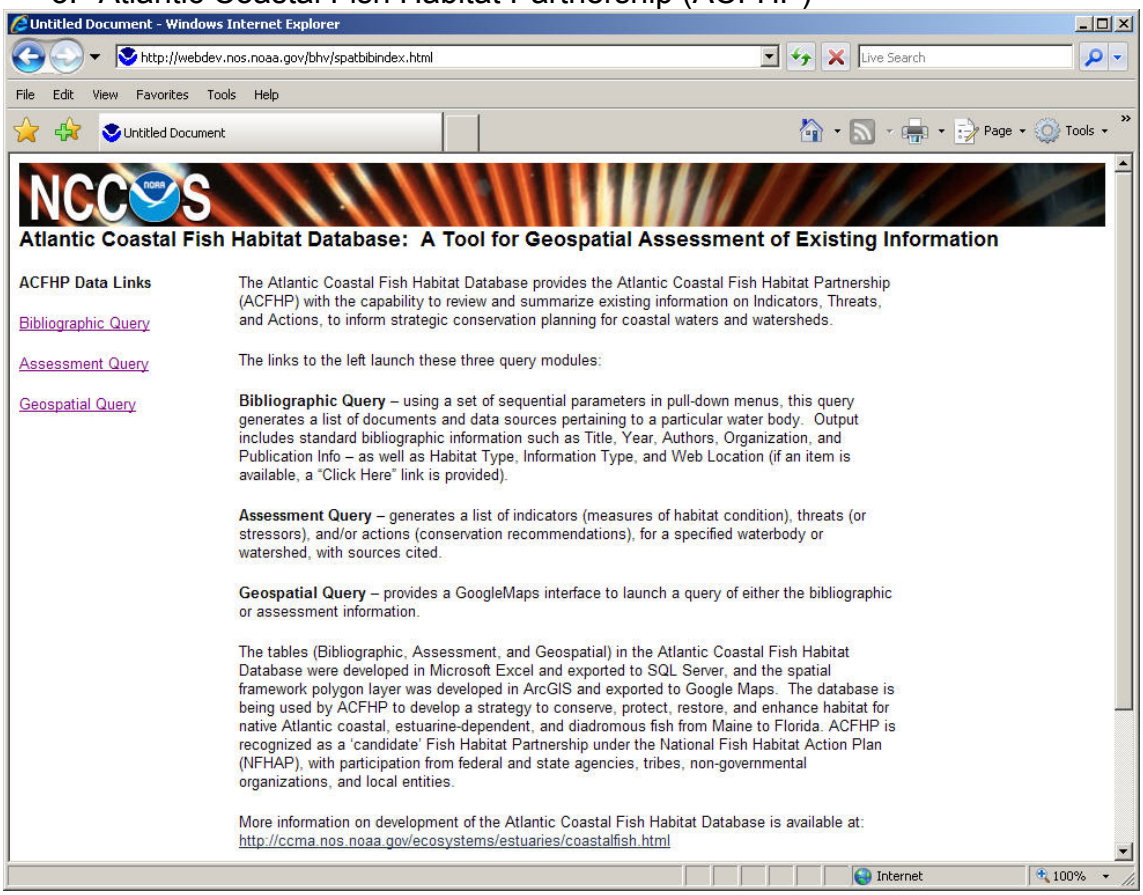


Figure 7. Web front page for Atlantic Coastal Fish Habitat Database (v.6.17.09).

Bibliographic Query. Clicking the link titled "Bibliographic Query" brings up a SQL Server query interface within a new window, as depicted in Figure 8: http://www8.nos.noaa.gov/bhv/spatbibQuery.aspx

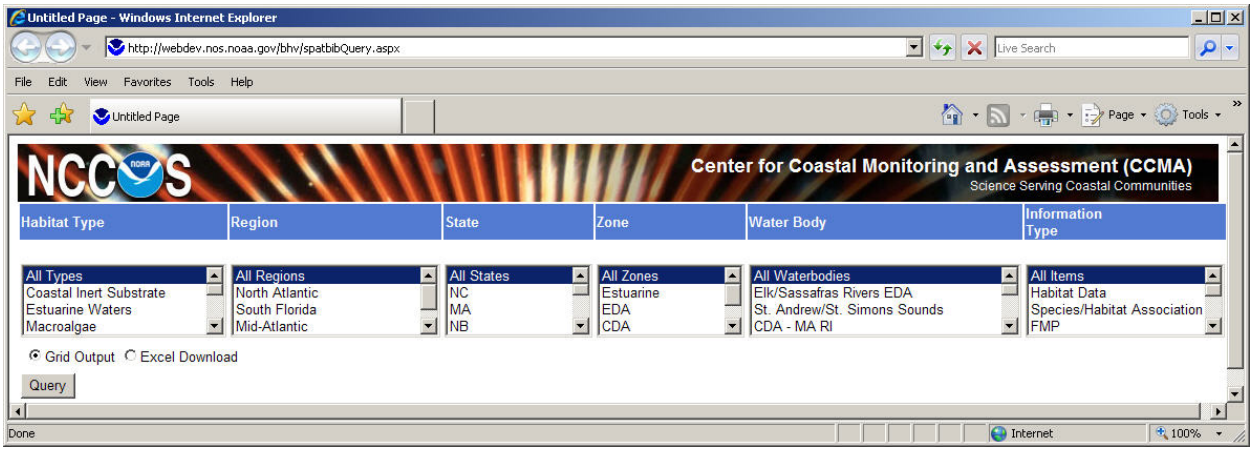


Figure 8. Bibliographic query window (v.6.17.09).

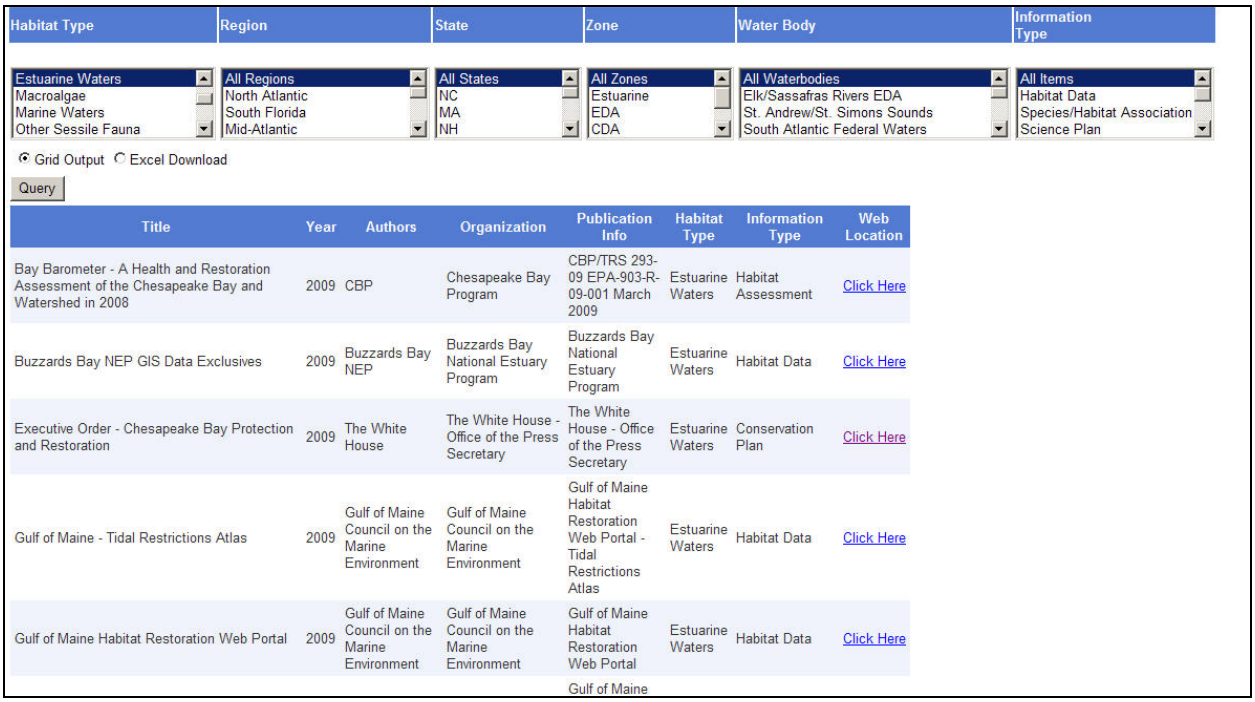
The query is based on fields in the Bibliographic Table, and the user is prompted to select based on these sequential criteria within pull-down menus:

Habitat Type: Based on a defined list of habitat types, plus the option for "All Types".
Region: Based on the four ACFHP regions, plus the option for "All Regions".
State: Includes Atlantic Coastal States, plus DC, NB (New Brunswick), and US (Federal Waters).
Zone: Estuarine, EDA, CDA, Marine–State, and Marine-Federal.
Waterbody: Name of waterbody (estuarine or marine) or watershed (EDA or CDA).
Information Type: Based on a defined list of information types.

The user also has a radio button option of viewing the results as "Grid Output" (default), or "Excel Download".

The "Query" button launches the query, and results are displayed as shown in Figure 9, with these fields pulled from the Bibliographic Table:

Title
Year
Authors
Organization
Publication Info
Habitat Type
Information Type
Web Location (if an item is available, a "Click Here" link is provided)



Habitat Type	Region	State	Zone	Water Body	Information Type
Estuarine Waters Macroalgae Marine Waters Other Sessile Fauna	All Regions North Atlantic South Florida Mid-Atlantic	All States NC MA NH	All Zones Estuarine EDA CDA	All Waterbodies Elk/Sassafras Rivers EDA St. Andrew/St. Simons Sounds South Atlantic Federal Waters	All Items Habitat Data Species/Habitat Association Science Plan

Grid Output Excel Download

Query

Title	Year	Authors	Organization	Publication Info	Habitat Type	Information Type	Web Location
Bay Barometer - A Health and Restoration Assessment of the Chesapeake Bay and Watershed in 2008	2009	CBP	Chesapeake Bay Program	CBP/TRS 293-09 EPA-903-R-09-001 March 2009	Estuarine Waters	Habitat Assessment	Click Here
Buzzards Bay NEP GIS Data Exclusives	2009	Buzzards Bay NEP	Buzzards Bay National Estuary Program	Buzzards Bay National Estuary Program	Estuarine Waters	Habitat Data	Click Here
Executive Order - Chesapeake Bay Protection and Restoration	2009	The White House	The White House - Office of the Press Secretary	The White House - Office of the Press Secretary	Estuarine Waters	Conservation Plan	Click Here
Gulf of Maine - Tidal Restrictions Atlas	2009	Gulf of Maine Council on the Marine Environment	Gulf of Maine Council on the Marine Environment	Gulf of Maine Habitat Restoration Web Portal - Tidal Restrictions Atlas	Estuarine Waters	Habitat Data	Click Here
Gulf of Maine Habitat Restoration Web Portal	2009	Gulf of Maine Council on the Marine Environment	Gulf of Maine Council on the Marine Environment	Gulf of Maine Habitat Restoration Web Portal	Estuarine Waters	Habitat Data	Click Here
				Gulf of Maine			

Figure 9. Bibliographic query output (v.6.17.09).

Note that because any given document may refer to multiple habitat types, they may appear in the output more than once. Additionally, a habitat type may be covered by the same document as a given waterbody, but may not occur in that waterbody.

Assessment Query. Clicking the link titled "Assessment Query" brings up the SQL Server query interface within a new window, as illustrated in Figure 10: http://www8.nos.noaa.gov/bhv/spatbibAssessment.aspx .

The query is based on fields in the Assessment Table, and the user is prompted to select based on these sequential criteria within pull-down menus:

Habitat Type
Region
Waterbody

The user also must select the type of assessment information with radio buttons: Indicator, Threat, Action, or All.

There is also a radio button option of viewing the results as a simple GridView (default), or Excel Export.

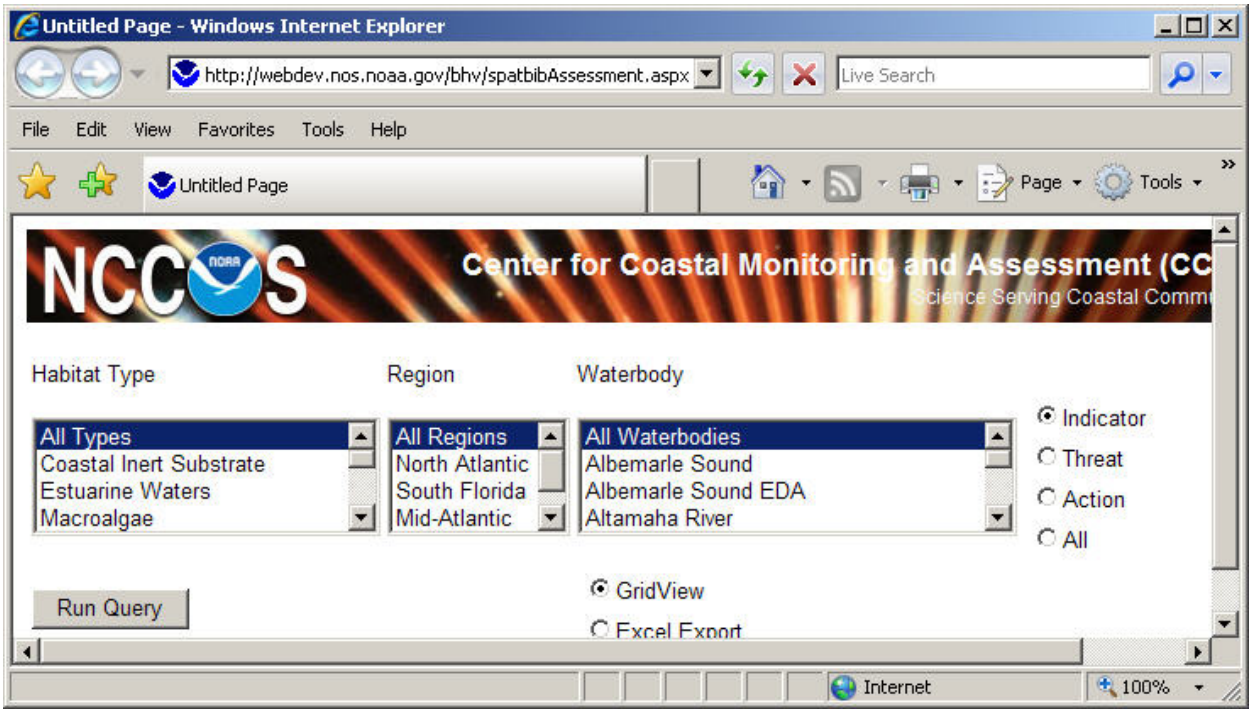
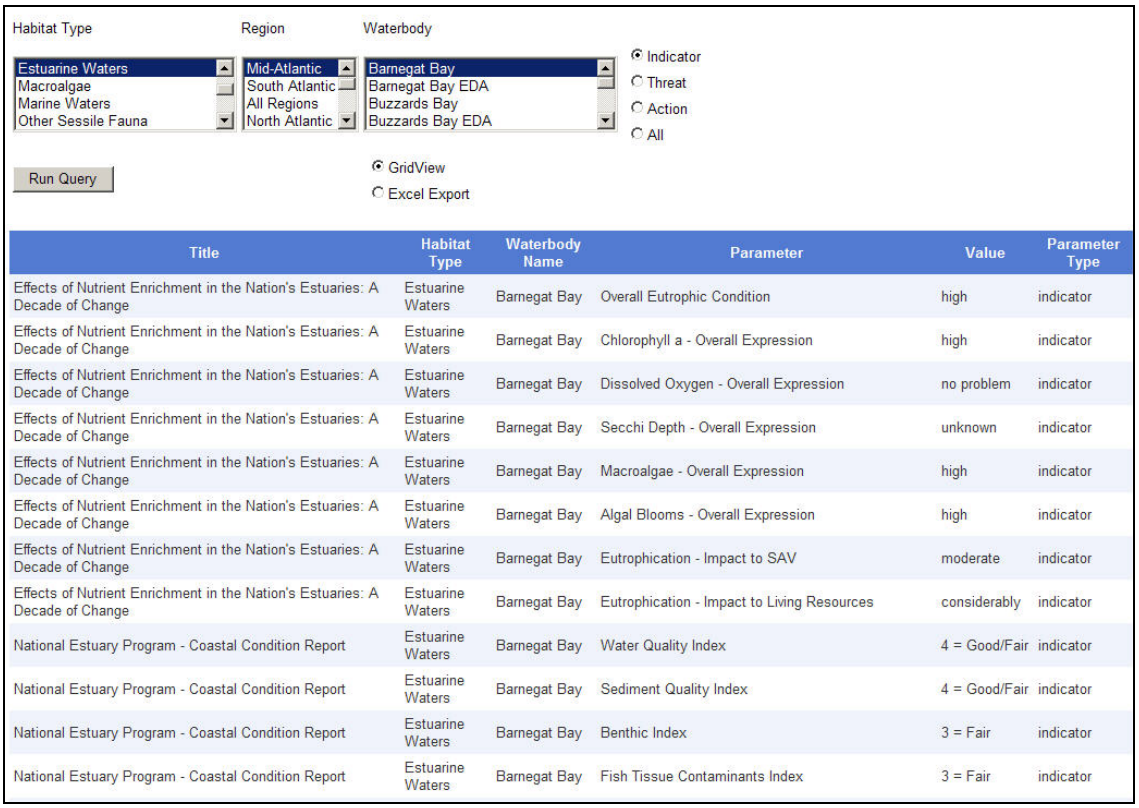


Figure 10. Assessment query window (v.6.17.09).

The “Query” button launches the query, and results are displayed as shown below, with these fields pulled from the Assessment Table, Bibliographic Table, or Geographic Table:

Title
Habitat Type
Waterbody Name
Parameter
Value
Parameter Type



Title	Habitat Type	Waterbody Name	Parameter	Value	Parameter Type
Effects of Nutrient Enrichment in the Nation's Estuaries: A Decade of Change	Estuarine Waters	Barnegat Bay	Overall Eutrophic Condition	high	indicator
Effects of Nutrient Enrichment in the Nation's Estuaries: A Decade of Change	Estuarine Waters	Barnegat Bay	Chlorophyll a - Overall Expression	high	indicator
Effects of Nutrient Enrichment in the Nation's Estuaries: A Decade of Change	Estuarine Waters	Barnegat Bay	Dissolved Oxygen - Overall Expression	no problem	indicator
Effects of Nutrient Enrichment in the Nation's Estuaries: A Decade of Change	Estuarine Waters	Barnegat Bay	Secchi Depth - Overall Expression	unknown	indicator
Effects of Nutrient Enrichment in the Nation's Estuaries: A Decade of Change	Estuarine Waters	Barnegat Bay	Macroalgae - Overall Expression	high	indicator
Effects of Nutrient Enrichment in the Nation's Estuaries: A Decade of Change	Estuarine Waters	Barnegat Bay	Algal Blooms - Overall Expression	high	indicator
Effects of Nutrient Enrichment in the Nation's Estuaries: A Decade of Change	Estuarine Waters	Barnegat Bay	Eutrophication - Impact to SAV	moderate	indicator
Effects of Nutrient Enrichment in the Nation's Estuaries: A Decade of Change	Estuarine Waters	Barnegat Bay	Eutrophication - Impact to Living Resources	considerably	indicator
National Estuary Program - Coastal Condition Report	Estuarine Waters	Barnegat Bay	Water Quality Index	4 = Good/Fair	indicator
National Estuary Program - Coastal Condition Report	Estuarine Waters	Barnegat Bay	Sediment Quality Index	4 = Good/Fair	indicator
National Estuary Program - Coastal Condition Report	Estuarine Waters	Barnegat Bay	Benthic Index	3 = Fair	indicator
National Estuary Program - Coastal Condition Report	Estuarine Waters	Barnegat Bay	Fish Tissue Contaminants Index	3 = Fair	indicator

Figure 11. Assessment query output (v.6.17.09).

Geospatial Query. Clicking the third "ACFHP Data Link" titled "Geospatial Query" brings up a GoogleMaps interface within the same window, as depicted in Figure 12: http://www8.nos.noaa.gov/bhv/spatbibAssessment.aspx

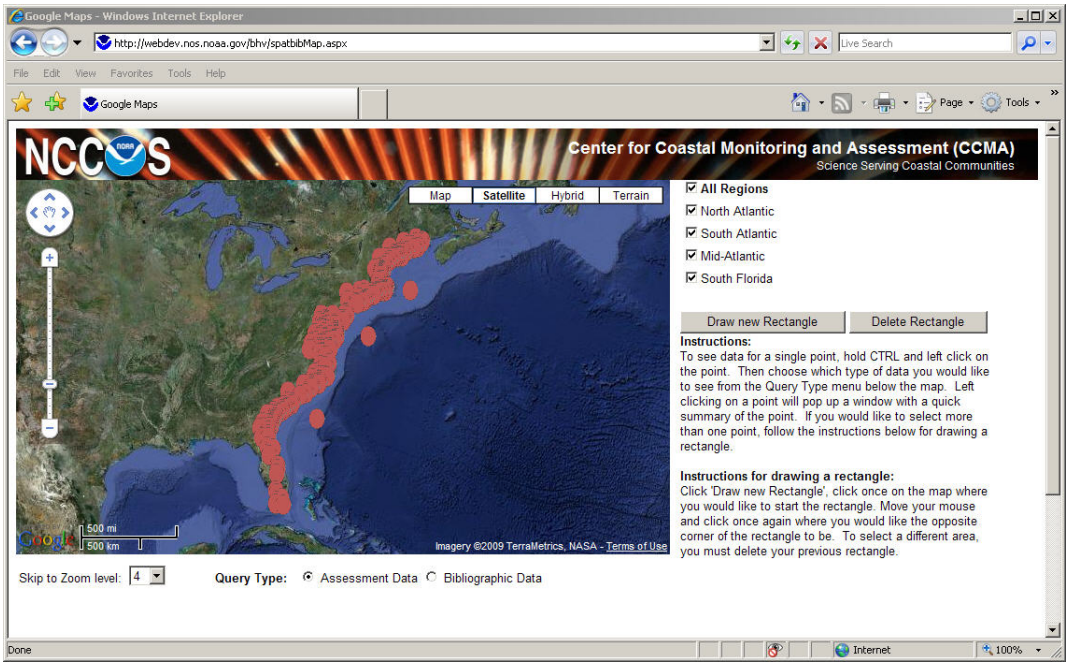


Figure 12. Geospatial query window with GoogleMaps interface (v6.17.09)

The user instantly sees a map query page of the ACFHP study area, with overlapping ovals representing all of the waterbodies and watersheds within the ACFHP spatial framework. Google Maps cannot readily display the actual polygons of the spatial framework (i.e. waterbody and watershed boundaries), but it can create "apparent" polygons around the centroids of each polygon. The map interface also features familiar zoom and pan tools, and the option of viewing as map/satellite/hybrid/terrain using standard GoogleMaps base imagery layers.

This page can be used to launch spatial queries of either the assessment or bibliographic data tables, similar to the corresponding queries described above. Spatial selection can be accomplished by:

1. Regions can be toggled on and off using click boxes.
2. Single waterbodies can be selected by holding CTRL and left-click on a point, then selecting either Assessment or Bibliographic Data as Query Type (see instructions on base map).
3. Draw a rectangle and capture a subset of the waterbodies (polygon centroids), see instructions on base map.

The "Query Type" radio buttons are set to "Assessment Data" or "Bibliographic Data", one or the other but not both. If "Assessment Data" is selected, these fields instantly appear as grid output with shaded blue background:

Reference Title
Waterbody
Parameter
Value
Parameter Type (e.g. indicator, threat, or action)

If "Bibliographic Data" is selected, these fields instantly appear as grid output with shaded blue background:

Title
Year
Authors
Organization
Publication Info
Web Location

An example of the grid output is shown in Figure 13, for a query of Bibliographic Data for South Atlantic Federal Waters.

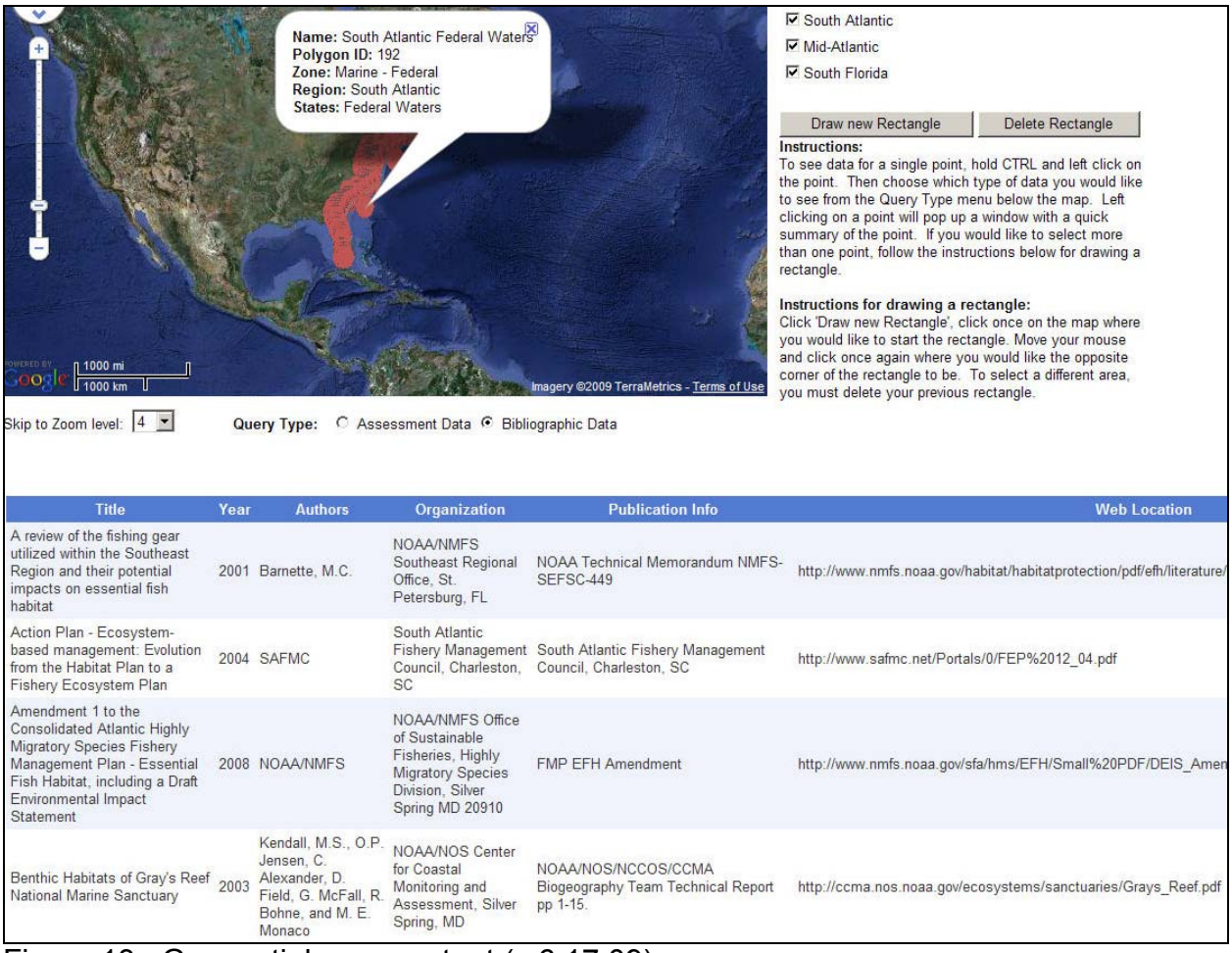


Figure 13. Geospatial query output (v.6.17.09)

Metadata

A single metadata record was developed for the public data offerings generated by the project, using MERMAid (Metadata Enterprise Resource Management Aid), a tool developed by NOAA's National Coastal Data Development Center (NOAA/NCDDC 2006). Well-written metadata can help an interested user understand the lineage and processing steps that went into developing a data set, and to explore and interpret the entities and attributes within that data set. Some software applications (e.g. ArcGIS) can "ingest" properly formatted FGDC-compliant metadata records, further enhancing the utility of the original data set. In the ACFHP metadata record, each of the tables within the ACFHP database (Bibliographic, Assessment, and Geospatial) are considered as individual *entities*, and each field within those tables are considered as *attributes*. After careful review, the metadata record was published to NOS' Data Explorer (NOAA/NOS 2009), where it is publicly available and searchable. A link to the metadata record is also provided on the ACFHP query tools front page.

SUMMARY OF INDICATORS, THREATS, AND ACTIONS

Tables 3 through 17, and Figures 14 through 16, illustrate how information on indicators, threats, and actions can be integrated, summarized, and put to use to assist regional conservation planning. In other words, use the database to move beyond an "assessment of existing information on fish habitat" towards an "assessment of fish habitat based on existing information".

Indicators

Habitat quality indicators typically focus on a single measurable parameter (e.g. Dissolved Inorganic Nitrogen), or in some cases report an index which has been derived from a set of parameters (e.g. Overall Eutrophic Condition). Although some source documents may ascribe a single "health score" to a given waterbody (e.g. annual State of the Bay reports), it is beyond the scope of this project to derive a single habitat score for each waterbody. On the other hand, when key indicators are developed using consistent methods across a set of waterbodies, they can be used for comparative analyses and displayed graphically. Of all the indicator data compiled within the Assessment Table, the most useful sources by far were those that report results at a local scale (e.g. individual waterbodies) within a broad spatial scope (regional or National). When comparing and interpreting indicator data, the user must be careful to consider the methods and caveats as described in the original source documents. In addition, the indicators themselves do not describe how fish populations actually respond to the underlying conditions.

Table 3 depicts rankings for overall metals and organics contamination status in 49 selected ACFHP waterbodies, as reported by NOAA's National Status and Trends Program (Kimbrough et al. 2008). For waterbodies with multiple MusselWatch sites, the "worst" rankings (not averages) are reported. Waterbodies with status of medium or high, or trends increasing, are relatively few, but include Boston Harbor, Buzzards Bay, Hudson River/Raritan Bay, Delaware Bay, Patapsco/Gunpowder River (includes Baltimore Harbor), James River (includes Elizabeth River and Norfolk Harbor), and St. Johns River. Another striking result here is that in the majority of estuarine waterbodies, contaminant indices are low and either stable or decreasing. However, the overall sampling design is intended to track status and trends at representative sites, not target problematic "hot spots". In addition, it is possible for individual contaminants (e.g. copper) to be relatively high, while the "metals index" remains relatively low. The "organics index" does not include contaminants of emerging concern such as polybrominated diphenyl ethers (PBDEs) (Kimbrough et al. 2009) or human pharmaceuticals (Pait et al. 2006). If a user wants to find out more about contaminants, the bibliographic database can direct them to the original source documents and data.

Table 4 summarizes results from *Effects of Nutrient Enrichment in the Nation's Estuaries: A Decade of Change*, better known as "The Eutro Report" (Bricker et al. 2007), a cooperative study by NOAA and many partners. These indicators were compiled using a combination of analytical and consensus-based methods, described in the original report. The first column of the table summarizes the "Overall Eutrophic Condition", ranked from low to high, or unknown. The list of 64 estuarine waterbodies

corresponds closely to those used in the ACFHP spatial framework (both studies employ the Coastal Assessment Framework), and the color-coded rankings enable a quick graphic interpretation of the table. The table also includes fields which indicate the effects of eutrophication, such as "Impact to Living Resources", and "Impact to SAV". Table 4 is supplemented with information from a previous version of the eutrophication report (Bricker et al. 1999) as needed.

Tables 5, 6, and 7 summarize information from U.S. EPA's National Coastal Conditions Report series – in this case the report that focuses on eighteen National Estuary Program (NEP) estuaries (U.S. EPA 2006). The first column of Table 5 displays an "Overall Condition" score from good to poor for each estuary, along with several other Index scores (Water Quality, Sediment Quality, Benthic, and Fish Contaminants). Note that Chesapeake Bay is not included in this summary, although the National Estuary Program was preceded and to some extent modeled after the Chesapeake Bay Program. Tables 6 and 7 report individual water quality and sediment quality indicator rankings that are used to derive the index scores reported in Table 5.

Table 8 addresses the question of well-studied versus poorly-studied waterbodies by counting the number of rows of indicator information recorded for each estuary. It must be recognized, however, that the Assessment Table is neither an exhaustive nor even a random sample of all of the indicator data that may be available, and it may contain some regional bias. In spite of that caveat, several trends and apparent "data gaps" can be qualitatively inferred:

- More information is available for larger estuaries (Delaware Bay, Chesapeake Bay, Long Island Sound) than for smaller ones (Hampton Harbor, Saco Bay, Waquoit Bay).
- More information is available for estuaries in heavily populated regions (Hudson River/ Raritan Bay, Delaware Bay) than for less populated regions (downeast Maine, portions of the Georgia coast).
- More information is available for National Estuary Program estuaries, largely because of EPA's consistent reporting of indicator data for these waterbodies.
- More information is available for the larger and heavily populated Chesapeake sub-estuaries (Potomac and James Rivers), but much less is reported separately for the smaller Chesapeake sub-estuaries (e.g. Honga, Lynnhaven, Elk/Sassafras Rivers, tidal Susquehanna River, Eastern Bay, Ingram/Fleets Bays, Piankatank River/Mobjack Bay).
- In addition to the smaller Chesapeake sub-estuaries, little indicator information was found for Nassau Sound along the northern Florida coast, and Wassaw Sound on the Georgia coast.
- Although it is not evident from Table 8, there are some localized areas that are data-rich but are not reported separately, such as the Elizabeth River in Norfolk VA and the Anacostia River in Washington DC. These are relatively small sub-estuaries of the James and Potomac River estuaries, respectively, with largely urban watersheds.

Figures 14, 15, and 16 illustrate how indicator information can be graphically displayed on maps, using a consistent GIS spatial template. In Figure 14, the *Water Quality Index* for sampling stations in EPA's National Coastal Condition Report III (U.S. EPA 2008,

Engle pers. comm., Whitall pers. comm..) is plotted as point data over the ACFHP spatial framework. Other parameters (indices and scores) available from this same dataset include:

Sediment Quality Index
Sediment Total Organic Carbon Score
Sediment Toxicity Score
Sediment Contaminant Score
Benthic Index Score
Water Quality Index
Bottom Dissolved Oxygen Score
Surface Chlorophyll a Score
Surface Dissolved Inorganic Nitrogen Score
Surface Dissolved Inorganic Phosphorus Score
Water Clarity Score
Tissue Contaminant Score

Note that parameters identified as "scores" contribute to the calculation of the summary Sediment and Water Quality Indices.

In Figure 15, the *Coastal Vulnerability Index* (CVI) for U.S. Atlantic coastline (Hammar-Klose and Thieler 2001) is plotted as short line segment data. This index represents the predicted vulnerability of a given coastline segment to the effects of sea level rise. The CVI is derived from a set of parameters, each of which can be mapped separately from the same data set, including erosion/accretion rates, tidal currents and wave climate, relative sea level rise, shoreline geomorphology and slope. Although these parameters may not be direct indicators of "fish habitat quality" *per se*, they may be very useful for conservation planning purposes. They are representative of the high-quality publicly available GIS data identified as "habitat data" in the spatial bibliography, and can be readily downloaded and used for various purposes.

In Figure 16, *Overall Eutrophic Condition* for 64 U.S. Atlantic coastal estuaries (Bricker et al. 2007) is plotted as points representing the centroids of individual estuaries. Several of the parameters reported separately (*Chlorophyll a, Algal Blooms, Dissolved Oxygen, Impact to SAV, and Macroalgae*) contribute to the development of the *Overall Eutrophic Condition* (OEC) index value. Parameters from this data set that could be considered and mapped include

Overall Eutrophic Condition
Chlorophyll a - Overall Expression
Harmful Algal Blooms - Overall Expression
Dissolved Oxygen - Overall Expression
Eutrophication - Impact to SAV
Macroalgae - Overall Expression
Eutrophication - Impact to Living Resources
Secchi Depth - Overall Expression
Future Outlook

Impact to Living Resources shows whether living resources (e.g. fish, shellfish, wildlife) are being impaired by eutrophication, but this indicator does not contribute to the OEC. *Secchi Depth* is recorded since it is a widely accepted indicator, but it does not contribute to the OEC since it can be affected by suspended sediment (turbidity) as well

as nutrient enrichment and algal growth. The *Harmful Algal Blooms* indicator primarily refers to nuisance and toxic blooms (e.g. red tide, brown tide), and is therefore not redundant with the *Chlorophyll a* indicator. Some of the indicators are reported separately for salinity zones within individual estuaries, but this is not reflected in Table 5 and Figure 16 of this report. Note that the *Overall Eutrophic Condition* for individual estuaries mapped in Figure 16 generally corresponds with the EPA *Water Quality Index* reported for sampling points in Figure 14.

Threats

Threats and Conservation Actions are more difficult to summarize and display than Indicator data, because they are typically reported as text information, and often in subjective language. They are typically associated with an individual waterbody, but are rarely reported consistently across a range of waterbodies. In spite of that, some qualitative analyses of the threats "as reported" are feasible, revealing some interesting results. A list of fifteen draft threat categories was developed during an ACFHP strategic planning session in June 2009. This process was consensus-based, and was independent of our compilation of threats within the Assessment Table. We read through the list of 1260 threats identified in the Assessment table, and quickly classified each with respect to the 15 ACFHP threat categories, then counted the number of instances of threats falling into each category, summing across regions and waterbodies. Table 9 presents the results of these classifications and counts of the threats, revealing some interesting results.

- *Water Quality* and *Dams and Passage* are the top two categories, followed by *Climate Change*, *Dredging Issues*, and *Contaminants*.
- Most of the threats (871 of 1260) fit clearly within the fifteen categories, but others are more difficult to classify, and were retained within "other" categories.
- There are few interesting "outliers" that don't easily fit into the classification scheme (e.g. light and noise pollution, unexploded ordnance).
- In some cases, multiple threats were reported and recorded together, and classified as *Multiple Threats Reported*. Many of these included altered hydrology and water quality. We did not attempt to separate them further, but this suggests an additional task for the next iteration of the Assessment Table (see *The Way Forward*, p. 33).
- Many of the threats classified as "other" belong within a larger "land use" classification, not just urban (i.e. impervious surfaces) but also agricultural and forestry practices.
- *Regulatory Systems* were identified as a threat category by the ACFHP strategic planning session, but no instances of threats in the assessment table were placed into this category. Regulations are generally considered as "actions" rather than "threats" within the Assessment table.

Other classification schemes, such as those developed by IUCN (2006a), ASMFC (Greene et al. 2009), and The Nature Conservancy (Odell 2008), could be applied to the compiled list, revealing potentially different results. Some classification schemes focus on the sources of threats, whereas others focus on the effects, and all provide varying levels of detail. This demonstrates how even subjective text information can be used for

qualitative analyses and reveal useful results if the information base is sufficiently robust.

Since each individual line of information in the assessment table is tied to a particular waterbody, classified threats can be tallied and qualitatively compared among zones (watersheds, estuaries, and marine), and regions (North Atlantic, Mid-Atlantic, South Atlantic and South Florida). Tables 10, 11, and 12 illustrate how the classified threats can be broken out by zone and/or region. Because of a sparser literature base for the South Florida region and the Marine-Federal zone, tallies for South Florida were combined with the South Atlantic region, and tallies for Marine-Federal waters were combined with Marine-State waters for a single "Marine" zone. Several caveats must be kept in mind to interpret these comparisons:

- These tallies represent how frequently a given threat is cited in a subset of the existing conservation plans and other literature for a given location. It *cannot* be inferred that they represent the actual importance of a given threat.
- These comparisons are based on the consensus-based draft ACFHP classification of threats to fish habitats developed in June 2009. Applying a different classification scheme would likely reveal different results.
- For some individual waterbodies, most of the threat information comes from one or two documents. Comparing information on a local basis may reveal the biases of individual documents, rather than reveal any real differences between the locations.

With those caveats in mind, several interesting results emerge and are depicted in Tables 10, 11, and 12.

- *Water Quality* is the most-cited classified threat in all regions (North Atlantic, Mid-Atlantic, South Atlantic and South Florida) (Table 10).
- *Dams and Passage* and *Contaminants* follow *Water Quality* as the most-cited classified threats in the North Atlantic region (Table 10).
- *Climate Change*, *Contaminants*, and *Invasive Species* follow *Water Quality* as the most-cited classified threats in the Mid-Atlantic region (Table 10).
- *Fishing Gear Impacts* and *Dams and Passage* follow *Water Quality* as the most-cited classified threats in the South Atlantic and South Florida regions combined (Table 10).
- *Dams and Passage* are the top cited threat in the *Watersheds* zone (including freshwater above head-of-tide), followed by *Water Quality* and *Impervious Surfaces* (Table 11).
- *Water Quality* is the top cited threat in the *Estuaries* zone, followed by *Contaminants* and *Dredging Issues* (Table 11).
- *Climate Change* is the top cited threat in the *Marine* zone, followed by *Fishing Gear Impacts* and *Dredging Issues* (Table 11).
- When tallied within a region x zone matrix (Table 12), other classified threats that emerge in addition to the ones cited above include *Water Withdrawals* in North Atlantic watersheds, *Invasive Species* in Mid-Atlantic estuaries, and *Boating Issues* in South Atlantic and South Florida marine waters.

Conservation Actions

Conservation actions and recommendations as reported in the existing literature, are recorded in the Assessment Table as 1860 instances of text information in a format similar to that for threats. In Table 13, a classification scheme is applied based on themes that emerged from visual inspection of the information. It could be considered an "emergent scheme", admittedly subject to the biases (e.g. "splitter" vs. "lumper") of the viewer, and not based on any group consensus. In spite of that, several trends are evident:

- Most conservation actions either refer to a specific threat (e.g. "stop pollution"), or to a specific habitat type (e.g. "restore wetlands"), or involve the designation of an area for a specific purpose, such as Marine Protected Areas (MPA) or Essential Fish Habitat (EFH).
- The most often cited types of recommended conservation actions involve Area Designation, Water Quality, Wetlands, and Fish Passage. Again, these are categories that emerged based on actions and habitat types as reported. "Area Designation" includes Marine Protected Areas (MPAs), Essential Fish Habitat (EFH), Habitat Areas of Particular Concern (HAPC), National Wildlife Refuges (NWR), etc.
- Water quality and fish passage issues were prominent as both threats and conservation recommendations, and to a lesser extent, fishing gear impacts and fishery regulation.
- Except for the recent Presidential Executive Order on restoration of the Chesapeake (The White House 2009), few actions specifically address Climate Change, even though it was widely cited as a threat, especially in marine waters.
- Some conservation recommendations were stated in such general terms that they couldn't be tagged to a specific threat, habitat type, or species of interest (e.g. "conserve fish habitat"), and were classified as "General Habitat Conservation".
- Two or more distinct actions were sometimes reported together, and were classified as "Multiple Recommendations".
- There were several interesting and specific "outlier" recommendations which didn't readily fit into the emergent classification scheme. One in particular recommended "experimental restoration in shallow, low-salinity areas to reach recovery threshold", with the premise that rapid and demonstrable restoration of an entire estuarine waterbody may not be feasible (Kemp and Goldman 2008).

In Tables 14, 15, and 16, the classified and tallied conservation actions are split out by zone and/or region. As with the analysis of threats, tallies for South Florida were combined with the South Atlantic region, and tallies for Marine-Federal waters were combined with Marine-State waters for a single Marine zone. Similar caveats apply as well:

- Conservation recommendations are often reported in the existing literature in language more subjective than that for threats or indicators, and their classification is likely to be more subjective also.
- These tallies represent how frequently a given conservation recommendation is identified in a subset of the existing conservation plans and other literature for a

given location. It *cannot* be inferred that they represent the actual priority or importance of a given action.
- These comparisons are based on an emergent scheme, and applying a predetermined or consensus-based classification scheme (e.g. IUCN 2006b) would likely reveal different results.
- For some individual waterbodies, the conservation actions may come from one or two documents. Comparing information on a local basis may merely reveal the biases of individual documents, rather than reveal any real differences between the locations.

In spite of these caveats, several interesting results emerge and are evident in Tables 14, 15, and 16:

- *Area Designation* emerged as the most-cited action in all regions (North Atlantic, Mid-Atlantic, South Atlantic and South Florida), except that it is tied with *Water Quality – Protect and Restore* in the Mid-Atlantic region (Table 14).
- *Improve Fish Passage* is the top cited action in the *Watersheds* zone (including freshwater above head-of-tide), followed by *Riparian Buffers – Conserve and Restore* and *Area Designation* (Table 15).
- *Area Designation* is the top cited action in the *Estuaries* zone, followed by *Wetlands – Protect and Restore,* and *Water Quality – Protect and Restore* (Table 15).
- *Area Designation* is the top cited action in the *Marine* zone, followed by *Monitoring and Assessment* and *Fishery Regulation* (Table 15).
- The widespread prominence of *Area Designation* as a conservation recommendation illustrates the emergence of Marine Spatial Planning in resource management.
- When tallied within a region x zone matrix (Table 12), other classified actions that emerge in addition to the ones cited above include *Watersheds – Conserve and Restore* in North Atlantic watersheds, *Conserve Species* in South Atlantic and South Florida watersheds (e.g. actions taken to benefit individual species of concern), *Control Invasive Species* and *SAV – Protect and Restore* in Mid-Atlantic estuaries.

Table 17 combines the content of Tables 12 and 16, so that the top three classified threats and actions can be viewed together within a region x zone matrix. Although threats and actions are treated as independent rows of information within the database, this view enables a few observations:

- In many cases, the top threats and actions for a given region and zone are related, e.g. *Dams and Passage* and *Improve Fish Passage* in North Atlantic Watersheds, *Water Quality* and *Water Quality – Protect and Restore* in Mid-Atlantic Estuaries, *Fishing Gear Impacts* and *Fishery Regulation* in South Atlantic/South Florida Marine Waters.
- In some cases, threats and actions for a given region and zone are not directly related. *Climate Change* scores as one of the top three threats in the Marine Zone of all regions, but there are few conservation actions which specifically address it. *Area Designation* is a widely cited conservation action, but it is often intended to address multiple threats.

DISCUSSION

Application of the results

The Atlantic Coastal Fish Habitat Partnership has made initial use of the *Assessment of Existing Information* (AEI) as described below. The Partnership has not yet applied the AEI in a systematic or structured manner, but expects to find further uses as the draft conservation strategic plan is refined, and as regional action plans are developed (Greene pers. comm.).

The Partnership developed a version of Table 9 (Classification of Threats, p. 44), modified to combine threats into categories defined in its draft conservation strategic plan where possible. Threats that were not combined into categories defined in the draft conservation plan, were still included in the table, in some cases in a modified format. The modified table was included in the Partnership's draft conservation strategic plan, along with language on how the AEI results and modified table were used in relation to the threat categories discussed in the draft plan. This information will need to be reviewed and approved in order to be included in ACFHP's final strategic conservation plan. It is important to note that the AEI results and the modified threat table haven't been thoroughly compared to the threat categories discussed in the draft plan.

To help inform the strategic planning process, indicator data from the EPA's National Coastal Conditions Report (provided in the AEI) were displayed on maps, in addition to other data sets not included in the AEI. Some ACFHP steering committee members considered the information displayed on these maps during deliberations regarding the selection of proposed areas of opportunity, noted in the Partnership's draft conservation strategic plan. The Partnership is still discussing questions of using geographic areas as a means of setting priorities.

The approach and results are also being adapted and used for other purposes. A similar spatial framework and National sources of indicator data are being developed to complete the coastal component of the National Fish Habitat Action Plan assessment targeted for completion in 2010 (NFHAP 2008). Beyond this, the approach may prove useful in broader initiatives, such as Integrated Ecosystem Assessments (IEAs) (Levin et al. 2008), Ecosystem Based Management (EBM) (Burgess et al. 2005), and Marine Spatial Planning (MSP) (NOAA/EGT 2009, CEQ 2009).

Strengths and challenges

The approach used here, developing a bibliography and fitting assessment information into a defined spatial framework, has some inherent strengths and presents some unique challenges:

- The assessment provides no information above and beyond what is already available, since it is based on existing sources. However, while the content by itself is not new, the way that it is organized reveals patterns that could not be discerned from the

original sources alone. Taking local information and zooming out to a regional scale can reveal "emergent properties" which would otherwise not be evident.

- This assessment does not attempt to derive a single overall condition score for each waterbody, as do some other assessment programs. The available information for any given waterbody comes from a diverse set of sources, and the amount of information available varies greatly between waterbodies. Although a scheme which reports single scores can be useful for comparing locations, it can also serve to conceal rather than reveal the underlying information that contributes to the scores.

- Much of the information captured is text, not numeric data. However, the analysis of threats and conservation actions demonstrates how even subjective information can be categorized, quantified, analyzed, and applied.

- All entries in the bibliographic and assessment tables are considered equally – no one source of data on indicators, threats, and conservation actions are given priority. As a result, the tallies of threats and conservation actions in Tables 9 through 17 only summarize how often they appear in the literature base – they do not infer the actual importance of a given threat or conservation action.

- The spatial framework cannot be instantly adjusted from a local to a National scale, since it is based on a static layer of polygons at a defined scale. Some data sets are inherently more "scaleable" than others, for example remotely sensed oceanographic data can be aggregated to multiple scales as needed, while other assessment information is only applicable to a single site.

- To some extent, the approach duplicates existing bibliographic databases such as NOAA's library holdings and *Aquatic Sciences and Fisheries Abstracts*. However, the ACFHP database provides three important advantages: 1. Includes "gray literature" and conservation plans that are not likely to be captured by searches of other databases, 2. Extracts and records the content of documents cited on habitat indicators, threats, and conservation actions, and 3. Links this information to a particular place via a defined spatial framework.

- The system is potentially "high-maintenance". New relevant information is being continually published, and must be reviewed and entered into the system if it is to be useful as a source of up-to-date assessment information. This is a legitimate issue, since many of the assessment reports cited are revised and reissued annually.

- The information on indicators, threats, and actions is not an exhaustive sample, nor even a random sample, of what is potentially available from the existing literature. It is recognized that there may be inherent biases in the information captured, as artifacts of the sources that are selected.

- The literature base is not comprehensive, and peer-reviewed scientific articles are underrepresented. The literature search deliberately sought synoptic regional and national-scale sources, whereas many peer-reviewed research articles are site-specific. Since the spatial bibliography is not comprehensive, it is best used in

combination with other search engines and databases of library holdings and scientific publications such as *Aquatic Sciences and Fisheries Abstracts*.

- The spatial bibliography can serve purposes not originally intended, for example as a literature review for planning scientific research in a particular location. Spatial bibliographies have been developed and applied in other regions for this purpose (SDNP 2003, Taylor and Nelson 2006, PMNM 2009).

- The bibliography and assessment database reveals data gaps. Some regions are well-studied, and others are less so. Synoptic national or regional assessments have been completed for some parameters (water and sediment quality), but not for other dimensions of fish habitat such as the status of SAV, oyster reef and mussel bed habitats.

- This approach represents a cost-effective and timely means of compiling a large amount of information. No original field research is required, and there is very little travel expense. Most of the work could be accomplished by a small team in one place with access to a research library, computer resources, and web development capabilities.

- The online web query tools do not provide the original source documents as pdfs, but point the user towards them with a "click here" link where possible. Web links to sources cited can become broken, generating "file not found" errors when running the web query tools. Fixing these broken links is part of the necessary system maintenance, along with updating bibliographic and assessment information.

THE WAY FORWARD

Based on our experience in developing the ACFHP database and developing the web tools, we offer these concise recommendations.

Coordinate efforts and foster partnerships

- Promote the database and web tools within the larger conservation community to maximize their use and to advance the goals of ACFHP.

- Gather feedback from users of the ACFHP database and web tools on the strengths and limitations, and develop a plan to periodically improve the content and function.

- Keep track of related efforts such as NFHAP's decision support tools, NOAA's regional ecosystem spatial databases, data portals, IMS sites, IOOS, and EBM tools so as to complement and not duplicate their capabilities.

- Engage with groups such as NFHAP and other regional Fish Habitat Partnerships, Restore America's Estuaries (RAE), NOAA's Community-based Restoration Program, NatureServe's Ecosystem Based Management (EBM) Tools Network, American Fisheries Society, and Society for Conservation GIS to extend results and survey user needs, give-and-take feedback, provide value-added, and avoid duplication of efforts.

- Extend these results to assist the coastal component of the NFHAP Assessment targeted for completion in 2010, using a similar spatial framework and National-scale synoptic sources of indicator data.

- Adapt this approach to assist broader initiatives such as Ecosystem Based Management (EBM), Integrated Ecosystem Assessments (IEAs), and Marine Spatial Planning (MSP).

Update and Improve the ACFHP Assessment of Existing Information

- Expand the bibliographic table with sources missed in the current version, including entries from existing bibliographies, and updated systematic searches of peer-reviewed literature and library holdings.

- Periodically update both the Bibliographic and Assessment tables with new and corrected information. Note that some indicator reports (e.g. "State of the Bay") are issued annually, and web links to documents must be checked and fixed as needed.

- Revisit and revise specific anomalies in the Bibliographic and Assessment tables, such as cases where multiple habitat threats or conservation recommendations are reported together, referring back to the original source documents.

- Explore the feasibility of migrating the relational database, its functionality and underlying data tables, into a new interactive ACFHP website.

- Re-classify threats and actions to meet the needs of ACFHP's planning process. Classification could be based on schemes developed by IUCN (2006a, 2006b), a modified scheme for marine and estuarine waters (Odell 2008), and/or ASMFC's recent Diadromous species review (Greene et al. 2009). Applying consistent schema could help integrate and "connect the dots" between the sometimes disparate indicator, threat, and conservation action information.

- Develop new ways to report and display information from the database, such as one-page summaries of indicator, threat, and conservation action information for each waterbody. Such a summary would likely include baseline characterization information from sources such as the National Estuarine Inventory Atlas and Coastal Assessment Framework (NOAA 1985, 1997), consistently reported core indicator information (U.S. EPA 2008, Bricker et al. 2007, Kimbrough et al. 2008), and brief summaries of threats and conservation recommendations.

- Explore the use of data portals and internet map services to assist conservation planning. Many of these are identified in the bibliography, and they may provide a low-cost and user-friendly way to meet mapping and data needs.

- Explore the use of desktop GIS to meet the mapping and analysis needs of Fish Habitat Partnerships. Data can be downloaded from sources identified, and imported into ArcGIS, ArcReader, or other low-cost GIS applications.

- Explore the feasibility of applying further analysis to indicator data sets such as EPA Coastal Conditions, NOAA's MusselWatch and Estuarine Eutrophication, etc. Intersect point layer data with the ACFHP polygon layer to "bin" the point data into the spatial framework. Consult with original authors and other experts on caveats, interpretation of results, and potential anomalies when attributing point data to a per-waterbody basis.

- Fix anomalies identified in the GIS base layers. Merge U.S. and Canada portions of Passamaquoddy Bay, and delineate disjunct CDAs treated as a single polygon.

- Review and revise the spatial framework within the Chesapeake Bay region. Determine which of the nineteen sub-estuaries can be combined without losing spatial resolution of the available data, and which areas should be considered as distinct. In the section on *Indicators* above on p. 24, it is noted that little information is reported separately for some of the smaller Chesapeake sub-estuaries. In contrast, there may be other data-rich areas that warrant distinct consideration, such as the Elizabeth River in Norfolk VA and the Anacostia River in Washington DC.

Table 3. MusselWatch rankings for overall metals and organics contamination status and trends in selected ACFHP waterbodies. For waterbodies with multiple MusselWatch sites, the "worst" rankings (not averages) are reported. Waterbodies with status of medium or high, or trends increasing, are highlighted for emphasis. Source: Kimbrough et al. 2008, Kimbrough pers. comm.

ACFHP State	ACFHP Waterbody	Metals Status	Metals Trends	Organics Status	Organics Trends
ME	Penobscot Bay	low	decreasing	low	stable
ME	Casco Bay	low	stable	low	decreasing
ME	Maine State Waters	low	stable	low	decreasing
NH	Great Bay	low	stable	low	stable
MA	Massachusetts State Waters	low	stable	low	decreasing
MA	**Boston Harbor**	low	stable	**medium**	decreasing
MA	Massachusetts Bay	low	stable	low	stable
MA	Cape Cod Bay	low	stable	low	decreasing
MA	Massachusetts State Waters	low	stable	low	stable
MA	**Buzzards Bay**	low	**increasing**	low	stable
RI	Narragansett Bay	low	stable	low	decreasing
RI	Rhode Island State Waters	low	stable	low	decreasing
CT	Connecticut River	low	stable	low	decreasing
NY	Long Island Sound	low	stable	low	stable
NY	Gardiners Bay	low	stable	low	stable
NY	Great South Bay	low	stable	low	stable
NY	**Hudson River/Raritan Bay**	low	stable	**high**	stable
NJ	New Jersey State Waters	low	stable	low	decreasing
NJ	Barnegat Bay	low	stable	low	decreasing
NJ	New Jersey Inland Bays	low	stable	low	stable
NJ	**Delaware Bay**	**medium**	stable	low	stable
MD	**Patapsco/Gunpowder River**	**medium**	stable	low	decreasing
MD	Chesapeake Bay	low	stable	low	decreasing
MD	Severn River	low	stable	low	decreasing
MD	Choptank River	low	stable	low	decreasing
MD	Patuxent River	low	stable	low	decreasing
MD	Potomac River	low	stable	low	stable
VA	Rappahannock River	low	stable	low	decreasing
VA	Poquoson/Back Rivers	low	stable	low	decreasing
VA	**James River**	**medium**	decreasing	low	decreasing
VA	Virginia Eastern Shore	low	stable	low	decreasing
VA	Chincoteague Bay	low	stable	low	stable
VA	Virginia State Waters	low	stable	low	stable
NC	Albemarle Sound	low	stable	low	decreasing
NC	Pamlico Sound	low	stable	low	decreasing
NC	Pamlico/Pungo Rivers	low	decreasing	low	stable
NC	Neuse River	low	stable	low	stable
NC	Bogue Sound	low	stable	low	decreasing
NC	Cape Fear River	low	stable	low	decreasing
SC	Winyah Bay	low	stable	low	stable
SC	North/South Santee Rivers	low	stable	low	stable
SC	Charleston Harbor	low	stable	low	decreasing
GA	Savannah River	low	stable	low	decreasing
GA	St. Catherines/Sapelo Sound	low	stable	low	decreasing
GA	Altamaha River	low	stable	low	stable
FL	**St. Johns River**	low	**increasing**	low	stable
FL	Florida State Waters - North	low	stable	low	stable
FL	Indian River	low	stable	low	stable
FL	Biscayne Bay	low	stable	low	stable

Table 4. Rankings for selected eutrophication indicators in ACFHP waterbodies from the National Estuarine Eutrophication Assessment. The first column (Overall Eutrophic Condition) provides a synoptic assessment of each waterbody, color-coded (red to blue) for easy interpretation. Rankings are from the 2007 report unless indicated from 1999. Sources: Bricker et al. 2007, Bricker et al. 1999, Bricker pers. comm.

ACFHP State(s)	ACFHP Waterbody	Overall Eutrophic Condition	Future Outlook	Chlorophyll a - Overall Expression	Harmful Algal Blooms - Overall Expression	Dissolved Oxygen - Overall Expression	Eutrophication - Impact to SAV	Macroalgae - Overall Expression	Eutrophication - Impact to Living Resources	Secchi Depth - Overall Expression
ME NB	Passamaquoddy Bay	Moderate	Large improvement	low	low	no problem	no problem	high	no impact	low
ME	Englishman / Machias Bay	Moderate High (1999)	unknown	moderate (1999)	moderate (1999)	no problem (1999)	unknown	high (1999)	unknown	low (1999)
ME	Narraguagus Bay	Moderate High (1999)	unknown	moderate (1999)	high (1999)	no problem (1999)	unknown	no problem (1999)	unknown	low (1999)
ME	Blue Hill Bay	Low	Small Deterioration	low	low	no problem	no problem	no problem	no impact	low
ME	Penobscot Bay	Low	unknown	low	no problem	no problem	unknown	no problem	unknown	moderate
ME	Muscongus Bay	Moderate Low (1999)	unknown	moderate (1999)	low (1999)	low (1999)	unknown	no problem (1999)	unknown	unknown
ME	Damariscotta River	Low	No Change	unknown	low	unknown	unknown	no problem	unknown	unknown
ME	Sheepscot Bay	Moderate High (1999)	unknown	moderate (1999)	high (1999)	low (1999)	unknown	moderate (1999)	unknown	moderate (1999)
ME	Kennebec / Androscoggin River	Moderate Low (1999)	unknown	moderate (1999)	no problem (1999)	low (1999)	unknown	no problem (1999)	unknown	moderate (1999)
ME	Casco Bay	Moderate High (1999)	Small Deterioration	moderate (1999)	low	no problem	no problem	unknown	unknown	moderate
ME	Saco Bay	Moderate (1999)	unknown	low (1999)	low	low (1999)	unknown	unknown	unknown	moderate (1999)
ME	Wells Bay	Low	Small Deterioration	low	no problem	low	no problem	no problem	unknown	unknown
NH ME	Great Bay	Moderate	Large Deterioration	low	low	no problem	low	high	slightly	moderate
NH	Hampton Harbor	Moderate	Small Deterioration	low	low	no problem	no problem	high	unknown	high
MA	Merrimack River	unknown	unknown	unknown	unknown	unknown	moderate (1999)	unknown	unknown	unknown
MA	Plum Island Sound	Moderate High	Large Deterioration	high	moderate	no problem	no problem (1999)	unknown	unknown	unknown
MA	Massachusetts Bay	Moderate	Large improvement	high	low	no problem	low (1999)	unknown	unknown	unknown
MA	Boston Harbor	Low	Large Deterioration	low	no problem	no problem	no problem	no problem	moderately	low
MA	Cape Cod Bay	Moderate	Large Deterioration	high	low	no problem	unknown	moderate	unknown	low (1999)
MA	Waquoit Bay	Moderate	Small Deterioration	moderate	no problem	low	low	high	considerably	unknown
MA	Buzzards Bay	Moderate	Large Deterioration	low	moderate	low	low	moderate	moderately	low (1999)

Table 4, continued. Rankings for selected eutrophication indicators in ACFHP waterbodies from the National Estuarine Eutrophication Assessment. The first column (Overall Eutrophic Condition) provides a synoptic assessment of each waterbody, color-coded (red to blue) for easy interpretation. Rankings are from the 2007 report unless indicated from 1999. Sources: Bricker et al. 2007, Bricker et al. 1999, Bricker pers. comm.

ACFHP State(s)	ACFHP Waterbody	Overall Eutrophic Condition	Future Outlook	Chlorophyll a - Overall Expression	Harmful Algal Blooms - Overall Expression	Dissolved Oxygen - Overall Expression	Eutrophication - Impact to SAV	Macroalgae - Overall Expression	Eutrophication - Impact to Living Resources	Secchi Depth - Overall Expression
RI MA	Narragansett Bay	High	Large improvement	moderate	moderate	high	no problem	high	considerably	moderate (1999)
CT	Connecticut River	Low	Large improvement	unknown	no problem	no problem	no problem	no problem	slightly	moderate (1999)
NY CT	Long Island Sound	High	Small improvement	high	low	high	low	no problem	moderately	low
NY	Peconic / Gardiners Bay	Low	No Change	low	low	no problem	high (1999)	no problem	unknown	low
NY	Great South Bay	Moderate High	No Change	high	moderate	no problem	moderate (1999)	high	moderately	low
NY NJ	Hudson River / Raritan Bay	Moderate	Small improvement	high	moderate (1999)	low	no problem (1999)	low (1999)	considerably	high
NJ	Barnegat Bay	High	Small improvement	high	high	no problem	moderate	high	considerably	high (1999)
NJ	New Jersey Inland Bays	High	Large Deterioration	low	low	no problem	high	high	considerably	high (1999)
DE	Delaware Inland Bays	Moderate	No Change	moderate	low	low	no problem	high	moderately	high
DE NJ	Delaware Bay	Moderate	No Change	high	no problem	low	no problem	no problem	no impact	high
MD DE	Maryland Inland Bays	Moderate	Large Deterioration	high	low	low	low	moderate	unknown	high
MD VA	Chincoteague Bay	High	Small Deterioration	high	high	no problem	low	moderate	unknown	high
MD VA	Chesapeake Bay	High	Small improvement	high	high	high	high	moderate	considerably	high
MD	Chester River	High	Small improvement	high	no problem (1999)	high	no problem	no problem (1999)	unknown	high
MD	Choptank River	High	Small improvement	high	high	low	no problem	no problem	considerably	low
MD VA	Tangier / Pocomoke Sound	Moderate High	Small Deterioration	high	low (1999)	no problem	moderate	high (1999)	considerably	moderate
MD	Patuxent River	High	Small Deterioration	high	moderate	high	no problem	no problem (1999)	considerably	moderate
MD DC VA	Potomac River	High	Small Deterioration	high	high	moderate	no problem	low (1999)	considerably	moderate
VA	Rappahannock River	Moderate High	No Change	high	moderate	moderate	moderate	no problem	moderately	high
VA	York River	Moderate High	No Change	high	moderate	low	no problem	moderate	moderately	moderate
VA	James River	Moderate High	No Change	high	moderate	no problem	no problem	no problem	moderately	high

Table 4, continued. Rankings for selected eutrophication indicators in ACFHP waterbodies from the National Estuarine Eutrophication Assessment. The first column (Overall Eutrophic Condition) provides a synoptic assessment of each waterbody, color-coded (red to blue) for easy interpretation. Rankings are from the 2007 report unless indicated from 1999. Sources: Bricker et al. 2007, Bricker et al. 1999, Bricker pers. comm.

ACFHP State(s)	ACFHP Waterbody	Overall Eutrophic Condition	Future Outlook	Chlorophyll a - Overall Expression	Harmful Algal Blooms - Overall Expression	Dissolved Oxygen - Overall Expression	Eutrophication - Impact to SAV	Macroalgae - Overall Expression	Eutrophication - Impact to Living Resources	Secchi Depth - Overall Expression
NC VA	Albemarle Sound	unknown	unknown	low (1999)	low (1999)	low (1999)	low (1999)	no problem (1999)	unknown	low (1999)
NC	Pamlico Sound	unknown	Large Deterioration	moderate (1999)	moderate	low (1999)	low (1999)	no problem (1999)	unknown	moderate (1999)
NC	Pamlico / Pungo Rivers	unknown	unknown	unknown	unknown	unknown	moderate (1999)	no problem (1999)	unknown	moderate (1999)
NC	Neuse River	High	Small Deterioration	high	high	low	low (1999)	no problem (1999)	considerably	high
NC	Bogue Sound	unknown	unknown	unknown	unknown	unknown	unknown	no problem (1999)	unknown	high (1999)
NC	New River	Moderate	No Change	high	low	low	unknown	no problem	moderately	high
NC	Cape Fear River	Moderate Low	Small Deterioration	moderate	no problem	low	unknown	no problem	moderately	moderate
SC	Winyah Bay	Moderate	Large Deterioration	moderate	no problem	moderate	no problem (1999)	no problem (1999)	unknown	high
SC	North / South Santee Rivers	Moderate	unknown	moderate	low	moderate	unknown	no problem (1999)	unknown	high
SC	Charleston Harbor	Moderate Low	Large Deterioration	moderate	low	no problem	no problem (1999)	moderate (1999)	unknown	high
SC	Stono / North Edisto Rivers	Moderate	Small Deterioration	moderate	low	moderate	no problem (1999)	no problem (1999)	unknown	high
SC	St. Helena Sound	Moderate	Small Deterioration	moderate	low	moderate	unknown	unknown	unknown	blackwater
SC	Broad River	Moderate Low	Large Deterioration	moderate	no problem	low	unknown	unknown	unknown	high
GA SC	Savannah River	Moderate	Large Deterioration	moderate	no problem	moderate	no problem	no problem	unknown	high
GA	Ossabaw Sound	Moderate Low	Small Deterioration	unknown	no problem	moderate	no problem	no problem	no impact	high (1999)
GA	St. Catherines / Sapelo Sounds	Moderate Low (1999)	unknown	moderate (1999)	no problem (1999)	low (1999)	no problem (1999)	no problem (1999)	unknown	high (1999)
GA	Altamaha River	Low	Large Deterioration	moderate (1999)	no problem	low	no problem	no problem	unknown	high (1999)
GA	St. Andrew / St. Simons Sounds	Low	Large Deterioration	moderate (1999)	no problem	low (1999)	no problem	no problem	unknown	blackwater
GA FL	St. Marys River / Cumberland Sound	Moderate Low	Small Deterioration	moderate (1999)	no problem	moderate	no problem	no problem	no impact	blackwater
FL	St. Johns River	High	Small improvement	high	high	moderate	no problem	high	considerably	high
FL	Indian River	Moderate	Small Deterioration	low	moderate	low	no problem	moderate	moderately	low
FL	Biscayne Bay	Moderate Low	No Change	low	no problem	moderate	no problem	no problem	slightly	low (1999)

Table 5. National Coastal Condition Report (NCCR) Indices for U.S. EPA National Estuary Program (NEP) estuaries. Source: U.S. EPA 2006.

ACFHP State	ACFHP Waterbody	**Overall Condition**	Water Quality Index	Sediment Quality Index	Benthic Index	Fish Tissue Contaminants Index
ME	Casco Bay	**5 = Good**	5 = Good	5 = Good	5 = Good	unknown
MA	Boston Harbor	**2.5 = Fair/Poor**	5 = Good	1 = Poor	1 = Poor	3 = Fair
MA	Cape Cod Bay	**2.5 = Fair/Poor**	5 = Good	1 = Poor	1 = Poor	3 = Fair
MA	Buzzards Bay	**3.25 = Fair/Good**	5 = Good	3 = Fair	4 = Good/Fair	1 = Poor
RI	Narragansett Bay	**1.75 = Poor/Fair**	3 = Fair	1 = Poor	2 = Fair/Poor	1 = Poor
CT	Connecticut River	**1.5 = Poor/Fair**	3 = Fair	1 = Poor	1 = Poor	1 = Poor
NY	Long Island Sound	**1.5 = Poor/Fair**	3 = Fair	1 = Poor	1 = Poor	1 = Poor
NY	Peconic (Gardiners) Bay	**4.33 = Good/Fair**	5 = Good	unknown	3 = Fair	5 = Good
NY	Hudson River/Raritan Bay	**1 = Poor**	1 = Poor	1 = Poor	1 = Poor	1 = Poor
NJ	Barnegat Bay	**3.5 = Fair/Good**	4 = Good/Fair	4 = Good/Fair	3 = Fair	3 = Fair
DE	Delaware Inland Bays	**2.5 = Fair/Poor**	3 = Fair	1 = Poor	1 = Poor	5 = Good
DE	Delaware Bay	**1.75 = Poor/Fair**	1 = Poor	4 = Good/Fair	1 = Poor	1 = Poor
MD	Chincoteague Bay	**3.5 = Fair/Good**	1 = Poor	5 = Good	3 = Fair	5 = Good
NC	Albemarle Sound	**4 = Good/Fair**	5 = Good	4 = Good/Fair	3 = Fair	4 = Good/Fair
NC	Pamlico Sound	**4 = Good/Fair**	5 = Good	4 = Good/Fair	3 = Fair	4 = Good/Fair
NC	Pamlico/Pungo Rivers	**4 = Good/Fair**	5 = Good	4 = Good/Fair	3 = Fair	4 = Good/Fair
NC	Neuse River	**4 = Good/Fair**	5 = Good	4 = Good/Fair	3 = Fair	4 = Good/Fair
FL	Indian River	**5 = Good**	5 = Good	5 = Good	5 = Good	unknown

Table 6. National Coastal Condition Report (NCCR) water quality indicators for U.S. EPA National Estuary Program (NEP) estuaries. These are the indicators that contribute to the "Water Quality Index" reported in Table 5. Source: U.S. EPA 2006.

ACFHP State	ACFHP Waterbody	Dissolved Inorganic Nitrogen (DIN)	Dissolved Inorganic Phosphorus (DIP)	Dissolved Oxygen	Chlorophyll a	Water Clarity
ME	Casco Bay	Good	Good	Good	Good	Good
MA	Boston Harbor	Good	Good	Good	Good	Good
MA	Cape Cod Bay	Good	Good	Good	Good	Good
MA	Buzzards Bay	Good	Fair	Good	Good	Good
RI	Narragansett Bay	Good	Fair	Good	Fair	Good
CT	Connecticut River	Good	Fair	Fair	Good	Good
NY	Long Island Sound	Good	Fair	Fair	Good	Good
NY	Peconic (Gardiners) Bay	Good	Fair	Good	Good	Good
NY	Hudson River/Raritan Bay	Fair	Poor	Good	Good	Good
NJ	Barnegat Bay	Good	Good	Good	Good	Poor
DE	Delaware Inland Bays	Fair	Fair	Good	Fair	Good
DE	Delaware Bay	Poor	Fair	Good	Fair	Fair
MD	Chincoteague Bay	Poor	Poor	Good	Fair	Poor
NC	Albemarle Sound	Good	Good	Fair	Fair	Good
NC	Pamlico Sound	Good	Good	Fair	Fair	Good
NC	Pamlico/Pungo Rivers	Good	Good	Fair	Fair	Good
NC	Neuse River	Good	Good	Fair	Fair	Good
FL	Indian River	Good	Good	Fair	Fair	Good

Table 7. National Coastal Condition Report (NCCR) sediment quality indicators for U.S. EPA National Estuary Program (NEP) estuaries. These are the indicators that contribute to the "Sediment Quality Index" reported in Table 5. Source: U.S. EPA 2006.

ACFHP State	ACFHP Waterbody	Sediment Total Organic Carbon (TOC)	Sediment Contamination	Sediment Toxicity
ME	Casco Bay	Good	Good	Good
MA	Boston Harbor	Good	Fair	Poor
MA	Cape Cod Bay	Good	Fair	Poor
MA	Buzzards Bay	Good	Fair	Poor
RI	Narragansett Bay	Good	Fair	Poor
CT	Connecticut River	Good	Poor	Poor
NY	Long Island Sound	Good	Poor	Poor
NY	Peconic (Gardiners) Bay	unknown	unknown	unknown
NY	Hudson River/Raritan Bay	Good	Poor	Poor
NJ	Barnegat Bay	Good	Good	Good
DE	Delaware Inland Bays	Good	Good	Poor
DE	Delaware Bay	Good	Good	Poor
MD	Chincoteague Bay	Good	Good	Good
NC	Albemarle Sound	Good	Good	Good
NC	Pamlico Sound	Good	Good	Good
NC	Pamlico/Pungo Rivers	Good	Good	Good
NC	Neuse River	Good	Good	Good
FL	Indian River	Good	unknown	unknown

Table 8. Number of indicators and threats recorded for each estuary. Sorted in descending order (of indicators recorded), with NEP and NERR designation noted.

Estuary Name	Number of Indicators	Number of Threats	NEP?	NERR?
Delaware Bay	**65**	**21**	Yes	
Chesapeake Bay	**53**	**29**	Yes (Chesapeake Bay Program)	
Long Island Sound	**44**	**9**	Yes	Yes
Casco Bay	**40**	**21**	Yes	
Albemarle Sound	**36**	**7**	Yes	Yes
Chincoteague Bay	**35**	**8**	Yes	
Barnegat Bay	**34**	**10**	Yes	
Great Bay	**33**	**24**	Yes	Yes
Hudson River/Raritan Bay	**33**	**19**	Yes	Yes
Indian River	**30**	**11**	Yes	
Narragansett Bay	**30**	**10**	Yes	
Buzzards Bay	**29**	**11**	Yes	
Pamlico Sound	**29**	**9**	Yes	
Cape Cod Bay	**29**	**7**	Yes (Massachusetts Bays)	Yes
Boston Harbor	**28**	**9**	Yes (Massachusetts Bays)	
James River	**27**	**12**	Yes (sub-estuary of Chesapeake Bay)	
Savannah River	**27**	**11**		Yes
Neuse River	**27**	**10**	Yes (sub-estuary of Pamlico Sound)	
Pamlico/Pungo Rivers	**27**	**6**	Yes (sub-estuary of Pamlico Sound)	Yes
Peconic (Gardiners) Bay	**27**	**4**	Yes	
Connecticut River	**26**	**8**	Yes (sub-estuary of Long Island Sound)	
Potomac River	**24**	**11**	Yes (sub-estuary of Chesapeake Bay)	
Cape Fear River	**22**	**10**		
Bogue Sound	**22**	**4**		
Delaware Inland Bays	**22**	**4**	Yes	
Maryland Inland Bays	**19**	**9**	Yes	
New Jersey Inland Bays	**18**	**7**		
Patuxent River	**18**	**4**	Yes (sub-estuary of Chesapeake Bay)	Yes
Charleston Harbor	**17**	**11**		
North/South Santee Rivers	**17**	**8**		
Winyah Bay	**17**	**8**		
Massachusetts Bay	**17**	**6**	Yes (Massachusetts Bays)	
Altamaha River	**17**	**5**		Yes
St. Catherines/Sapelo Sounds	**16**	**2**		
Biscayne Bay	**15**	**11**		
Penobscot Bay	**14**	**23**		
St. Marys River/Cumberland Sound	**14**	**7**		
St. Johns River	**13**	**13**		
Rappahannock River	**13**	**6**	Yes (sub-estuary of Chesapeake Bay)	
Choptank River	**13**	**3**	Yes (sub-estuary of Chesapeake Bay)	
Great South Bay	**13**	**3**		

Table 8, continued. Number of indicators and threats recorded for each estuary. Sorted in descending order (of indicators recorded), with NEP and NERR designation noted.

Estuary Name	Number of Indicators	Number of Threats	NEP?	NERR?
St. Andrew/St. Simons Sounds	**12**	**6**		
Ossabaw Sound	**12**	**5**		
Sheepscot Bay	**11**	**12**		
Passamaquoddy Bay	**10**	**15**		Yes
Wells Bay	**10**	**12**		
Merrimack River	**10**	**4**		
Broad River	**10**	**3**		Yes
Plum Island Sound	**10**	**2**		
Kennebec/Androscoggin River	**9**	**16**		
Englishman/Machias Bay	**9**	**15**		Yes
Hampton Harbor	**9**	**12**		Yes
Saco Bay	**9**	**11**		Yes
Tangier/Pocomoke Sound	**9**	**10**	Yes (sub-estuary of Chesapeake Bay)	
York River	**9**	**8**	Yes (sub-estuary of Chesapeake Bay)	
Stono/North Edisto Rivers	**9**	**5**		
Waquoit Bay	**9**	**5**		
Chester River	**9**	**3**	Yes (sub-estuary of Chesapeake Bay)	
New River	**9**	**3**		
St. Helena Sound	**9**	**3**		
Blue Hill Bay	**8**	**14**		Yes
Damariscotta River	**8**	**14**		
Muscongus Bay	**8**	**14**		
Narraguagus Bay	**8**	**13**		
Patapsco/Gunpowder Rivers	**8**	**7**	Yes (sub-estuary of Chesapeake Bay)	Yes
Severn River	**7**	**2**	Yes (sub-estuary of Chesapeake Bay)	
Wassaw Sound	**5**	**3**		
Virginia Eastern Shore	**5**	**1**	Yes (sub-estuary of Chesapeake Bay)	
Poquoson/Back Rivers	**4**	**5**	Yes (sub-estuary of Chesapeake Bay)	
Nassau Sound	**1**	**5**		
Ingram/Fleets Bays	**1**	**4**	Yes (sub-estuary of Chesapeake Bay)	
Lynnhaven River	**1**	**4**	Yes (sub-estuary of Chesapeake Bay)	
Eastern Bay	**1**	**3**	Yes (sub-estuary of Chesapeake Bay)	
Piankatank River/Mobjack Bay	**1**	**3**	Yes (sub-estuary of Chesapeake Bay)	
Elk/Sassafras Rivers	**1**	**2**	Yes (sub-estuary of Chesapeake Bay)	
Honga River	**1**	**2**	Yes (sub-estuary of Chesapeake Bay)	Yes
Susquehanna River	**1**	**2**	Yes (sub-estuary of Chesapeake Bay)	

Table 9. Classification of Threats as recorded in the Assessment Table (total n=1260). The classification scheme was developed by discussions of the ACFHP Steering Committee, June 2009. Threats include those attributed to estuaries, watersheds, and marine waters.

Classified Threat	Number of Instances	Notes
2. Water Quality	**225**	including nutrients, eutrophication, DO, BOD
1. Dams and Passage	**106**	including all barriers to fish migration
5. Climate Change	**97**	including Sea Level Rise
6. Dredging Issues	**89**	including dredge spoil disposal
7. Contaminants	**84**	generally in sediments or tissues
8. Fishing Gear	**73**	impacts of bottom tending fishing gear
4. Impervious Surfaces	**64**	also Urban Land Development
9. Invasive Species	**54**	also Non-Native Species
11. Water Withdrawals	**25**	when reported separately from Altered Hydrology / Multiple Threats
13. Aquaculture	**17**	
10. Boating issues	**15**	Vessel damage, sewage discharge
3. Energy Development	**9**	Wind, tidal, hydro
15. Temperature	**8**	when reported separately from Climate Change
12. Groundwater	**5**	when reported separately from Altered Hydrology / Multiple Threats
14. Regulatory Systems	**0**	these were generally classified as "Actions"
Multiple Threats Reported	**96**	many include altered hydrology and water quality
Other - Habitat Loss	**47**	reported as a threat - but can be considered a result
Other - Algal blooms	**23**	may or may not be related to water quality
Other - Forestry Practices	**23**	watershed land use
Other - Stormwater Issues	**22**	non-point source
Other - Agricultural Runoff	**20**	non-point source
Other - Marine Debris	**19**	
Other - Agricultural Practices	**17**	watershed land use
Other - Tidal Restriction	**17**	hydrology
Other - Bacterial Contamination	**16**	distinct from water quality and contaminants?
Other - Riparian Buffers	**14**	watershed land use?
Other - Sedimentation	**14**	Distinct threat?
Other - Disease of Biotic Habitats	**10**	group with bacterial contamination, pathogens?
Other - Shoreline Erosion	**10**	
Other - Sewage and Septic Issues	**9**	associated with Water Quality?
Other - Marine Infrastructure	**5**	associated with Dredging Issues?
Other - Intakes and Impingement	**3**	associated with Water Withdrawals?
Other - Storm Events	**3**	
Other - Unexploded Ordnance	**3**	
Other - Nuisance Macroalgae	**2**	group with Algal Blooms?
Other - Ocean Noise	**2**	impacts to marine mammals
Other - Lighting on Beaches	**1**	impacts to nesting sea turtles
Other - Recreational Vehicles	**1**	in wetlands and beaches
Other - Shoreline Hardening	**1**	associated with Altered

Table 10. Instances of classified threats within the Assessment Table (total n=1260), tallied by region. Results for the South Atlantic and South Florida are combined.

Classified Threat	North Atlantic	Mid-Atlantic	South Atlantic + South Florida
01. Dams and Passage	**39**	**32**	**35**
02. Water Quality	**90**	**87**	**48**
03. Energy Development	**7**	**2**	
04. Impervious Surfaces	**18**	**28**	**18**
05. Climate Change	**23**	**52**	**22**
06. Dredging Issues	**29**	**28**	**32**
07. Contaminants	**33**	**33**	**18**
08. Fishing Gear	**9**	**20**	**44**
09. Invasive Species	**16**	**33**	**5**
10. Boating issues	**5**	**5**	**5**
11. Water Withdrawals	**14**	**6**	**5**
12. Groundwater	**1**		**4**
13. Aquaculture	**15**	**2**	
14. Regulatory Systems			
15. Temperature	**1**	**7**	
Multiple Threats Reported	**20**	**41**	**35**
Other - Acid Rain		**2**	
Other - Agricultural Practices		**13**	**4**
Other - Agricultural Runoff	**2**	**3**	**15**
Other - Algal blooms	**5**	**16**	**2**
Other - Altered Hydrology	**2**		
Other - Bacterial Contamination	**9**	**7**	
Other - Disease of Biotic Habita	**2**	**7**	**1**
Other - Fish Waste Disposal	**1**	**1**	
Other - Forestry Practices	**12**	**11**	
Other - Habitat Loss	**31**	**7**	**9**
Other - Intakes and Impingemen	**1**	**2**	
Other - Lighting on Beaches			**1**
Other - Marine Debris	**17**		**2**
Other - Marine Infrastructure	**3**	**1**	**1**
Other - Nuisance Macroalgae		**2**	
Other - Ocean Noise	**1**	**1**	
Other - Recreational Vehicles			**1**
Other - Riparian Buffers		**14**	
Other - Sedimentation	**11**	**3**	
Other - Sewage and Septic Issue	**4**	**5**	
Other - Shoreline Erosion	**6**	**1**	**3**
Other - Shoreline Hardening		**1**	
Other - Storm Events	**1**	**2**	
Other - Stormwater Issues	**4**	**9**	**9**
Other - Tidal Restriction	**5**	**12**	
Other - Unexploded Ordnance		**3**	

Table 11. Instances of classified threats within the Assessment Table (total n=1260), tallied by zone. Results for the Marine-State and Marine-Federal zones are combined.

Classified Threat	Watersheds	Estuaries	Marine
01. Dams and Passage	100	6	
02. Water Quality	51	164	9
03. Energy Development		5	4
04. Impervious Surfaces	51	11	2
05. Climate Change	13	32	52
06. Dredging Issues	5	58	26
07. Contaminants	6	68	10
08. Fishing Gear	1	41	31
09. Invasive Species	16	37	1
10. Boating issues		8	7
11. Water Withdrawals	18	7	
12. Groundwater		5	
13. Aquaculture		13	
14. Regulatory Systems			
15. Temperature	8		
Multiple Threats Reported	30	63	3
Other - Habitat Loss	9	37	1
Other - Algal blooms		17	6
Other - Forestry Practices	23		
Other - Stormwater Issues	13	5	4
Other - Agricultural Runoff	11	5	4
Other - Marine Debris		16	3
Other - Agricultural Practices	17		
Other - Tidal Restriction	6	6	5
Other - Bacterial Contamination		12	4
Other - Riparian Buffers	14		
Other - Sedimentation	2	12	
Other - Disease of Biotic Habitats		9	1
Other - Sewage and Septic Issue	1	2	7
Other - Shoreline Erosion	3	2	5
Other - Marine Infrastructure		1	4
Other - Intakes and Impingement		1	2
Other - Unexploded Ordnance	1	1	1
Other - Storm Events		3	
Other - Acid Rain	2		
Other - Altered Hydrology		2	
Other - Fish Waste Disposal			2
Other - Nuisance Macroalgae		2	
Other - Ocean Noise			2
Other - Lighting on Beaches	1		
Other - Recreational Vehicles			1
Other - Shoreline Hardening	1		

Table 12. Top three classified threats by zone and region, based on a tally of instances within the Assessment Table (total n=1260). Tallies for the South Atlantic and South Florida regions are combined, as are tallies for the Marine-State and Marine-Federal zones. Results are displayed within a region x zone matrix.

Region / Zone	Watersheds	Estuaries	Marine (S+F)
North Atlantic	**Dams and Passage (37)** Water Quality (28) Water Withdrawals (14)	**Water Quality (55)** Contaminants (23) Dredging Issues (16)	**Dredging Issues (13)** Climate Change (11) Fishing Gear (8)
Mid-Atlantic	**Dams and Passage (32)** Impervious Surfaces (25) Water Quality (16)	**Water Quality (70)** Contaminants (28) Invasive Species (19)	**Climate Change (23)** Fishing Gear (11) Dredging Issues (9)
South Atlantic + South Florida	**Dams and Passage (31)** Impervious Surfaces (17) Water Quality (7)	**Water Quality (40)** Fishing Gear (31) Dredging Issues (26)	**Climate Change (18)** Fishing Gear (12) Dredging Issues (4) Boating Issues (4)

Table 13. Classification of Actions as recorded in the Assessment Table (total n=1860). The classification scheme is based on themes that emerged from the data itself. Most actions address either a particular habitat type (e.g. “restore wetlands”) or a particular threat (e.g. “improve fish passage”). Actions include those attributed to estuaries, watersheds, and marine waters.

Classified Action	Number of Instances	Notes
Area Designation	**304**	Includes MPAs, EFH, HAPCs, Conservation Priority Areas
Water Quality - Protect and Restore	**134**	
Wetlands - Protect and Restore	**121**	
Improve Fish Passage	**109**	Includes barrier removal
Monitoring and Assessment	**93**	Includes Mapping and Research Recommendations
Conservation Planning	**89**	Includes policy, legislation, and enforcement
Riparian Buffers - Conserve and Restore	**86**	
Control Invasive Species	**81**	
General Habitat Conservation	**79**	Actions not specific towards a threat, habitat type, or species
SAV - Protect and Restore	**79**	
Watersheds - Conserve and Restore	**73**	
Fishery Regulation	**68**	Some overlap with MPAs
Clean Boating	**47**	Includes no discharge zones, pumpouts, vessel groundings, etc.
Improve Stormwater Management	**47**	Includes urban runoff
Hydrology - Protect and Restore	**46**	Includes freshwater and tidal flow
Education, Outreach, and Partnerships	**45**	
Improve Wastewater Management	**45**	Includes sewage and septic issues
Beaches and Shorelines - Protect and Restore	**44**	Includes dune restoration, some beach nourishment (also a threat?)
Shellfish Beds - Protect and Restore	**42**	
Conserve Species	**34**	Actions directed towards individual species (e.g. shortnose sturgeon)
Agricultural Conservation BMPs	**31**	
Multiple Recommendations	**29**	Several recommendations reported in single item
Forestry BMPs	**26**	Some overlap with Watershed and Agricultural BMPs
Dredging Regulation	**24**	
Prepare for Climate Change Impacts	**22**	
Clean Up Marine Debris	**21**	
Clean Up Contaminants	**14**	
Improve Public Access	**8**	
Reduce Sedimentation	**7**	
Other - Threat misclassified as Action?	**5**	
Other - mine drainage mitigation	**2**	
Other - preserve historic resources	**1**	
Other - experimental restoration	**1**	
Other - improve benthic productivity	**1**	
Other - respond to natural disasters	**1**	

Table 14. Instances of classified actions within the Assessment Table (total n=1860), tallied by region. Results for the South Atlantic and South Florida are combined.

Classified Action	North Atlantic	Mid-Atlantic	South Atlantic + South Florida
Area Designation	**56**	**106**	**142**
Water Quality - Protect and Restore	11	**106**	17
Wetlands - Protect and Restore	**53**	**58**	10
Improve Fish Passage	**38**	42	**29**
Monitoring and Assessment	33	42	18
Conservation Planning	16	**67**	6
Riparian Buffers - Conserve and Restore	21	**60**	5
Control Invasive Species	8	**67**	5
General Habitat Conservation	26	42	11
SAV - Protect and Restore	13	**61**	5
Watersheds - Conserve and Restore	31	40	2
Fishery Regulation	6	17	**45**
Clean Boating	23	21	3
Improve Stormwater Management	9	31	7
Hydrology - Protect and Restore	18	17	11
Education, Outreach, and Partnerships	30	15	
Improve Wastewater Management	7	37	1
Beaches and Shorelines - Protect and Restore	11	28	5
Shellfish Beds - Protect and Restore	14	21	7
Conserve Species	6	15	14
Agricultural Conservation BMPs		25	6
Multiple Recommendations	5	18	6
Forestry BMPs		26	
Dredging Regulation		8	16
Prepare for Climate Change Impacts		22	
Clean Up Marine Debris	14	4	3
Clean Up Contaminants	2	11	1
Improve Public Access		8	
Reduce Sedimentation	1	6	
Other - Threat misclassified as Action?		5	
Other - mine drainage mitigation		2	
Other - preserve historic resources			1
Other - experimental restoration		1	
Other - improve benthic productivity		1	
Other - respond to natural disasters			1

Table 15. Instances of classified actions within the Assessment Table (total n=1860), tallied by zone. Results for the Marine-State and Marine-Federal zones are combined.

Classified Action	Watersheds	Estuaries	Marine
Area Designation	**69**	**128**	**107**
Water Quality - Protect and Restore	**51**	**79**	**4**
Wetlands - Protect and Restore	**15**	**98**	**8**
Improve Fish Passage	**97**	**12**	
Monitoring and Assessment	**8**	**43**	**42**
Conservation Planning	**30**	**46**	**13**
Riparian Buffers - Conserve and Restore	**81**	**4**	**1**
Control Invasive Species	**6**	**73**	**2**
SAV - Protect and Restore	**2**	**75**	**2**
Watersheds - Conserve and Restore	**55**	**16**	**2**
General Habitat Conservation	**42**	**26**	**1**
Fishery Regulation	**1**	**39**	**28**
Clean Boating	**1**	**36**	**10**
Improve Stormwater Management	**30**	**15**	**2**
Hydrology - Protect and Restore	**22**	**24**	
Education, Outreach, and Partnerships	**21**	**18**	**6**
Improve Wastewater Management	**21**	**22**	**2**
Beaches and Shorelines - Protect and Restore	**4**	**23**	**17**
Shellfish Beds - Protect and Restore	**1**	**40**	**1**
Conserve Species	**24**	**10**	
Agricultural Conservation BMPs	**31**		
Multiple Recommendations	**13**	**16**	
Forestry BMPs	**26**		
Dredging Regulation	**1**	**23**	
Prepare for Climate Change Impacts	**20**	**2**	
Clean Up Marine Debris		**17**	**4**
Clean Up Contaminants	**3**	**11**	
Improve Public Access	**2**	**6**	
Reduce Sedimentation	**1**	**6**	
Other - Threat misclassified as Action?		**5**	
Other - mine drainage mitigation	**2**	**1**	
Other - preserve historic resources			**1**
Other - experimental restoration		**1**	
Other - respond to natural disasters		**1**	
Other - improve benthic productivity		**1**	

Table 16. Top three classified actions by zone and region, based on a tally of instances within the Assessment Table (total n=1860). Tallies for the South Atlantic and South Florida regions are combined, as are tallies for the Marine-State and Marine-Federal zones. Results are displayed within a region x zone matrix.

Region / Zone	Watersheds	Estuaries	Marine (State+Federal)
North Atlantic	**Improve Fish Passage (38)** Watersheds - Conserve and Restore (24) Riparian Buffers - Conserve and Restore (21)	**Wetlands - Protect and Restore (38)** Area Designation (27) Monitoring and Assessment (25)	**Area Designation (15)** Wetlands - Protect and Restore (7) Monitoring and Assessment (7)
Mid-Atlantic	**Riparian Buffers - Conserve and Restore (55)** Water Quality - Protect and Restore (45) Improve Fish Passage (30)	**Control Invasive Species (61)** Water Quality - Protect and Restore (60) SAV - Protect and Restore (59)	**Area Designation (33)** Monitoring and Assessment (28) Fishery Regulation (12)
South Atlantic + South Florida	**Improve Fish Passage (29)** Area Designation (28) Conserve Species (13)	**Area Designation (55)** Fishery Regulation (33) Dredging Regulation (15)	**Area Designation (59)** Fishery Regulation (12) Monitoring and Assessment (7)

Table 17. Top three classified threats and actions, by zone and region, based on tallies of instances within the Assessment Table. Results for Tables 12 and 16 are combined, so that the top three classified threats and actions can be viewed together. Results are displayed within a region x zone matrix, and are combined for the South Atlantic and South Florida regions, and for the Marine-State and Marine-Federal zones.

Region / Zone	Watersheds	Estuaries	Marine (State+Federal)
North Atlantic	***Threats:*** **Dams and Passage (37)** Water Quality (28) Water Withdrawals (14) ***Actions:*** **Improve Fish Passage (38)** Watersheds - Conserve and Restore (24) Riparian Buffers - Conserve and Restore (21)	***Threats:*** **Water Quality (55)** Contaminants (23) Dredging Issues (16) ***Actions:*** **Wetlands - Protect and Restore (38)** Area Designation (27) Monitoring and Assessment (25)	***Threats:*** **Dredging Issues (13)** Climate Change (11) Fishing Gear (8) ***Actions:*** **Area Designation (15)** Wetlands - Protect and Restore (7) Monitoring and Assessment (7)
Mid-Atlantic	***Threats:*** **Dams and Passage (32)** Impervious Surfaces (25) Water Quality (16) ***Actions:*** **Riparian Buffers - Conserve and Restore (55)** Water Quality - Protect and Restore (45) Improve Fish Passage (30)	***Threats:*** **Water Quality (70)** Contaminants (28) Invasive Species (19) ***Actions:*** **Control Invasive Species (61)** Water Quality - Protect and Restore (60) SAV - Protect and Restore (59)	***Threats:*** **Climate Change (23)** Fishing Gear (11) Dredging Issues (9) ***Actions:*** **Area Designation (33)** Monitoring and Assessment (28) Fishery Regulation (12)
South Atlantic + South Florida	***Threats:*** **Dams and Passage (31)** Impervious Surfaces (17) Water Quality (7) ***Actions:*** **Improve Fish Passage (29)** Area Designation (28) Conserve Species (13)	***Threats:*** **Water Quality (40)** Fishing Gear (31) Dredging Issues (26) ***Actions:*** **Area Designation (55)** Fishery Regulation (33) Dredging Regulation (15)	***Threats:*** **Climate Change (18)** Fishing Gear (12) Dredging Issues (4), Boating Issues (4) ***Actions:*** **Area Designation (59)** Fishery Regulation (12) Monitoring and Assessment (7)

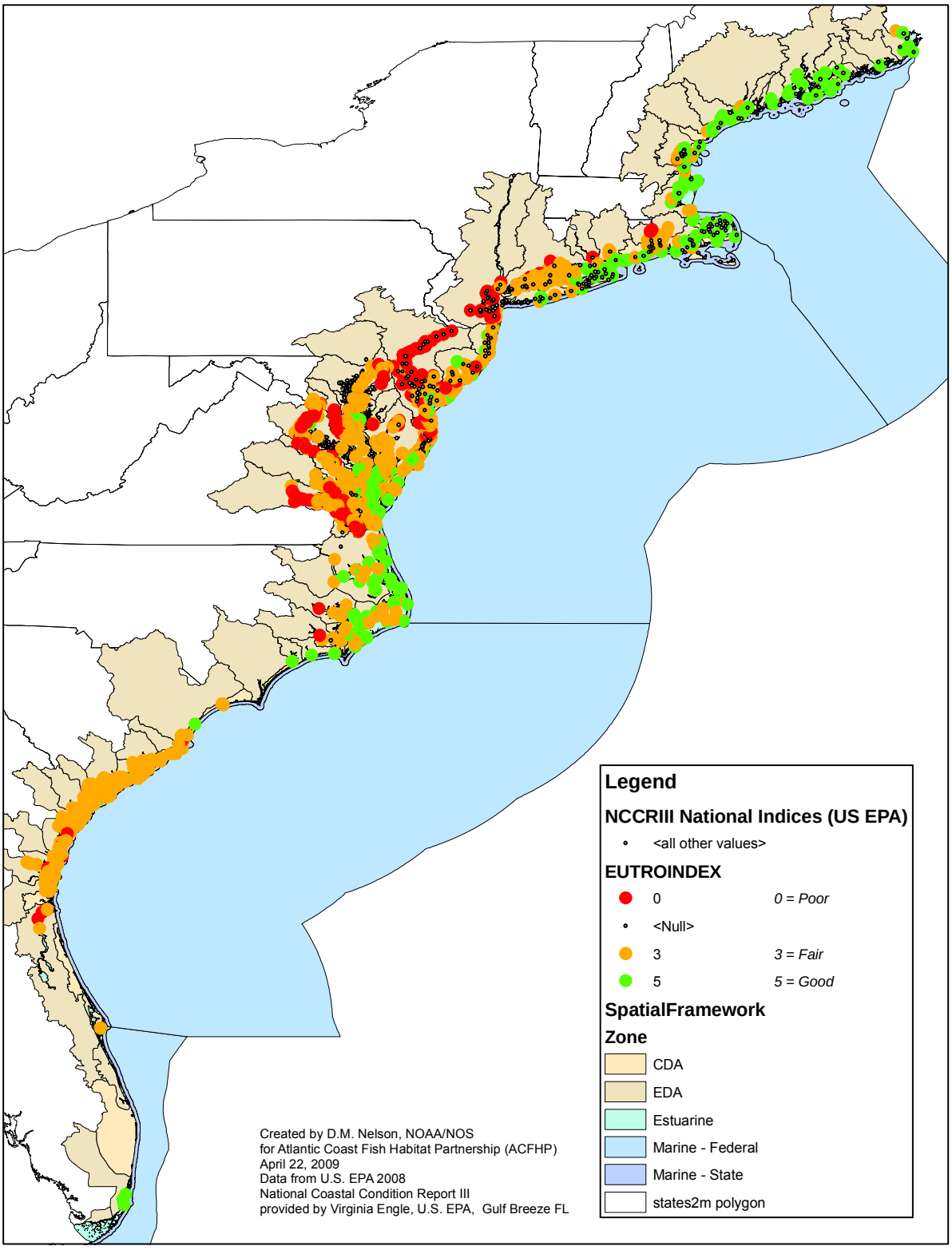


Figure 14. Water Quality Index for sampling stations in EPA's National Coastal Condition Report III (U.S. EPA 2008, Engle pers. comm.), overlaid on the ACFHP base map. filename: NCCR3_EutroIndex_June18.emf

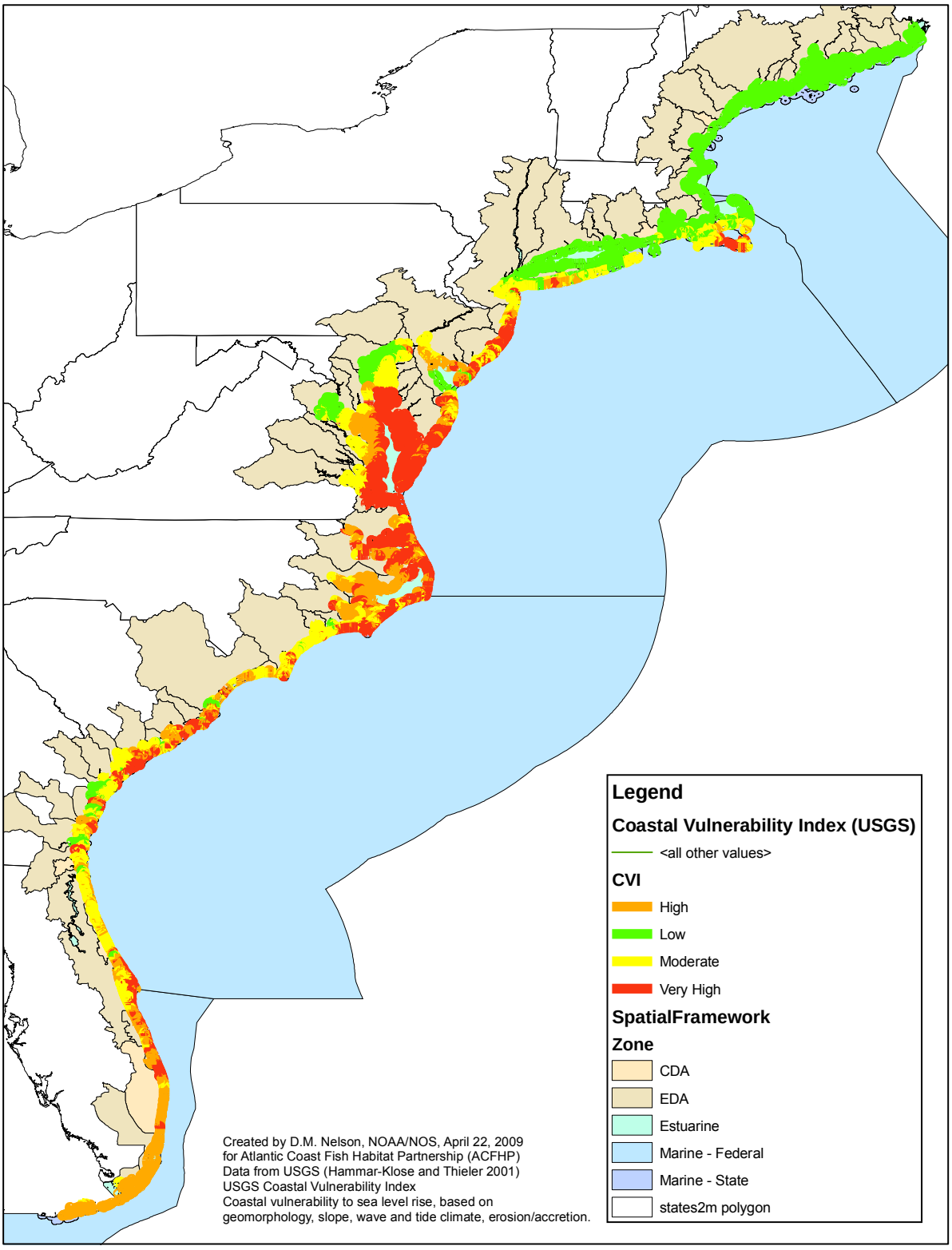


Figure 15. Coastal Vulnerability Index for U.S. Atlantic coastline (Hammar-Klose and Thieler 2001), overlaid on the ACFHP base map. filename: USGS_CVI_June18.emf

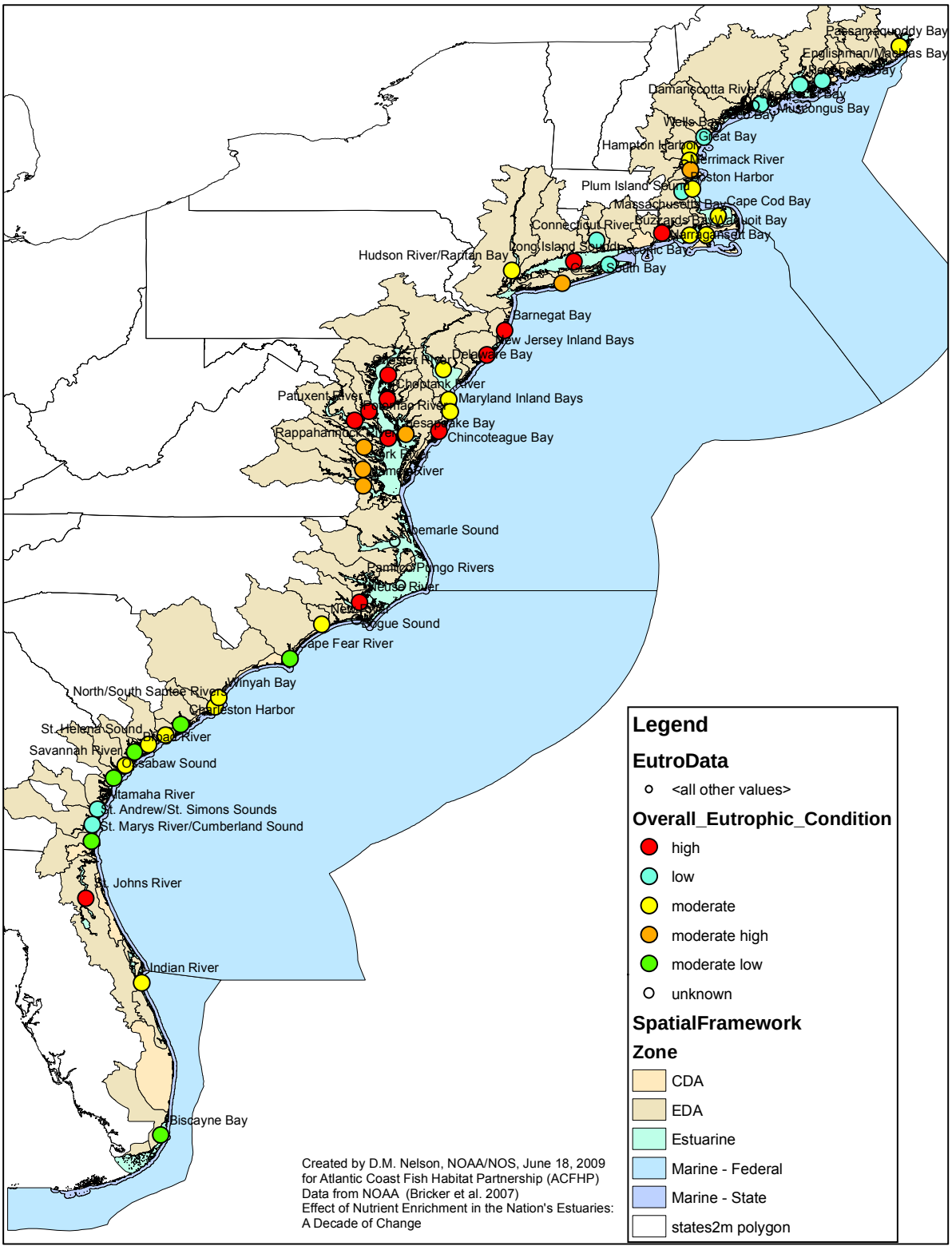


Figure 16. Overall Eutrophic Condition for 64 U.S. Atlantic coastal estuaries (Bricker et al. 2007), overlaid on the ACFHP base map. filename: EutroCondition_June18.emf

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APPENDICES AND ATTACHMENTS

Bibliographic Table – filename ACFHP_Biblio_Table_May29.xlsx
Assessment Table – filename ACFHP_Assessment_Table_June1.xlsx
Geospatial Table – filename ACFHP_Polygons_Table.xlsx
Data Summary Tables – filenames Visual_Indicator_Summaries_Jun4.xlsx, ACFHP_Threats.xlsx, ACFHP_Actions.xlsx
Metadata – filename ACFHP_Metadata.txt

Microsoft Excel versions of these data tables are available upon request.

Appendix 1: Timeline for the completion of this project

June 2008 - Project proposal to ACFHP Steering Committee, Manchester NH.

August 2008 - Workplan developed by ASMFC, CSS, and NOAA.

October 2008 - ACFHP Steering Committee, Rehoboth DE.

March 3, 2009: Poster presentation titled "*A Geospatial Bibliography to Assess Existing Information on Atlantic Coastal Fish Habitat*" at Coastal GeoTools Conference, Myrtle Beach SC. Proceedings available at http://www.csc.noaa.gov/geotools/documents/2009_preceedings.pdf

March 13, 2009: Deliver bibliographic and assessment tables and written status update to ASMFC, and launch first version publicly-available web application.

March 19, 2009: Meet with ASMFC staff, and ACFHP Assessment Subcommittee (via WebEx and conf call), to present the work products (bibliography, assessment information, and web application)

April 3, 2009: After making revisions based on Subcommittee's comments, deliver final draft work products to ASMFC.

April 21, 2009: Present work products (bibliography, assessment information, and web application) to ACFHP Steering Committee

April 26, 2009: Oral presentation to Northeast Association of Fish and Wildlife Agencies (NEAFWA) conference, Symposium on Habitat Assessment, Lancaster PA, titled "*Assessment of Existing Atlantic Coastal Fish Habitat Information Using a Bibliographic and Spatial Framework*". http://www.neafwa.org/ .

May 31, 2009: After receiving feedback from the ACFHP Assessment Subcommittee and Steering Committee, final work products (data tables) delivered to ASMFC.

June 2009 – Launch revised web-based queryable database for use by ACFHP

July 6, 2009 - Draft final report delivered to ACFHP.

July 21, 2009 – Poster presentation at CoastalZone'09, Boston MA, titled "*A Spatial Bibliography to Assess Existing Information on Atlantic Coastal Fish Habitat*". Proceedings available at http://www.csc.noaa.gov/cz/ .

July 23, 2009 – Oral presentation and discussion titled "*A Spatial Bibliography to Assess Existing Information on Atlantic Coastal Fish Habitat*" at NFHAP Coastal Assessment meeting, Grand Haven MI.

July 31, 2009 - Final project summary report delivered to ACFHP for use in conservation planning.

February 2010 – Results published as NOAA Tech. Memo., and final web query application launched.

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