NOAA Technical Memorandum NOS OR&R 11

Environmental Sensitivity Index Guidelines
Version 3.0

Hazardous Materials Response Division
Office of Response and Restoration
NOAA Ocean Service
National Oceanic and Atmospheric Administration

Seattle, Washington

Office of Response and Restoration
National Ocean Service
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

NOAA is responsible for protecting and restoring marine and coastal environments impacted by spills and hazardous substance releases. The Office of Response and Restoration (OR&R) is the focal point for NOAA's spill preparedness, emergency response, and restoration programs. OR&R's Hazardous Materials Response Division and its contingent of on-scene Scientific Support Coordinators have earned a wide reputation for delivering scientifically valid solutions to the Federal On-Scene Coordinator (the U.S. Coast Guard in the coastal zone, or EPA in inland areas).

OR&R's Coastal Protection and Restoration Division and Damage Assessment Center are critical components of NOAA's natural resource trusteeship responsibilities. The CPR Division works closely with the U.S. Environmental Protection Agency to redress the environmental effects of hazardous waste sites across the United States. Coastal Resource Coordinators provide site-specific technical expertise in ecological risk assessment and coastal remediation issues. This expertise ranges from physical science to ecology, marine biology, and oceanography. In their NOAA trusteeship role, CRCs assess the longer-term risks to coastal resources (including threatened and endangered species) from Superfund-site contamination, support decision-making for site remedies and habitat restoration, and negotiate protective remedies with the responsible parties to ensure that cleanup, restoration, and recovery are appropriate and fully monitored.

While the HAZMAT and CPR divisions work to prevent and minimize injury to natural resources during spill response and waste site remediation activities, the Damage Assessment Center focuses on addressing the injury that remains after the cleanup or response. DAC's Rapid Assessment Program goes on-scene at oil or hazardous materials releases to assess damages to NOAA trust resources, including National Marine Sanctuaries and National Estuarine Research Reserves. DAC works with other trustees and NOAA's Office of General Counsel in pursuing compensation from responsible parties to restore injured resources. The compensation DAC receives is designed to benefit the natural resources injured by the release.

The Regional Programs section actively engages local and regional communities in integrating sound coastal resource management, oil spill prevention and response, and safe and efficient marine transportation. Administered collaboratively with the NOS Coastal Services Center, Regional Projects serves as liaison between NOS scientific and technical expertise and the needs of the maritime industry, port authorities, coastal resource managers, and other NOAA clients in the coastal zone. Regional Programs matches specific coastal-zone conditions and needs with tailored services, tools, and products from across NOS, including physical oceanographic real-time systems, electronic chart systems, coastal geographic information systems frameworks, photogrammetry, and digital hydrographic surveys.

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March 2002

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1 INTRODUCTION

Environmental Sensitivity Index (ESI) maps have been an integral component of oil-spill contingency planning and response since 1979, when the first ESI maps were prepared days in advance of the arrival of the oil slicks from the IXTOC 1 well blowout in the Gulf of Mexico. Since that time, ESI atlases have been prepared for most of the U.S. shoreline, including Alaska and the Great Lakes (Table 1). Nearly all of the maps of the lower 48 states have been compiled at a scale of 1:24,000, using U.S. Geological Survey (USGS) 7.5-minute quadrangles as the base map. For work in Alaska, 15-minute USGS topographic quadrangles at a scale of 1:63,360 and 2-degree sheets at a scale of 1:250,000 have been used as base maps.

Before 1989, traditional sensitivity maps were produced as color paper maps, with limited distribution (because of the cost of reproduction), and without a means for ready updating. However, since 1989, ESI atlases have been generated from digital databases using Geographic Information System (GIS) techniques. As the oil-spill response community moves towards development of automated sensitivity maps, it is important to define what comprises the ESI mapping system and how this information is being developed and distributed using GIS technology.

The primary objectives of this report are to outline the basic elements of a sensitivity mapping system, guide the collection and synthesis of data, and define the data structure for a digital ESI application using GIS technology. There are many aspects of a fully functional application that are still under development, such as pre-set queries and integration with other spill response systems (e.g., trajectories and equipment inventories), or are specific to the type of software being used (e.g., the user interface), that are not addressed at this time. However, we recommend standard output formats and symbology for maps to be shown on the screen or printed out in hard copy. Hard copy products are as important as developing the on-screen user interface. The printed map is still a major product for spill response applications.

The Need for Standardization

The spill contingency planning requirements of the Oil Pollution Act of 1990 (OPA 90) and similar legislation passed by many states require information on the location of sensitive resources to be used as the basis for establishing protection priorities.

Table 1. Environmental Sensitivity Index (ESI) atlases published for the U.S. (Bold names indicate atlases produced in digital format.)

Name	Year Published	No. of Maps
Alabama	1981/**1996**	20/**29**
Alaska (5 atlases)	1982-1986	329
Alaska (Aleutians East Borough)	**2001**	**13**
Alaska (Aleutians West Coastal Resources Area)	**2001**	**9**
Alaska (Northwest Arctic)	**2002**	**33**
Alaska (Prince William Sound)	1983/**2000**	42/**46**
Alaska (Southeast 4 volumes)	**1992-2001**	**199**
California (Central)	**1994**	**49**
California (Northern)	**1994**	**39**
California (Southern)	1980/**1995**	52/**51**
California (San Francisco Bay)	1986/**1999**	23/**27**
Connecticut	1984/**2001**	17/**25**
Delaware/New Jersey/Pennsylvania	1985/**1996**	59/**64**
Florida (7 atlases/**6 atlases**)	1981-1984/**1995-1997**	246/**296**
Georgia	1985/**1997**	29/**39**
Guam	1993	15
Hawaii	1986/**2001**	86/**96**
Lake Erie System	1985	66
Lake Huron (Michigan)	**1994**	**69**
Lake Michigan (Eastern Shore)	1986	23
Northern Lake Michigan	**1994**	**70**
Southern Lake Michigan	**1994**	**11**
Western Lake Michigan	**1993**	**54**
Lake Ontario (New York)	**1993**	**34**
Lake Superior (3 volumes)	**1993**	**133**
Louisiana	**1989**	**98**
Maine (Downeast)	1985	42
Maine (Mid-Coast)	1985	35
Maine (Southern/New Hampshire)	1983	25
Maryland (2 volumes)	1983	119
Massachusetts	1980/**1999**	51/**55**
Mississippi	**1996**	**29**
New York (Harbor/Hudson River)	1985	37
New York (Long Island)	1985	41
New York/New Jersey Metropolitan Region	**2001**	**23**
North Carolina (2 volumes/**3 volumes**)	1983/**1996**	113/**135**
Oregon/Washington (Outer Coast)	1989	55

Table 1. Continued.

Name	Year Published	No. of Maps
Oregon/Washington, Columbia River	**1989**	**26**
Puerto Rico (ESI/**ESI-RSI**)	1984/**2000**	35/**68**
Rhode Island/Massachusetts	1983	18
Rhode Island	**2001**	**16**
St. Lawrence River	1985	17
St. Marys River	1986	15
South Carolina	1982/**1996**	50/**63**
Texas (Galveston Bay)	1979	19
Texas (South)	1980	15
Texas (Upper Coast)	**1995**	**51**
U.S. Virgin Islands/**U.S.-British Virgin Islands**	1986/**2001**	8/**14**
Virginia (2 volumes)	1983	104
Washington (Strait of Juan de Fuca/	1984	36
Northern Puget Sound Washington (Central/Southern Puget Sound)	1985	44

Digital databases being developed to support oil-spill planning and response functions are a subset of those needed for a wide range of natural resource management applications. Standardizing the basic elements for a spill application speeds the development of systems and facilitates their use by national response teams and organizations, such as the U.S. Coast Guard, industry response staff, and spill cooperatives. Data sharing and updates are greatly facilitated by a uniform data structure.

Report Outline

This report is divided into six chapters, with the following content and intended users:

Chapter 1-Introduction to Environmental Sensitivity Index mapping

Chapter 2—The basic components of sensitivity mapping, data layers and how they are defined, for the resource manager developing sensitivity data.

Chapter 3—Detailed guidelines for geologists responsible for the shoreline classification.

Chapter 4-Detailed guidelines for resource managers on how to collect and compile the biological and human-use resource information on hard copy maps and data tables.

Chapter 5—Guidelines on how the data are digitized, stored, and delivered as a GIS product, for all users but especially for the GIS manager.

Chapter 6—Description of the map product, for all users.

2 THE ENVIRONMENTAL SENSITIVITY INDEX MAPPING SYSTEM

ESI maps are comprised of three general types of information:

1. Shoreline Classification–ranked according to a scale relating to sensitivity, natural persistence of oil, and ease of cleanup.

2. Biological Resources–including oil-sensitive animals and rare plants; and habitats, which are used by oil-sensitive species or are themselves sensitive to oil spills, such as submersed aquatic vegetation and coral reefs.

3. Human-Use Resources–specific areas that have added sensitivity and value because of their use, such as beaches, parks and marine sanctuaries, water intakes, and archaeological sites.

Each of these elements is discussed in the following sections.

Shoreline Classification

Shoreline habitats are at risk during spills because of the high likelihood of being directly oiled when floating slicks impact the shoreline. Oil fate and effects vary significantly by shoreline type, and many cleanup methods are shoreline-specific. The concept of mapping coastal environments and ranking them on a scale of relative sensitivity was originated in 1976 for Lower Cook Inlet (Michel et al. 1978). Since that time, the ranking system has been refined and expanded to cover shoreline types for most of North America, Central America, and portions of the Middle East. The ranking system is most developed for sub-arctic, temperate, and tropical zones. However, some shoreline types unique to the Arctic zone, such as peat scarps and eroding tundra scarps, are included in the ranking scheme. The classification scheme has also been modified to include lacustrine and riverine shoreline types (NOAA 1995). The complete list of standard ESI shoreline rankings is composed of categories for four environmental settings: estuarine, lacustrine, riverine, and palustrine (Table 2) To facilitate data use and exchange, these shoreline types and ranks should be used on all sensitivity mapping projects.

Table 2. ESI shoreline classification for the three types of environmental settings.

ESI NO.	ESTUARINE	LACUSTRINE	RIVERINE
1A	Exposed rocky shores	Exposed rocky shores	Exposed rocky banks
1B	Exposed, solid man-made structures	Exposed, solid man-made structures	Exposed, solid man-made structures
1C	Exposed rocky cliffs with boulder talus base	Exposed rocky cliffs with boulder talus base	Exposed rocky cliffs with boulder talus base
2A	Exposed wave-cut platforms in bedrock, mud, or clay	Shelving bedrock shores	Rocky shoals; bedrock ledges
2B	Exposed scarps and steep slopes in clay		
3A	Fine- to medium-grained sand beaches		
3B	Scarps and steep slopes in sand	Eroding scarps in unconsolidated sediments	Exposed, eroding banks in unconsolidated sediments
3C	Tundra cliffs		
4	Coarse-grained sand beaches	Sand beaches	Sandy bars and gently sloping banks
5	Mixed sand and gravel beaches	Mixed sand and gravel beaches	Mixed sand and gravel bars and gently sloping banks
6A	Gravel beaches Gravel Beaches (granules and pebbles)*	Gravel beaches	Gravel bars and gently sloping banks
6B	Riprap Gravel Beaches (cobbles and boulders)*	Riprap	Riprap
6C*	Riprap		
7	Exposed tidal flats	Exposed tidal flats	
8A	Sheltered scarps in bedrock, mud, or clay Sheltered rocky shores (impermeable)*	Sheltered scarps in bedrock, mud, or clay	
8B	Sheltered, solid man-made structures Sheltered rocky shores (permeable)*	Sheltered, solid man-made structures	Sheltered, solid man-made structures
8C	Sheltered riprap	Sheltered riprap	Sheltered riprap
8D	Sheltered rocky rubble shores		

Table 2. ESI shoreline classification, cont.

ESI NO.	ESTUARINE	LACUSTRINE	RIVERINE
8E	Peat shorelines		
8F			Vegetated, steeply-sloping bluffs
9A	Sheltered tidal flats	Sheltered sand/mud flats	
9B	Vegetated low banks	Vegetated low banks	Vegetated low banks
9C	Hypersaline tidal flats		
10A	Salt- and brackish-water marshes		
10B	Freshwater marshes	Freshwater marshes	Freshwater marshes
10C	Swamps	Swamps	Swamps
10D	Scrub-shrub wetlands; Mangroves†	Scrub-shrub wetlands	Scrub-shrub wetlands
10E	Inundated low-lying tundra		

* Denotes that a category or definition applies only in Southeast Alaska.
† In tropical climates 10D indicates areas of dominant mangrove vegetation

ESI NO.	PALUSTRINE**
10B	Freshwater marshes
10C	Swamps
10D	Scrub-shrub wetlands

**Palustrine environment ESI codes are assigned based on the National Wetland Inventory (NWI) habitat classification system.

The classification scheme is based on an understanding of the physical and biological character of the shoreline environment, not just the substrate type and grain size. Relationships among physical processes, substrate type, and associated biota produce specific geomorphic/ecologic shoreline types, sediment transport patterns, and predictable patterns in oil behavior and biological impact. The concepts relating natural factors to the relative sensitivity of coastline, mostly developed in the estuarine setting, were slightly modified for lakes and rivers. The sensitivity ranking is controlled by the following factors:

1. Relative exposure to wave and tidal energy
2. Shoreline slope
3. Substrate type (grain size, mobility, penetration and/or burial, and trafficability)
4. Biological productivity and sensitivity

All of these factors and first-hand observations from spills were considered when developing the relative ESI rankings for shoreline types. Each of the natural factors is discussed in detail below.

Relative Degree of Exposure to Wave and Tidal Energy

Biologists have long recognized that the makeup of intertidal biological communities is closely correlated with relative degree of exposure. In *Between Pacific Tides*, Rickets et al. (1968) classified the coastal habitats of the central California coast as *exposed* and *sheltered*, differentiating between settings subject to intense pounding by the large waves on that coast and those sheltered by offshore rocks, barrier beaches, and other protective features. Early geomorphology studies at the *Metula*, *Urquiola*, and *Amoco Cadiz* oil spills showed that the level of impacts of oil spills is closely related to the relative degree of exposure of the impacted habitat (Hayes and Gundlach 1975; Gundlach and Hayes 1978; Gundlach et al. 1978; Michel et al. 1978).

Two physical factors, wave-energy flux and tidal-energy flux, primarily determine the degree of exposure, also referred to as the *hydrodynamic energy level*, at the coastline. Wave-energy flux is basically a function of the average wave height, measured over at least one year. Where waves are typically large (e.g., heights more than one meter occur frequently), the impact of oil spills on the exposed habitats is reduced because:
1) offshore-directed currents generated by waves reflecting off hard surfaces push the oil away from the shore; 2) wave-generated currents mix and rework coastal sediments, which are typically coarse-grained in these settings, rapidly removing stranded oil; and 3) organisms adapted to living in such a setting are accustomed to short-term perturbations in the environment.

Tidal-energy flux is also important in determining the potential of oil-spill impacts on coastal habitats, although not as pervasive as wave-energy flux. The most important considerations are the potential for strong tidal currents to remove stranded oil and to build and move intertidal sand and/or gravel bars that bury oil. The effect of the currents on biological communities can also be pronounced. For example, highly mobile substrates set in motion by strong tidal currents typically harbor considerably fewer infauna than stable substrates. Tidal currents generally increase as tidal range increases.

Wave and tidal energy combine to produce a continuum of energy along a coastline. For the sake of portrayal on a map, this continuum must be broken into classes, clear-cut

divisions of high, medium, or low energy. Within a mapping region, the degree of energy present on one shoreline segment is assessed relative to the overall energy levels in the region. High-energy shorelines (1A-2B) are regularly exposed to large waves or strong tidal currents during all seasons. They most commonly occur along the outermost coastline of a region or where dominant winds cause waves to strike the shoreline directly or by wave refraction. Medium-energy shorelines (3A-7) often have seasonal patterns in storm frequency and wave size. Low-energy shorelines (8A-10E) are sheltered from wave and tidal energy, except during unusual or infrequent events. As a general rule, high- and medium-energy shorelines should not be mapped adjacent to low-energy shorelines unless there is a significant change in shoreline orientation or there is some offshore obstruction to wave energy.

Inherent in these energy classes are inferences to the persistence of stranded oil. *High energy* means rapid natural removal, usually within days to weeks. *Low energy* means slow, natural removal, usually within years. *Medium energy* means that stranded oil will be removed when the next high-energy event occurs, which could be days or months after the spill. The removal of oil on a medium-energy coast is an event-driven process. Shorelines that do not have predictable, seasonal storms that generate waves of a significant size or from a particular direction are even more difficult to characterize. Along these shorelines, high-energy events usually happen more than once each year but their timing is generally unknown. A shoreline of this type has the potential for longer-than-usual oil persistence. This type of shoreline has storm berms with one to three years of vegetation growth and greater macroalgae coverage on the larger boulders in the intertidal zone than would be seen on a beach exposed to more frequent storms. Efforts should be made to differentiate beaches with irregular patterns in sediment mobility, particularly for gravel beaches.

Shoreline Slope

Shoreline slope is a measure of the steepness of the intertidal zone between maximum high and low tides. It can be characterized as steep (greater than 30 degrees), moderate (between 30 and 5 degrees), or flat (less than 5 degrees).

The importance of shoreline slope in exposed settings is its effect on wave reflection and breaking. Steep intertidal areas are usually subject to abrupt wave run-up and breaking, and even reflection in places, which enhances natural cleanup of the shoreline. Flat intertidal areas, on the other hand, promote dissipation of wave energy further offshore,

which lets oil remain longer in the intertidal zone. Also, the broad intertidal areas typically have more extensive areal biological communities (e.g., mussel beds, clam beds, and plant communities). In sheltered habitats, slope is a less important distinguishing factor with regard to oil-spill impacts, except that sensitive biological communities have more area to develop where the slopes are flatter.

Substrate Type

Substrate types are classified as:

- *Bedrock*, which can be further divided into impermeable and permeable, depending upon the presence of surficial deposits on top of the bedrock

- *Sediments*, which are divided by grain size as:
  - Mud, consisting of silt and clay, less than 0.06 millimeters (mm)
  - Fine- to medium-grained sand, ranging in size from 0.06-1 mm
  - Coarse-grained sand, ranging from 1-2 mm
  - Granule, ranging from 2-4 mm
  - Pebble, ranging from 4-64 mm
  - Cobble, ranging from 64-256 mm
  - Boulder, greater than 256 mm

- *Man-made materials,* such as:
  - Riprap, or broken rock of various sizes, usually cobble or larger, that are permeable to oil penetration
  - Seawalls that are composed of solid material, such as concrete or steel, which are impermeable to oil penetration

The most important substrate distinction is between bedrock and unconsolidated sediments. In unconsolidated sediments, there is the potential for penetration and/or burial of the oil. Penetration and burial are mechanically different but, when either or both occur in sedimentary substrates, they increase the persistence of oil, lead to potential long-term biological impacts, and make cleanup much more difficult and intrusive.

Penetration occurs when oil stranded on the surface sinks into permeable sediments; the depth of penetration is controlled by the grain size of the substrate, as well as the sorting (range of grain sizes in the sediments). Deepest penetration is expected for coarse sediments (gravel) that are most uniform in grain size (well-sorted). On gravel beaches,

heavy oil accumulations can penetrate up to one meter. If the sediments are poorly sorted, such as on mixed-sand-and-gravel beaches, oil usually penetrates less than 50 centimeters (cm). Sand beaches are also differentiated into grain-size categories (fine- to medium-grained versus coarse-grained) that differ by permeability and thus potential depths of penetration. Muddy sediments have the lowest permeability and also tend to be water-saturated, so oil penetration is very limited. However, where infauna burrow into the substrate, burrows can provide a mechanism for oil to penetrate an otherwise impermeable substrate.

Burial occurs when clean sediments are deposited on top of oil layers. The rate of burial can vary widely and can be as short as six hours (one-half of a tidal cycle) after the initial stranding of oil. The most rapid burial usually occurs on coarse-grained sand beaches, because they have the highest mobility under normal wave and tidal conditions. Storms can mobilize gravel berms or bars, burying oil in gravel beaches. Along shorelines with strong seasonal storm patterns, there can be annual erosion/deposition cycles in the beach profile and sediment distribution patterns. These shorelines have the greatest potential for burial, particularly if the oil is stranded at the beginning of the depositional period.

Identifying man-made substrates is generally simple due to their often unnatural appearance from the air. Of the man-made shoreline types, riprap is the most important substrate to identify, in both sheltered and exposed energy regimes, due to response considerations and the potential for persistence of oil.

Substrate type also affects the trafficability, or ability for people and machinery to maneuver during a cleanup effort. In general, highly trafficable shorelines are ranked lower on the ESI scale than those on which cleanup crews will have difficulty moving or, more importantly, where they will cause additional damage in their cleanup effort. For example, fine-grained sand beaches are typically compacted and hard with little chance of workers trampling oil deep into the substrate. Therefore, they are generally the most trafficable of the sedimentary substrates. Coarse-grained beaches, on the other hand, tend to have moderate to steep slopes, are much less compacted, and have a high permeability, making walking difficult and more likely to drive any stranded oil deeper into the substrate. Gravel beaches are less trafficable still, due in part to multiple berms and cobbles and boulders. Vehicles tend to force oil into gravel beaches. Lastly, wetland habitats, because of their muddy substrate, have very low trafficabilty. Using equipment on muddy substrates is not possible because of the substrates' innate softness. Any traffic

in a wetland habitat risks driving pooled oil deeper into the muddy substrate, affecting both the plants and burrowing fauna.

Biological Productivity and Sensitivity

The biological productivity of shoreline habitat is an integral component of the ESI ranking. Vegetated habitats, such as marshes and mangroves, have the highest ranking because of the potential for long-term impacts resulting from both exposure to oil and potential damages associated with cleanup activities in these kinds of habitats. Recovery of the ecological services can take decades in these most productive habitats. The ESI ranking reflects the general sensitivity of shoreline habitats. That is, all fine-grained sand beaches have an ESI = 3. Tidal flats are ranked high on the ESI scale because of their high benthic productivity and importance as feeding areas for fish and birds. The presence of other sensitive resources on a specific shoreline segment, such as turtle nesting on a fine-grained sand beach, does not affect the ESI ranking. The seasonal presence of other resources on a shoreline segment is addressed by mapping biological and human-use resources.

Definitions of ESI Rankings

Rank of 1: Exposed, Impermeable Vertical Substrates

The essential elements are:

- Regular exposure to high wave energy or tidal currents.
- Strong wave-reflection patterns are common.
- Substrate is impermeable (usually bedrock or cement) with no potential for subsurface penetration.
- Slope of the intertidal zone is 30 degrees or greater, resulting in a narrow intertidal zone.
- By the nature of the high-energy setting, attached organisms are hardy and accustomed to high hydraulic impacts and pressures.

Shoreline types that meet these elements include:

1A = Exposed rocky shores (estuarine, lacustrine, and riverine)

1B = Exposed, solid, man-made structures (estuarine, lacustrine, and riverine)

1C = Exposed rocky cliffs with boulder talus base

1C = Exposed, rocky cliffs/Boulder talus base

These shoreline types are exposed to large waves, which tend to keep oil offshore by reflecting waves. The substrate is impermeable so oil remains on the surface where natural processes will quickly remove any oil that does strand within a few weeks. Also, any stranded oil tends to form a band along the high-tide line or splash zone, above the elevation of the greatest biological value. No cleanup is generally required or recommended.

Rank of 2: Exposed, Impermeable Substrates, Non-Vertical

The essential elements are:

- Regular exposure to high wave energy or tidal currents.
- Regular strong wave-reflection patterns.
- Slope of the intertidal zone is usually less than 30 degrees, resulting in a wider intertidal zone; it can be less than five degrees and the intertidal zone can be up to hundreds of meters wide.
- Substrate is impermeable with no potential for subsurface penetration over much of the intertidal zone, although there can be a thin, mobile veneer of sediment in patches on the surface.
- Sediments can accumulate at the base of bedrock cliffs, but are regularly mobilized by storm waves.
- By the nature of the setting, attached organisms are hardy and used to high hydraulic impacts and pressures.

Shoreline types that meet these elements include:

2A = Exposed wave-cut platforms in bedrock, mud, or clay (estuarine)

2A = Shelving bedrock shores (lacustrine)

2A = Rocky shoals; bedrock ledges along rivers (riverine)

2B = Exposed scarps and steep slopes in clay (estuarine)

As with ESI = 1, these shorelines rank low because they are exposed to high wave energy. However, they have a flatter intertidal zone, sometimes with small accumulations of sediment at the high-tide line, where oil could persist for several weeks to months. When the sediments have been formed into a beach on the rocky platform that has~~with~~ multiple, wave-built berms, the maps designate the beach as a separate shoreline type. Along coastal plain areas, the equivalent shoreline type consists of scarps in relict marsh clay. Biological impacts can be immediate and severe, particularly if fresh oil slicks cover tidal pool communities on rocky platforms. However, the oil is usually removed

quickly from the platform by wave action. Cleanup is not necessary except for removing oiled debris and oil deposits at the high-tide line, in areas of high recreational use, or to protect a nearshore resource, such as marine birds.

Rank of 3: Semi-Permeable Substrate, Low Potential for Oil Penetration and Burial; infauna present but not usually abundant

The essential elements are:

- The substrate is semi-permeable (fine- to medium-grained sand), with oil penetration usually less than ten cm.
- Sediments are well-sorted and compacted (hard).
- On beaches, the slope is very low, less than five degrees.
- The rate of sediment mobility is low, so the potential for rapid burial is low.
- Surface sediments are subject to regular reworking by waves and currents.
- There are relatively low densities of infauna.

Shoreline types that meet these elements include:

3A = Fine- to medium-grained sand beaches (estuarine)

3B = Scarps and steep slopes in sand (estuarine)

3B = Eroding scarps in unconsolidated sediments (lacustrine)

3B = Exposed, eroding river banks in unconsolidated sediments (riverine)

3C = Tundra cliffs (estuarine)

This shoreline rank includes exposed sand beaches on outer shores, sheltered sand beaches along bays and lagoons, and sandy scarps and banks along lake and river shores. Compact, fine-grained sand substrates inhibit oil penetration, minimizing the amount of oiled sediments to be removed. Furthermore, fine-grained sand beaches generally accrete slowly between storms, reducing the potential for burial of oil by clean sand. On sheltered sand beaches, burial is seldom of concern because of the low wave energy. On exposed beaches, oil may be buried deeply if the oil stranded right after an erosional storm or at the beginning of a seasonal accretionary period. Cleanup on fine-grained sand beaches is simplified by the hard substrate that can support vehicular and foot traffic. Infaunal densities vary significantly both spatially and temporally.

Rank of 4: Medium Permeability, Moderate Potential for Oil Penetration and Burial; infauna present but not usually abundant

The essential elements are:

- The substrate is permeable (coarse-grained sand), with oil penetration up to 25 cm possible.
- The slope is intermediate, between 5 and 15 degrees.
- Rate of sediment mobility is relatively high, with accumulation of up to 20 cm of sediments within a single tidal cycle possible; there is a potential for rapid burial and erosion of oil.
- Sediments are soft, with low trafficability.
- There are relatively low densities of infauna.

Shoreline types that meet these elements include:

4 = Coarse-grained sand beaches (estuarine)

4 = Sand beaches (lacustrine)

4 = Sandy bars and gently sloping banks (riverine)

Coarse-grained sand beaches are ranked separately and higher than fine- to medium-grained sand beaches because of the potential for higher oil penetration and burial, which can be as great as one meter. These beaches can undergo very rapid erosional and depositional cycles, with the potential for rapid burial of oil, even after only one tidal cycle. Cleanup is more difficult, as equipment tends to grind oil into the substrate because of the loosely packed sediment. Also, cleanup techniques have to deal with multiple layers of oiled and clean sediments, increasing the amount of sediments to be handled and disposed of. These more mobile sediments usually have low infaunal populations, which also vary greatly over time and space.In some areas, there is no clear distinction between beach types because they cannot be readily differentiated by grain size. Under these conditions, such as along the Great Lakes, all sand beaches are ranked as ESI = 4.

Rank of 5: Medium-to-High Permeability, High Potential for Oil Penetration and Burial; infauna present but not usually abundant

The essential elements are:

- Medium-to-high permeability of the substrate (mixed sand and gravel) allows oil penetration up to 50 cm.

- Spatial variations in the distribution of grain sizes are significant, with finer-grained sediments (sand to pebbles) at the high-tide line and coarser sediments (cobbles to boulders) in the storm berm and at the toe of the beach.
- The gravel component should comprise at least 20 percent of the sediments.
- The slope is intermediate, between eight and 15 degrees.
- Sediment mobility is very high only during storms, thus there is a potential for rapid burial and erosion of oil during storms.
- Sediments are soft, with low trafficability.
- Infauna and epifauna populations are low, except at the lowest intertidal levels.

Shoreline types that meet these elements include:

5 = Mixed sand and gravel beaches (estuarine and lacustrine)

5 = Mixed sand and gravel bars and gently sloping banks (riverine)

The gravel-sized component can be composed of bedrock, shell fragments, or coral rubble. Because of higher permeabilities, oil tends to penetrate deeply into sand and gravel beaches, making it difficult to remove contaminated sediment without causing erosion and sediment disposal problems. These beaches may undergo seasonal variations in wave energy and sediment reworking, so natural removal of deeply penetrated oil may only occur during storms that occur just once or twice per year. Biological use is low, because of high sediment mobility and rapid drying during low tide.

These types of beaches range widely in relative degree of exposure. Sediment mobility can be inferred by the extent of attached fauna and macroalgae. Indicator species or assemblage coverages can be used to reflect the potential rate of sediment reworking. For example, in southeastern Alaska, the presence of greater than
20 percent attached algae, mussels, and barnacles indicates beaches that are relatively sheltered, with the more stable substrate supporting a richer biota. Where there are significant differences in the degree of exposure of sand and gravel beaches, the more exposed or mobile beaches can be designated as 5A and the less exposed or stable beaches can be designated as 5B. Pocket beaches, in particular, can have microenvironments that are more protected from wave energy (called wave shadows) where natural removal may be much slower than the adjacent beach.

Rank of 6: High Permeability, High Potential for Oil Penetration and Burial

The essential elements are:

- The substrate is highly permeable (gravel-sized sediments), with penetration up to 100 cm.
- The slope is intermediate to steep, between ten and 20 degrees.
- Rapid burial and erosion of shallow oil can occur during storms.
- There is high annual variability in degree of exposure, and thus in the frequency of mobilization by waves.
- Penetration can extend to depths below those of annual reworking.
- Sediments have lowest trafficability of all beaches.
- Natural replenishment rate of sediments is the slowest of all beaches.
- Infauna and epifauna populations are low, except at the lowest intertidal levels.

Shoreline types that meet these elements include:

6A = Gravel beaches (estuarine and lacustrine)

6A = Gravel bars and gently sloping banks (riverine)

6A = Gravel beaches (cobbles and boulders) (estuarine - Southeast Alaska only)

6A = Gravel beaches (granules and pebbles) (estuarine – Southeast Alaska only)

6B = Riprap (estuarine, lacustrine, and riverine)

6B = Gravel beaches (cobbles and boulders) (estuarine – Southeast Alaska only)

6C = Riprap (estuarine - Southeast Alaska only)

Gravel beaches are ranked the highest of all beaches primarily because of the potential for very deep oil penetration and slow natural removal rates of subsurface oil. The slow replenishment rate of gravel makes removal of oiled sediment highly undesirable, and so cleanup of heavily oiled gravel beaches is particularly difficult. For many gravel beaches, significant wave action (meaning waves large enough to rework the sediments to the depth of oil penetration) occurs only every few years, leading to long-term persistence of subsurface oil. Shell fragments can be the equivalent of gravel along Gulf of Mexico and South Atlantic beaches.

Fine-grained gravel beaches are composed primarily of pebbles and cobbles (from 4 to 256 mm), with boulders as a minor fraction. Little sand is evident on the surface, and there is less than 20 percent sand in the subsurface. There can be zones of pure pebbles or cobbles, with the pebbles forming berms at the high-tide line and the cobbles and

boulders dominating the lower beachface. Sediment mobility limits the amount of attached algae, barnacles, and mussels to low levels. The distinction can also be made on the basis of grain size and extent of rounding of the sediments on a shoreline. The gravel is rounded or well-rounded only on those beaches regularly mobilized during storms.

Large-grained gravel beaches have boulders dominating the lower intertidal zone. The amount of attached algae and epifauna is much higher, reflecting the stability of the large sediments. A boulder-and-cobble armoring of the surface of the middle to lower intertidal zone is common on these beaches. Armor may have a very important effect on oil persistence in gravel beaches. Oil beneath an armored surface would tend to remain longer than would subsurface oil on an unarmored beach with similar grain size and wave conditions because of the higher velocities required to mobilize the armor (NOAA 1993). Sub-rounded to sub-angular gravel is a very good indicator of these less mobile beaches.

Riprap is a man-made equivalent of this ESI rank, with added problems because it is usually placed at the high-tide line where the highest oil concentrations are found and the riprap boulders are sized so that they are not reworked by storm waves. Flushing can be effective for removing mobile oil, but large amounts of residue can remain after flushing, particularly for heavy oils. Sometimes, the only way to clean riprap completely is to remove and replace it.

Rank of 7: Exposed, Flat, Permeable Substrate; infauna usually abundant

The essential elements are:

- They are flat (less than three degrees) accumulations of sediment.
- The highly permeable substrate is dominated by sand, although there may be silt and gravel components.
- Sediments are water-saturated so oil penetration is very limited.
- Exposure to wave or tidal-current energy is evidenced by ripples in sand, scour marks around gravel, or presence of sand ridges or bars.
- Width can vary from a few meters to nearly one kilometer.
- Sediments are soft, with low trafficability.
- Infaunal densities are usually very high.

Shoreline types that meet these elements include:

7 = Exposed tidal flats (estuarine and lacustrine)

Exposed tidal flats commonly occur with other shoreline types, usually marsh vegetation, on the landward edge of the flat. Oil does not readily adhere to or penetrate the compact, water-saturated sediments of exposed sand flats. Instead, the oil is pushed across the surface and accumulates at the high-tide line. Even when large slicks spread over the tidal flat at low tide, the tidal currents associated with the next rising tide pick up the oil and move it alongshore. However, oil can penetrate the tops of sand bars and burrows if they dry out at low tide. Because of the high biological use, impacts can be significant to benthic invertebrates exposed to the water-accommodated fraction or smothered. Cleanup is always difficult because of the potential for mixing the oil deeper into the sediment, especially with foot traffic.

Rank of 8: Sheltered Impermeable Substrate, Hard; epibiota usually abundant

The essential elements are:

- They are sheltered from wave energy or strong tidal currents.
- Substrate is hard, composed of bedrock, man-made materials, or stiff clay.
- The type of bedrock can be highly variable, from smooth, vertical bedrock, to rubble slopes, which vary in permeability to oil.
- Slope is generally steep (greater than 15 degrees), resulting in a narrow intertidal zone.
- There is usually a very high coverage of attached algae and organisms.

Shoreline types that meet these elements include:

8A = Sheltered rocky shores and sheltered scarps in bedrock, mud, or clay (estuarine)

8A = Sheltered rocky shores (impermeable) and sheltered scarps in bedrock, mud, or clay (estuarine – Southeast Alaska only)

8A = Sheltered scarps in bedrock, mud, or clay (lacustrine)

8B = Sheltered, solid man-made structures, such as bulkheads (estuarine, lacustrine, and riverine)

8B = Sheltered rocky shores (permeable) (estuarine – Southeast Alaska only)

8C = Sheltered riprap (estuarine, lacustrine, and riverine)

8D = Sheltered rocky rubble shores (estuarine)

8E = Peat shorelines (estuarine)

8F = Vegetated, steeply-sloping bluffs (riverine)

Oil tends to coat rough rock surfaces in sheltered settings, and oil persists long-term because of the low-energy setting. Where appropriate, mapping should differentiate between solid rock surfaces, which are impermeable to oil, and rocky rubble slopes, which tend to trap oil beneath a veneer of coarse material. Both types can have large amounts of attached organisms, supporting a rich and diverse community. Cleanup is often required because natural removal rates are slow. Yet cleanup is often difficult and intrusive. Sheltered seawalls and riprap are the man-made equivalents, with similar oil behavior and persistence patterns. Usually, more intrusive cleanup is necessary for aesthetic reasons. In riverine settings, terrestrial vegetation along the river bluff indicates low energy and thus slow natural removal rates.

Rank of 9: Sheltered, Flat, Semi-Permeable Substrate, Soft; infauna usually abundant

The essential elements are:

- They are sheltered from exposure to wave energy or strong tidal currents.
- The substrate is flat (less than three degrees) and dominated by mud.
- The sediments are water-saturated, so permeability is very low, except where animal burrows are present.
- Width can vary from a few meters to nearly one kilometer.
- Sediments are soft, with low trafficability.
- Infaunal densities are usually very high.

Shoreline types that meet these elements include:

9A = Sheltered tidal flats (estuarine)

9A = Sheltered sand/mud flats (lacustrine)

9B = Vegetated low banks (estuarine and riverine)

9B = Sheltered, vegetated low banks (lacustrine)

9C = Hypersaline tidal flats (estuarine)

The soft substrate and limited access makes sheltered tidal flats almost impossible to clean. Usually, any cleanup efforts mix oil deeper into the sediments, prolonging recovery. Once oil reaches these habitats, natural removal rates are very slow. They can be important feeding areas for birds and rearing areas for fish, making them highly sensitive to oil-spill impacts. In areas without a significant tidal range, such as the Great Lakes, sheltered flats are created by less-frequent variations in water level. These flats are

unique in that low-water conditions can persist for weeks to months, providing a mechanism for sediment contamination in areas that can be subsequently flooded. Low riverine banks are often muddy, soft, and vegetated, making them extremely difficult to clean. Natural removal rates could be very slow, and depend on flooding frequency.

Rank of 10: Vegetated Emergent Wetlands

The essential elements are:

- The substrate is flat and can vary from mud to sand, though high organic, muddy soils are most common.
- Various types of wetland vegetation, including herbaceous grasses and woody vegetation, cover the substrate. Floating aquatic vegetation (FAV) and submersed aquatic vegetation (SAV) are treated separately from the ESI classification as biological resources under the habitat/rare plant coverage.
- The break between salt- and brackish-water marshes and freshwater marshes occurs at the inland extent of 0.5 ppt salinity under average yearly low-flow conditions (Cowardin et al. 1979).
- The difference between scrub-shrub wetlands (<6 m) and swamps (=6 m) is plant height (Cowardin et al. 1979).

Shoreline types that meet these elements include:

10A = Salt- and brackish-water marshes (estuarine)

10B = Freshwater marshes (estuarine, lacustrine, riverine, and palustrine)

10C = Swamps (estuarine, lacustrine, riverine, and palustrine)

10D = Scrub-shrub wetlands (estuarine, lacustrine, riverine, and palustrine)

10D = Mangroves (in tropical climates) (estuarine)

10E = Inundated, low-lying tundra (estuarine)

Marshes, mangroves, and other vegetated wetlands are the most sensitive habitats because of their high biological use and value, difficulty of cleanup, and potential for long-term impacts to many organisms. When present, mangroves are considered a specific habitat type and are not grouped with scrub-shrub vegetation. Many factors influence how oil affects wetlands: oil type, extent of vegetation contamination, degree of sediment contamination, exposure to natural removal processes, time of year of the spill, and species types.

Biological Resources

Animals, plants, and habitats potentially at risk from oil spills are segmented into seven elements based on major taxonomic and functional groupings. Each element is further divided into groups of species or sub-elements with similar taxonomy, morphology, life history, and/or behavior relative to oil spill vulnerability and sensitivity (Table 3). For example, there are ten sub-elements for birds, including alcids, diving birds, gulls and terns, landfowl, passerine birds, pelagic birds, raptors, shorebirds, wading birds, and waterfowl.

Marine, coastal, and aquatic/wetland species may be present over a very large geographic area. Maps or data indicating the entire distribution of a large number of species potentially located in an area may not be very helpful to responders setting protection priorities. Therefore, it is important to identify the types of species that tend to be vulnerable to spilled oil, the most sensitive life-stages, and in which habitats these life-stages occur, as habitat type plays an important role in the persistence of oil and species exposure to oil.

Biological resources are most at risk from oil spills when:

- Large numbers of individuals are concentrated in a relatively small area;
- Marine or aquatic species come ashore during special life stages or activities, such as nesting, birthing, resting, or molting;
- Early life stages or important reproductive activities occur in sheltered, nearshore environments where oil tends to accumulate;
- Limited suitable habitat exists within an area for specific life stages or along critical migratory routes;
- Specific areas are known to be vital sources for seed or propagation;
- A species is threatened, endangered, or rare; or
- A significant percentage of the population is likely to be exposed to oil.

Therefore, the goal of mapping biological resources is to emphasize identifying locations and areas of the highest concentrations, and the most sensitive life-history stages and

Table 3. Biological resources included on sensitivity maps.

Data Element	Sub-Element	Areas/Sites to be Mapped
Marine Mammals	Dolphins	Concentration areas
	Manatees	Concentration areas, cold weather refugia
	Pinnipeds (Seals, Sea Lions, Walruses)	Haulouts, pupping sites, concentration areas
	Polar Bears	Concentration areas, denning concentrations
	Sea Otters	Concentration areas
	Whales	Migratory or other concentration areas
Terrestrial Mammals	Bats	Colonies for threatened and endangered species
	Bears	Intertidal feeding or aquatic/wetland concentrations, hazard areas for spill responders
	Canines	Threatened/endangered or rare species
	Felines	Threatened, endangered, or rare species
	Small Mammals	Aquatic fur-bearer concentrations, other special areas
	Ungulates	Migratory or other concentration areas
Birds	Alcids	Rookeries; wintering/rafting areas
	Diving Birds	Rookeries; forage/wintering areas; roosting concentrations
	Gulls and Terns	Nesting sites; other concentration areas
	Landfowl	Nesting sites and concentrations areas
	Passerine Birds	Threatened, endangered, or rare occurrences and nesting sites
	Pelagic Birds	Rookeries; roosting and rafting concentrations
	Raptors	Nesting sites; migratory/feeding concentrations
	Shorebirds	Nesting sites; migratory stopover concentrations
	Wading Birds	Rookeries; feeding and roosting concentrations
	Waterfowl	Migratory and wintering concentrations, nesting areas
Reptiles and Amphibians	Alligators/Crocodiles	Concentration areas, especially nesting
	Lizards, Snakes, Amphibians, and Other Reptiles	Threatened, endangered, or rare occurrences, especially aquatic/ wetland concentrations
	Turtles	Nesting and concentration areas
Fish	Anadromous Marine	Spawning, nursery, and other concentration areas
	Resident Fish	

Table 3. Continued.

Data Element	Sub-Element	Areas/Sites to be Mapped
Fish	Diadromous Fish	Spawning runs, nursery areas, threatened, endangered, or rare occurrences
	Estuarine Nursery Fish	Spawning, nursery, and other concentration areas
	Estuarine Resident Fish	Spawning, nursery, and other concentration areas
	Freshwater Fish	Spawning and nursery areas; threatened, endangered, or rare occurrences
	Marine Benthic Fish	Spawning and nursery areas; concentrations in reefs, SAV, and other habitats
	Marine Pelagic Fish	Spawning, nursery, and other concentration areas
Invertebrates	Bivalves	Harvest areas; high concentrations; threatened, endangered, or rare occurrences
	Cephalopods	Harvest areas; high concentrations
	Crabs	Harvest and nursery areas; high concentrations
	Echinoderms	Harvest areas; high concentrations
	Gastropods	Harvest areas; high concentrations, threatened, endangered, or rare occurrences
	Insects	Threatened, endangered, or rare occurrences
	Lobsters and Crayfish	Nursery, spawning, and harvest areas; threatened, endangered, or rare occurrences
	Shrimp	Harvest and nursery areas; high concentrations
Habitats and Plants	Algae	Algal beds, important species
	Coral Reefs	Living, reef-building coral areas; rare species
	FAV	Floating aquatic vegetation
	Hardbottom Reefs	Other hard substrates that provide structural habitats or cover
	Kelp	Beds or forests of kelp
	SAV	Submersed aquatic vegetation
	Upland Plants	Special/rare upland (terrestrial) plants, habitats, or communities
Wetlands	Special/rare wetland plants, habitats, or	communities
	Worm Beds	Intertidal or subtidal beds of structure-building worm species

activities for certain species. The types of species that are typically mapped are those that are vulnerable and sensitive to oil spills and disturbance-related response activities; species that are threatened, endangered, or rare; and species that are of commercial/recreational importance (Table 3). In general, coastal, marine, aquatic, wetland, and riparian species and habitats are emphasized. In some cases, the sensitivity of a habitat type may be low, but the sensitivity of species that use or rely on the habitat may be high.

In addition to the geographic or spatial data depicted for biological resources, important attribute data are also included. Attribute data include: species names (common and scientific); the legal status of each species (state and/or federal threatened, endangered, and special concern listings); concentration/abundance; seasonal presence by month; and special life-history time-periods (e.g. spawning, nesting). In addition to federal and state legal status, the global conservation status ranks for certain species, as defined by The Nature Conservancy and the Natural Heritage Programs, are included in atlases published since 1997.

The concentration of a species in a given location may include qualitatively or quantitatively defined descriptions of species abundance (e.g., high, medium, or low), or numbers indicating the number of individuals, nesting or breeding pairs, or nests which occur at a site or within a polygon. The data collection tables, atlas introductory pages, and metadata identify the types of numbers included in the concentration field. When concentration is not known, the concentration field is left blank.

The monthly seasonality data contain “Xs” or abundance values in months when the species are present in the site or polygon location. The “Xs” indicate presence, while the numbers correspond to abundance categories. Monthly abundance is only used for fish and invertebrates data based on NOAA’s Estuarine Living Marine Resources (ELMR) databases. The numbers listed for each month in which the species is present correspond to: 1 = no information; 2 = rare; 3 = common; 4 = abundant; and 5 = highly abundant. In cases where ELMR fisheries data are used, the months in which high salinity (low rainfall, stream flow, or runoff), transitional, and low-salinity time-periods occur are indicated directly under the listing of the fish and invertebrates seasonalities as: H = high, T = transitional, and L = low.

Associated with each species location and monthly presence are the time-periods when various life-history stages or activities occur. The life-history time periods are different for each biological element. The life-history time periods listed are those that have resulted in the concentration of the species at the particular location (e.g., a nesting colony, spawning site, or nursery area has been mapped) and often are related to sensitive time-periods associated with reproductive activities or early life-history stages.

Finally, the databases include source documentation at the feature/species level. That is, for every species associated with each feature (a site or location indicated by a point, line, polygon, etc.) there can be a unique source or sources. Two source fields are used for biological resources, a geographic and a seasonality source. Typically, one source will provide the geographic location, species name or list, concentration, and type of resource occurrence (nesting site, migratory stop-over), while another source will be used to determine seasonality and life-history information. The same source may provide all of the information and would be listed as both the geographic and seasonality source.

Human-Use Resources

Human-use resources can be divided into four major components (Table 4):

- High-use recreational and shoreline access locations;
- Management areas;
- Resource extraction locations; and
- Archaeological and historical cultural resource locations.

Each of these components is discussed below.

Recreational Areas/Access Locations

Recreational areas shown on sensitivity maps include high-use recreational beaches, sport-fishing, diving sites, surfing areas, and artificial reefs (used for both fishing and diving). Boat ramps and marinas are shown, both as recreational sites and access points for response activities. Airports, ferries, and helipads are shown as access points.

Management Areas

Officially designated management areas include designated critical habitats, national parks, state and regional parks, Indian reservations, marine sanctuaries, Nature Conservancy lands, wildlife refuges, and preserves and reserves set aside by various agencies and organizations. Other ecological sites that have special resource management status can be included as "Special Management Areas."

Table 4. Commonly mapped human-use resources.

Data Element	Sub-Element	Mapped Areas
Recreation/Access	Access	Vehicular access to the shoreline
	Airport	Includes airports, landing strips, etc.
	Artificial reef	Attracts high concentrations of fish and divers
	Beach	High-use recreational beaches
	Boat Ramp	High-use marine/estuarine facilities
	Diving Site	High-use recreational areas
	Ferry	High-use ferry routes
	Helipad	Designated helicopter landing sites
	Marina	High-use marine/estuarine facilities
	Recreational Fishing	High-use recreational areas
	Surfing	High-use recreational areas
Management Areas	Designated Critical Habitat	Officially designated by USFWS
	Indian Reservation	Indian Reservations and Tribal Lands
	Marine Sanctuary	Waters managed by NOAA
	National Park	Land managed by NPS
	Nature Conservancy	Protected land owned by TNC
	Park	State and regional parks
	Special Management Areas	Usually water-associated
	Wildlife Refuge, Preserve, Reserve	Federally and state managed
Resource Extraction	Aquaculture Site	Hatcheries, ponds, pens, etc
	Commercial Fishing	Important, high-use areas
	Log Storage Sites	Areas of high economic importance
	Mining	Intertidal/subtidal mining leases
	Subsistence	Designated harvest sites
	Water Intake	Industrial; drinking water; cooling water
Cultural Resources	Archaeological Site	Water, coastal, or wetland-associated
	Historical Site	Water, coastal, or wetland-associated

Resource Extraction Sites

Resource extraction locations include aquaculture, commercial and subsistence fisheries, log-storage areas, mining-lease sites, and water intakes. Log-storage sites and intertidal and subtidal mining leases are included so that appropriate protection and cleanup strategies can be developed. Log-storage sites can contain large numbers of valuable wood products that, when oiled, must be cleaned at great expense before sale. Owners of intertidal mining leases must be contacted before removal of oiled sediment. For aquaculture, water intakes, and other economic resources, an owner and emergency contact name and telephone number may be listed.

High-value commercial fishing areas are also a critical component to ESI mapping, particularly leased shellfish beds and nearshore, shallow-water fisheries such as crabbing, shrimp harvest, lobster harvest, and estuarine fisheries. Often, the concern is to minimize impacts to the catch and fishing equipment as gear is pulled from the water through surface slicks. Non-commercial seafood harvest areas, including subsistence use areas, identify fishing sites and invertebrate collection areas that are often of great cultural and economic importance to local populations.

Cultural Resources

Cultural resources include archaeological, historical, and other sites of religious or cultural importance. The most sensitive types of cultural resources are those that are located in the intertidal zone, or sites located very close to the shoreline where they may be directly oiled or disturbed by response or cleanup activities. If there are multiple sites close to one another, than the general area is often indicated by one point or a series of points along the shoreline. However, many archaeological, historical, and cultural sites are location-sensitive, so the exact location of the site often cannot be disclosed. In such cases, the resources are often described in general in the introductory pages of the atlas and not shown at all; or a symbol in the general, but not the actual location of the site, is shown on the ESI map instead. It is important to note that users of ESI products must go the original source to obtain location-sensitive data.

3 SHORELINE CLASSIFICATION METHODOLOGY

Introduction

The ESI scale, as described in Section 2, categorizes coastal habitats in terms of their susceptibility to spilled oil, taking into consideration a number of natural physical and biological factors. Because the scale was constructed on the basis of spill experience and fieldwork in each of the habitat types, the need for extensive fieldwork when assessing a region's sensitivity to spilled oil is reduced. Typically, a state's coastline can be field-classified within weeks, weather and tides permitting. The practical application of the ESI scale relies primarily on recognizing shoreline habitats using maps, literature, remote imagery, low-altitude aerial surveys, and ground observations. Of these, the bulk of the classification takes place via low-altitude aerial surveys. Nevertheless, ESI shoreline classification involves several data sources and a multi-step workflow, of which the aerial survey is just one component. The process involved in a typical ESI survey, as described below, is outlined in Figure 1.

Initial Data

Before shoreline classification can take place in the field, the following basic data set (shown in Figure 1 as the shaded squares) must be obtained and processed:

1. Base maps
2. Shoreline
3. Wetland boundaries
4. Aerial photos
5. Previous shoreline studies

Base map. The base maps used for each project are generally the most current topographic maps available. These maps are used during the field surveys and also serve as a background for the final ESI hard-copy maps. For domestic projects, U.S. Geological Survey (USGS) 7.5-minute quadrangle maps (1:24,000) are most commonly used. In some regions, such as Alaska, the most detailed maps available are at a scale of 1:63,360, and these are used as the base maps. International atlases used U.S. Defense Mapping Agency and foreign government agency maps that are published at a scale of 1:50,000.

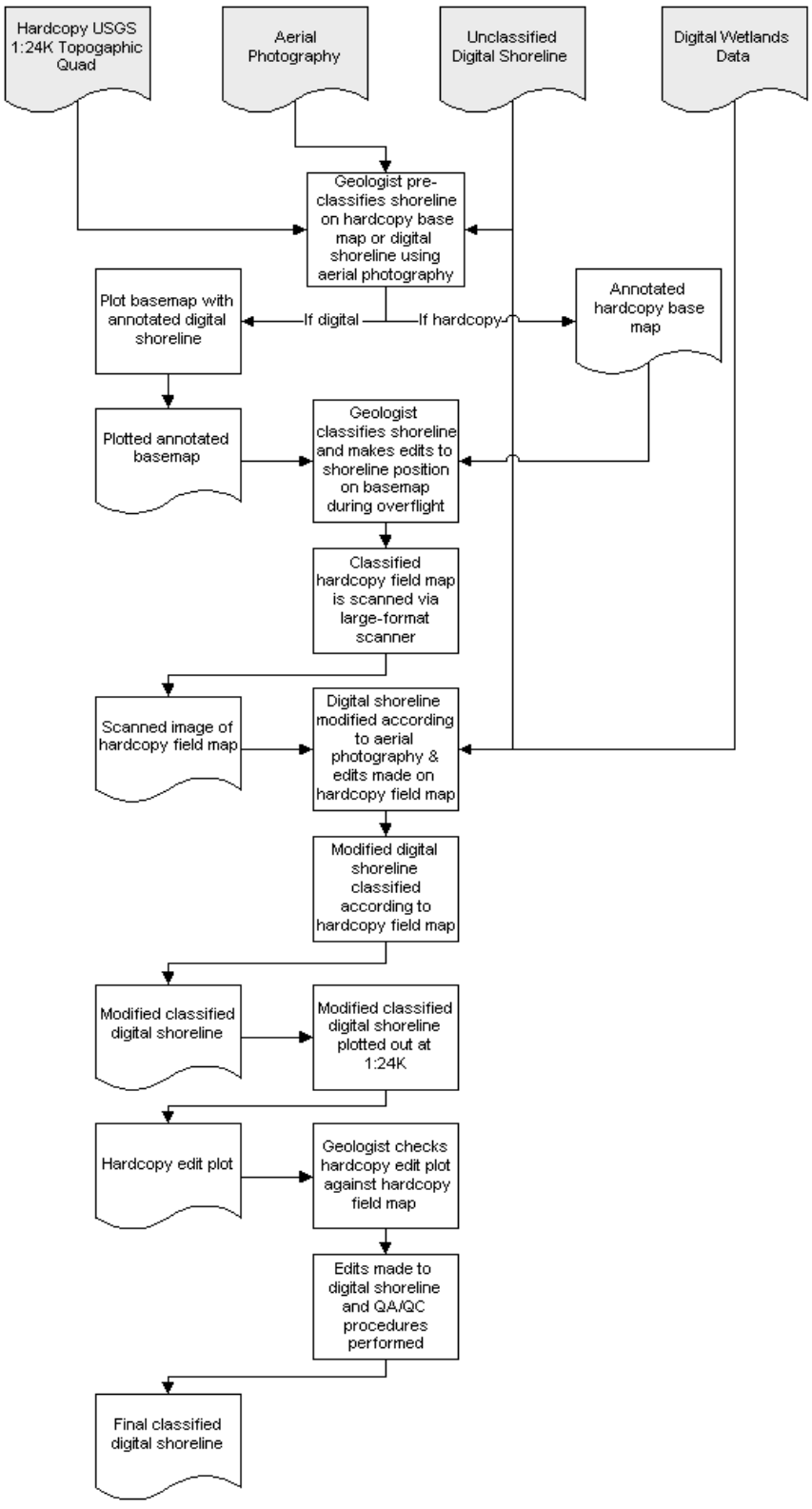


Figure 1. Flowchart of the process for classifying and digitizing the shoreline habitats.

Before field use, all base maps are scanned as grey-scale digital images using a tablet scanner.

In some instances, Digital Raster Graphic (DRG) files have been obtained and plotted at an appropriate scale for use as field base maps, as have digital orthophoto quarter quads (DOQQs) and portions of satellite imagery.

Shoreline. The shoreline used for ESI mapping is a key data layer because many other data layers use the shoreline as a boundary. For example, polygons for shorebirds are created as a buffer around the shoreline; turtle-nesting beaches are digitized buffers around certain sand beaches. Shorelines are digitized in-house or are provided by state or Federal agencies. The shoreline that is used for each ESI project is often dictated by the shoreline that is used by the state and/or Federal agencies for existing mapping projects; most commonly, this shoreline is from 1:24,000 USGS topographic maps or NOAA coastal survey maps. However, in some situations a more current shoreline is digitized from DOQQs or other imagery. When this occurs, the new shoreline is plotted atop the scanned base map and is used in the field during the shoreline surveys. Regardless of the shoreline source, any changes in shoreline position (i.e., new man-made features, inlets, etc.) noted during overflights are incorporated into the final shoreline coverage.

Wetland Boundaries. When wetlands are mapped as polygonal features, an outside source typically provides their boundaries digitally. Commonly, National Wetlands Inventory (NWI) data are used for domestic projects, but State agencies have also contributed data. In some cases, the only available source for the areal extent of wetlands is their delineation as shown on the topographic base map. When this occurs, the boundaries are verified or modified during the project overflights and used in the final ESI data and atlas.

Aerial Photos Copies of recent aerial photos available through Federal and State agencies are generally obtained before overflights. Color, color infrared, and black-and-white photography all provide an overview and generate a preliminary ESI classification. In general, hard-copy photos are most useful for preliminary shoreline classification when they are of a scale comparable to 1:12,000. Photographs available at scales smaller than 1:12,000 (e.g., 1:40,000) are most useful if provided in a digital format, so that they may be enlarged interactively to enhance the detail in the intertidal zone. DOQQs are of particular value since they can be easily geographically registered to match the shoreline to be used in the project and digitally magnified to permit preliminary ESI classification.

Previous Shoreline Studies To become familiar with the field area, the geologist reviews literature (including ESI atlases) pertaining to the map area.

Preliminary Shoreline Classification

The geologist uses aerial photography with shoreline studies to begin classifying the coastal habitats after the data have been acquired and before field-classifying the shoreline , (Figure 1). If the digital shoreline is available at the time of the preliminary classification, the geologist may update shoreline arcs with the appropriate ESI values and replot them atop the scanned base map for use in the field. If the digital shoreline is not ready to be attributed, the hard-copy base maps are hand-annotated. In addition to classifying the shoreline, any sheltered and/or exposed tidal flats that appear may be added to the base map at this time. Once areas with available aerial photos have been pre-classified, the actual field surveys take place.

Field Survey Methodology

The fieldwork involved in an ESI shoreline classification consists of two parts: 1) aerial surveys and 2) ground verification. Aerial surveys are conducted using fixed, high-wing aircraft and/or helicopters. Because the intertidal zone is being mapped, it is critical that the survey takes place within 2.5 hours of low tide so that the maximum area of intertidal substrate is exposed. Surveys are coordinated with spring low tides when possible and flight plans are always scheduled to maximize time on-site during low tide.

During the overflight, the pilot maintains an altitude between 300 and 600 ft and speeds of 80 to 90 knots. The geologist annotates the shoreline with ESI rankings as it appears on the base map, carefully noting transitions in habitats. Shorelines with more than one ESI type in the intertidal zone are annotated on the map in order from landward to seaward ESI classifications (e.g., a seawall fronted by a fine-grained sand beach is noted as 1B/3A). Because of GIS limitations, a maximum of three ESI classes may be assigned to one segment of coastline. In addition to classifying the shoreline, the observer takes low-altitude, oblique photographs representating each ESI habitat. In areas where the coastline significantly differs from the base map, through natural or artificial processes,

the geologist modifies the base map coastline by hand, while the pilot circles the area at a higher altitude. This new coastline is then classified.

Tidal flats are mapped using aerial photographs, maps, and field observations. While aerial photographs provide an overview of intertidal features, they are often not obtained during low tide, making tidal flat boundaries taken from them somewhat unreliable. Field observation provides the most reliable information and the geologist must hand-sketch the extent of any tidal flats. Only tidal flats exposed subaerially are mapped. In some cases, tidal flats are portrayed accurately on the base map and are simply annotated during the overflight with the appropriate ESI class. In some areas, the tidal flat is so narrow that it is not mapped as an individual polygonal feature, but as the seaward component of a double ESI class shoreline. Because of the mobility of exposed tidal flats and the nature of the method used to map them, their location on an ESI map should be considered approximate.

Wetland classification and map detail depends on the complexity of the map region and the availability of polygonal data. When available, polygonal data are incorporated into the final ESI map. The existing ESI categories pertaining to wetlands (10A-10E) are in part the result of use of NWI and other datasets. It is often not possible to clearlyidentify freshwater vs. salt- and brackish water marsh from the air. Typically, the only field modification of the wetland data provided is to cross out or sketch tracts of wetlands that no longer exist or have been modified by coastal engineering. In the cases when no digital wetland data exist, the areal extent of wetlands is generally not defined and only their presence and classification along the outer-shoreline is shown. In areas where extensive tracts of wetlands in the coastal zone have no polygonal data, the geologist may verify boundaries during overflights, from existing topographic maps, and by analyzing aerial photographs. Human-use features, such as marinas, boat ramps, and aquaculture sites, are also mapped during the aerial photograph analysis and overflights.

Ground verification takes place daily, depending on the timing of the overflights. Ideally, an example of each habitat should be visited and photographed on the ground. At a minimum, ground verification concentrates on confirming grain-size classifications for sedimentary substrates, since this can be difficult to recognize from the air. If a portion of the coast is identified during the overflights as problematic or difficult to classify, that segment or one like it is ground-checked and the maps are updated according to the ground observations. In regions with complex wetland habitats, it is essential to field-verify classifications made from the air.

Shoreline Classification Revision and Editing

Once the field component of the project is complete, the maps are scanned and the digital shoreline arcs are updated with the ESI attributes noted in the field (Figure 1). For a full explanation of this process see Chapter 5. The shape and position of the digital shoreline is also changed at this time to reflect field observations. After the information from the field maps has been incorporated into the digital database, the now-ESI color-coded shoreline is replotted at the same scale as the original base maps. The classified shoreline plots are then compared by the geologist to the original field-annotated base maps and any errors in shoreline attributes as recorded in the GIS database are corrected. Also at this time, any inconsistencies relating to exposure to wave energy are corrected. This pertains more to man-made or rocky substrates than sedimentary (e.g., exposed riprap adjacent to sheltered seawall). After these revisions and the performance of GIS QA/QC procedures, the ESI shoreline classification is complete.

Spatial Accuracy of Classification Methodology and Sources of Error

The only quantitative test of the spatial accuracy of the ESI shoreline classification was conducted during the Hawaii ESI mapping in August 2000. In the test, boundaries between ESI categories as mapped from the air (specific coastal habitats such as coarse-grained sand beaches, wave-cut platforms, and salt marsh) were located in the field and their positions were recorded with a handheld global positioning system (GPS). Coordinates were collected for over 60 points. The field-recorded GPS coordinates were then compared to the coordinates of the same points in the final digital ESI data to determine the spatial accuracy of ESI breaks or nodes as mapped.

Error analysis showed that occurrences of error were unsystematic and, therefore, genuinely random. It was initially assumed that errors in the x and y dimensions were independent of one another and normally distributed about the true location with an equal variance, or that there was no directional bias in the error. This assumption was verified by examining a circular plot of all measured deviation vectors from the mapped locations. The relatively circular distribution of points about the center of the plot illustrated that error was occurring unsystematically in all directions. When the angles of the error vectors were normalized based upon the orientation of the shoreline at the mapped point

of measurement, it was shown once again that error was distributed in a more-or-less circular pattern about the center or "true location." Error vectors clustered parallel to the shore would have indicated positional inaccuracy parallel to the shoreline that likely would have resulted from field or aerial survey work. The error analysis concluded that, regardless of error magnitude, there was no evidence of directional bias in the data.

The magnitude of the error present and the probability of its occurrence were analyzed statistically. There are a variety of statistical methods accepted as measures of map accuracy. Three of the most commonly used and accepted are the root mean squared (RMS) error value, the 95-percent error bound, and the circular error probable (CEP) or 50-percent error bound. The RMS value is derived directly from the data, whereas the percent error bounds are based on a probability function that incorporates the RMS value. Table 5 contains the three error reporting methodologies used and the accompanying values derived from the data collected in the August 2000 study.

Table 5. Error reporting methods and values from the Hawaii test of the spatial accuracy of the breaks between shoreline types.

Reporting method	Error (m)	Percentage of errors smaller
Circular Error Probable (CEP)	28.0	50%
Root Mean Squared (RMS)	33.5	63%
95% Error Bound	58.2	95%

In a practical sense the information presented in Table 5 means, using the RMS as an example, that the map user can be sure that 63 out of every 100 of ESI breaks mapped and included in digital databases are at least within 33.5 meters of their true geographic position. It should be noted that the numbers in Table 5 are statistical generalities, describing the data overall. In many cases, the mapped ESI break is likely closer to the true geographic location. The amount of error occurring at an individual ESI break fluctuates depending on the habitats mapped, among other factors (Table 6). For example, more positional error would be expected in the case of adjacent mobile, sedimentary substrates (that grade laterally into one another), than in the case of a seawall abutting a riprap structure. In general, there are three primary causes of error:

1) Error associated with mapping natural, gradual changes as discrete points;
2) Error associated with inaccuracies in the shoreline(s) used (hard-copy and digital); and
3) Human error (in the field).

The three primary sources of error listed above are the most readily identifiable and perhaps most significant. However, as outlined in Table 6, they are only part of a range of error sources. The degree to which these sources compound each other or cancel out one another is difficult to determine. As such, one can only measure and describe the total error that results from a combination of all these factors.

While there are still unknowns about the individual error sources, the magnitude of spatial error found in the August 2000 study is such that it would be almost imperceptible on the hard-copy product, either at the compilation scale 1:24,000 or at the typical publication scale of 1:48,000. At 1:24,000, 58.2 m (the 95-percent error value) translates to roughly .095 inches or about a $1/10^{th}$ of an inch error in final ESI break placement. The results presented are given as representative for ESI shoreline classification data, though they will vary to some degree for each atlas. As a greater body of data accumulates, these results will undoubtedly be refined. In the case of ESI maps generated in Alaska and Central America, where base maps of 1:63,360 and 1:50,000 scales, respectively, are used for ESI mapping, these results cannot be considered representative.

The spatial accuracy of the ESI mapping process becomes more important when the ESI data are disseminated and used in digital form. The difficulty in applying traditional

Table 6. Factors contributing to spatial error in ESI data.

Base map Error
1. Trends in shoreline associated with mappable coastal habitat change may be generalized on a base map scale of 1:24,000 2. Hard-copy shoreline may be inaccurate (due to map's age, tidal stage mapped, and/or human error)
ESI Process Error
1. The field geologist may misplace the ESI break (varying degrees of error depending on map reference points available) 2. Width of pencil mark used to indicate ESI break (10m error @1:24,000). 3. Digital shoreline used may not match base maps used in the field 4. If provided by an outside source, the digital shoreline may be digitized from maps that are not the same edition as those used in the field.

Table 6. Cont**.**

5. Error introduced when pencil marks are digitized as points 6. Error associated with re-projection of shoreline or warping of map during digitization
Cartographic Error
1. ESI break may not be a discrete point (i.e., gradual natural transitions in coastal geomorphology)
Thematic Factors Affecting Spatial Error
1. The field geologist may misidentify ESI types 2. The field geologist may merge ESI types to simplify mapping (a visual interpretation of minimum mapping unit)

concepts of scale such as the representative fraction (e.g., 1:24,000) to digital data is a problem that is of great concern to those that produce and use such data. Interactive mapping applications and tools, which allow you to reproduce and present data at scales greater than that at which the data was collected, make it critical that results of studies such as these be made available to the user community of digital ESI data through accompanying metadata or similar means.

4 COMPILING BIOLOGY AND HUMAN-USE RESOURCE INFORMATION

Introduction

Producing an ESI atlas involves gathering biological and human-use data from a variety of sources, compiling it into maps, entering the data into a GIS, and creating two final products: ESI maps that are bound together in a hard-copy atlas, and digital data on CD-ROM that can be viewed using ArcInfo, ArcView, ESI Viewer, or in portable document format (PDFs). This chapter describes the methodology for compiling biological and human-use (socio-economic) resources onto maps and data tables for data entry. These guidelines are for biologists or resources managers who compile and edit ESI data.

General Guidelines

The first step in the data compilation phase involves making contacts by phone and email with scientists and resource managers who can provide expert knowledge and suggest relevant source materials for biological and human-use resources in the study area. Please see Table 7 for guidelines on what types of biological information are typically gathered, and how this information is mapped. While making the initial contacts, the biologist responsible for data compilation sets up times to meet with the resource experts at their offices, or in a location where many different resource experts are able to convene. These data collection meetings typically include a group of scientists who research similar species (e.g., four or five bird experts from various agencies that are responsible for part of the study area), or are in the same region, (e.g., fish, bird, and reptile experts from one island in Hawaii or one borough in Alaska). Some phone and email contacts do not require follow-up meetings, but rather the resource experts send digital or hard-copy data.

Before the meetings, the biologist gathers a set of hard-copy base maps that will be used for data compilation. USGS topographic quadrangles are typically used, and the scales of the maps vary, but typically data are compiled onto 1:24,000-scale quads for most areas, and 1:250,000-scale quads for Alaska. NOAA nautical charts are used for data

Table 7. General guidelines for mapping biological resources.

ELEMENT	SUB-ELEMENT	DESCRIPTION
Marine Mammals	Dolphins and whales	Restricted to water. There are no restrictions to offshore or inshore extent.
	Manatees	Restricted to water. Manatees are generally shown in estuarine waters and often associated with cold-weather refuge areas such as springs, river mouths, power plant cooling water outfalls, etc. They may also concentrate in inlet mouths.
	Pinnipeds (seals and sea Lions, Walruses)	Can be displayed on water and land. On land, pinniped haulout and pupping sites may be shown as points or polygons occurring on beaches, rocky headlands, and across small islands.
	Polar bears	Can be displayed on land or water as polygons, or as points to identify denning sites. They are often associated with pack ice, but do not range far inland. They are described as marine mammals because they are classified as such in the Marine Mammal Protection Act.
	Sea otters	Occur in nearshore waters. They may also be associated with kelp beds and invertebrate concentration areas.
Terrestrial Mammals	Small, semi-aquatic furbearing	Typically shown throughout salt, brackish, and freshwater wetlands, and occasionally in other shoreline habitats.
	Bears	In Alaska, they are shown along streams with salmon runs, or where they present a hazard to spill responders. Threatened and endangered species and other special aquatic or wetland concentrations may also be shown.
	Other mammals	Mostly threatened, endangered, or other important species are mapped case-by-case.
Birds	Alcids	Occur in offshore waters and on islands or cliffs where they nest.
	Diving birds	Typically shown in nearshore areas along shorelines, and on tidal flats, islands, and in sheltered bays, estuaries, lagoons, etc.
	Gulls and terns	Usually shown as buffers along shorelines, and on tidal flats, islands, and in sheltered bays, estuaries, lagoons, etc.
	Landfowl	Occur in terrestrial areas, sometimes in and around wetland areas.
	Passerine birds	Endangered, threatened, or rare passerines that rely on coastal or wetland habitats are included when appropriate, especially if nesting occurs in the area.
	Pelagic birds	Occur in offshore waters and on islands or cliffs where they nest.
	Raptors	Occur along rivers, coastal shorelines, in wetlands, and in sheltered waters.

Table 7. Continued.

ELEMENT	SUB-ELEMENT	DESCRIPTION
	Shorebirds	Typically mapped using a 75-100m buffer (onshore and offshore) along sand and gravel beaches. They are also mapped on tidal flats and in wetland habitats.
	Wading birds	Usually restricted to wetlands, tidal flats, tidal creeks, and the margins of sheltered waters (bays, estuaries, lagoons, sloughs)..
	Waterfowl	Waterfowl (ducks and geese) are usually mapped in nearshore areas, such as bays, estuaries, and lagoons, and are also commonly shown extending through salt, brackish, and fresh wetlands, and into rivers. Some species groups, such as sea ducks, may be mapped further offshore
Reptiles and Amphibians	Turtles	May include sea turtles and diamondback terrapins. Sea turtle nesting and haul-out areas are usually mapped as points or as 75-100m onshore/offshore buffers along sand beaches. Important marine foraging and nursery concentration areas may also be shown. Diamondback terrapins are usually mapped as polygons in wetlands.
	Alligators and crocodiles	Often restricted to sheltered waters (estuaries, bays, etc.), streams, wetlands, and nesting along sand or vegetated shorelines.
	Lizards, snakes, amphibians and other reptiles	In some cases other threatened, endangered, or rare species may be included, such as salt marsh snakes.
Fish		Almost always restricted to water. General distributions are usually defined by bathymetric contours, distance from the shoreline, habitat type (such as reefs), or salinity zone. Anadromous fish are usually mapped as polygons and arcs in streams and rivers, but occasionally a point representing the stream mouth is used instead. Some important concentration areas and spawning areas are also mapped in addition to more general distributions. Occasionally rare species occurrences are mapped as points or polygons.
Invertebrates	Abalones, cephalopods, clams, crabs, echinoderms, gastropods, lobsters, mussels, oysters, scallops, and shrimp	Almost always restricted to water and tidal flats. General distributions are usually defined by bathymetric contours or distance from the shore. There may also be special concentration areas defined by habitat type or fishing concentrations.
	Insects	Typically only depicted if they are threatened, endangered, or rare and associated with coastal, wetland, or aquatic habitats.

Table 7. Cont.

ELEMENT	SUB-ELEMENT	DESCRIPTION
Habitats and Rare Plants	Algae, coral reefs, hard-bottom reefs, eelgrass, kelp, SAV, FAV, worm beds	Generally restricted to water and tidal flats.
	Upland plants	Upland (terrestrial) plants, habitats, or communities; usually restricted to rare species.
	Wetland plants	Wetland plants, habitats, or communities; usually restricted to rare species.

compilation in areas that are beyond the quad boundaries, but are included in the digital data. Meetings typically begin with an explanation of what all involved parties hope to achieve, such as what types of resources should be included, and what types of data are available at the time. During the meetings, resource experts may choose to sketch biological and human-use resource distributions onto compilation maps based on hard-copy data and opinion, as well as provide corresponding concentration and seasonality information for the species mapped. USGS topographic quadrangles are used for data compilation. During the meetings, resource experts also provide hard-copy maps and reports, digital data, and information on other digital data that are available for free download on their agency websites.

Following the meetings, the biologist reviews the information that was compiled onto the maps, as well as the hard-copy and digital data that were provided, to decide how each biological and human-use resource can best be depicted using the available information. Once all of the data have been reviewed, the biologist begins planning how each resource will be mapped throughout the entire study area, rather than deciding on a map-by-map basis as she/he proceeds, which tends to lead to inconsistencies. During this process, it is important to try to limit the number of species that will be mapped to those species that are rare and/or protected, and to those of commercial/recreational/cultural value, so as not to attempt to map the complete inventory of species in an area.

It is also important to consider not mapping the complete distribution of all species, but rather to focus on mapping specific concentration areas during certain life-history stages (e.g., nesting, overwintering, spawning), or ecologically sensitive areas (e.g., rare/endangered species), to assure that the information mapped is as useful as possible,

and not too general and/or overwhelming. During this planning period, resource experts may be sending data unavailable at the time of the meetings, and the biologist may also need to make additional phone calls to contacts who were unable to attend the meetings and to new contacts who were suggested by the meeting participants. Once all of the data have arrived, the biologist may proceed with the next step of compiling the data onto a clean set of topographic maps, as described below.

The biologist draws biological and human-use features as points, polygons, and lines, and uniquely numbers them on the topographic maps and in corresponding data tables for easy identification and editing. Points are typically used for bird nests, Natural Heritage Program data, human-use features (e.g., marinas, boat ramps), pinniped haul-out sites, and to identify stream mouths used by anadromous or native stream species. Lines depict anadromous fish runs in streams. Polygons identify all other biological resources and some human-use features, such as management areas, and can range from small shoreline buffers or wetland polygons, to large polygons that cover the distribution of a species across several maps. When drawing polygons, lines already present on the topographic maps can be used as part of the polygon. For example, a polygon for a species restricted to the water can include the shoreline as the landward extent of the polygon. Following this convention reduces clutter and ambiguity, especially along the shoreline. Roads, contour lines, and bathymetry lines can also be used in this manner.

The numbering system mentioned above, listed as the wildhab# (biology) or socval# (human-use) in corresponding data tables, includes the topographic map number, a dash, and the feature number. Please see Tables 8-11 for descriptions of the data tables and the attribute fields that are used. For example, wildhab# = 1-01 is map number one, polygon number one. Human-use features are preceded by an "H" (e.g., 1-H1). Biology and human-use resources are treated separately. For example, biological polygons might consist of 1 to 25 on map #1 (1-01 to 1-25), while human-use features might consist of H1 to H11 (1-H1 to 1-H11). If a set of polygons or points on one map contains the same species, concentrations, seasonalities, and sources, all the polygons can be given the same wildhab#. The same convention applies to human-use data. In the digital data, the biological and human-use identifiers are all numeric.

When polygons or lines extend to the edge of a map, they must be edge-matched with the corresponding polygons or lines on adjacent maps. The biological or human-use attributes of the polygons or lines must also be matched, so that the resources listed for

the polygons correspond (including species, concentrations, seasonality, and life-history information, and source).

As an example, if polygon 1-05 (sawfish and sailfish) extends to the right-hand edge of map #1 but does not end there, and the left-hand edge of map #2 is continuous with the right-hand edge of map #1, there must be a corresponding polygon containing sawfish and sailfish with the same attributes as wildhab# 1-05 on map #2. This polygon is then annotated in the biological resources data table for map #2 with a wildhab#, and rather than repeating the attributes for wildhab# 1-05 in the appropriate columns, the phrase "same as 1-05"is used.

Where edge-matching is intended, a note should be written in the map margin indicating which polygon or feature should be edge-matched on adjacent maps. Continuing with the above example, "edge-match 1-05 to 2-01" should be written in the margin of map #1 near the unclosed edges of the polygon #05. On map #2, "edge-match 2-01 to 1-05" should be written in the margin near the unclosed edges of polygon #01. This convention greatly improves communication between the data compiler and the GIS technicians. When a polygon extends to the edge of a map, but not beyond, the polygon should be closed to indicate that it does not continue onto the next map.

Biological Resources

The biological resources to be mapped are arranged hierarchically into elements, sub-elements, and species (see Table 3; Chapter 2). During the biology compilation and editing, colors are used to distinguish among elements:

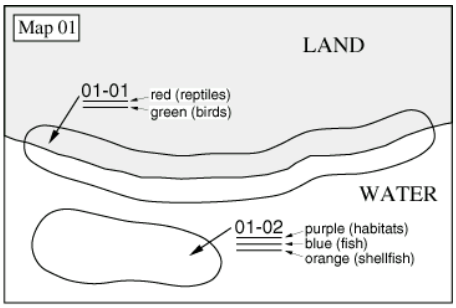
marine mammals	—	brown
terrestrial mammals	—	brown
birds	—	green
reptiles/amphibians	—	red
fish	—	blue
invertebrates	—	orange
habitats	—	purple

These colors resemble the final map product. To efficiently digitize the biological data, each polygon is traced and each wildhab# is underlined with the appropriate color using

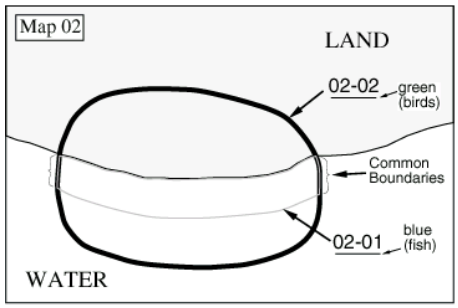
colored pencils. This allows the digitizing technician to separate information into the proper element or data layer.

Overlapping Distributions of Biological Polygons

In most instances, several species will display similar or partially overlapping distributions. If different polygons were displayed for each species, ESI maps would become much too busy, and many features would become wholly or partially obscured. For this reason, individual polygons can contain any number of species, even if they are different sub-elements or elements. Where groups of species have the same or very similar distributions, a single polygon can represent all the species (Figure 2). This multi-resource polygon would be identified by a single wildhab# on the topographic map and in the data tables. The color code for each element would be indicated with colored pencils near the site number on the topographic map.



Polygon 01-01 = sea turtles and diving birds
Polygon 01-02 = seagrass, fish, and shellfish



Polygon 02-01 = fish
Polygon 02-02 = diving birds

Figure 2. Biological polygons with multiple elements (top) and overlapping biological polygons (bottom).

Digitizing Directions

During the biology data compilation, short digitizing directions can be written on the maps (instead of polygons) when a species or group of species covers large areas, specific habitat types, or major geographical features. During the GIS phases of ESI production, these directions on the compilation maps are converted to polygons that completely fill the areas or habitats specified by the data compiler.

To indicate digitizing directions, a small box is drawn on the map within the area or major geographic feature identified, and a wildhab# is assigned to the box as if it were a polygon. The specific directions are then written inside the box. For example, several species of waterfowl, fish, and invertebrates may occur throughout Fish Bay. A box would be drawn within the bay and "All Fish Bay Waters" would be written in the box along with the wildhab#, for instance "1-34," and the color code for each biological element. During digitizing of the biology, a multi-resource polygon would be created that included all of Fish Bay. In cases where drawn polygons become confusing, written digitizing directions could also be included, and should be located directly under the wildhab#.

Tabular Data Guidelines for Biological Data

As the biological features (polygons, lines, and points) are drawn on the maps, attribute data (species, concentration, seasonality, and source information) are recorded in associated data forms. Attribute data are collected and recorded at the species level. For example, if mallard, black duck, and great blue heron are all mapped in the same wetland and are grouped together into polygon #4-14, then it is necessary to record the concentration, seasonality, and source of the geographic and seasonality information for each species separately. These forms, combined with the maps, allow for complete and accurate data compilation, entry, and processing.

The Biological Resources form (Table 8) identifies the various species associated with the biology polygons on the ESI maps and their individual concentrations. The form also includes fields or columns (Table 9) for seasonality and source numbers that link to other tables. The Seasonality/Life-history forms (Table 11) include fields or columns that must be populated if seasonality and breeding information exist.

Table 8. Biological resources form.

Site #[1] (Map#-Poly#)	**Species Name**[2]	**Concentration**[3] (High, Medium, Low, #)	**Season ID#**[4]	**Geog Source**[5]	**Seasonality**[6] **Source**
1-01	Brown pelican	High	1	1	3
1-02	Brown pelican	High	2	1	3
	Loggerhead turtle	Med	1	2	2
1-03	Piping plover	10 nests	1	4	5
	Least tern	2 nests	1	4	5

1 = unique id indicating the location of the biological resource
2 = species common name
3 = descriptive concentration or # individuals per polygon
4 = number code to differentiate polygons in which the same species has different seasonal distributions
5 = unique id identifying the source that provided locational information
6 = unique id identifying the source that provided seasonality information

Table 9. Column descriptions of the Biological Resources form.

COLUMN	DESCRIPTION
Wildhab# (map#–poly#)	Identifies each polygon by map number and polygon number. The map number is entered in the bottom right corner of the map. Multiple polygons with the same combination of species, concentration, seasonality, and source can be assigned the same wildhab#.
Species Name	Refers to the common name of a species found within a polygon. When a polygon contains an assemblage of species, each species associated with the wildhab# should be listed separately. Species name, in combination with Season ID#, is linked to the Seasonality/Life-history data tables. Species name is also linked to the Atlas Species List.
Concentration	Refers to the concentration of a species within a polygon. Concentration can be given as "high," "medium," or "low," or as another appropriate descriptive term, or as the number of individuals or nests within the polygon. The definition or range of values represented by each descriptive category or numerical value must be described in the introductory pages of the atlas and in the metadata report. If numerical concentrations are used, indicate whether the numbers represent individuals, nests, breeding pairs, etc. If abundance categories are listed by month in the seasonality tables (e.g., for ELMR data), the concentration field is left blank.
Season ID#	Refers to a code number (e.g., 1, 2, 3, etc.) representing the seasonal distribution of a species within a polygon or group of polygons. The code number, in combination with species name, is linked to the seasonal information given in the Seasonality/Life-history data tables (Table 10). When the same species is present in different seasons, different season ID#s are used. For instance, least terns may be present in several different polygons at two different times of the year. They may be listed for wildhab# 1-05 (and other maps and polygons) as being present in spring only, while least terns listed for wildhab# 1-12 are present year round. In this case, the first listings for least terns would have season ID# "1," and the second listing would have Season ID# "2." Follow this convention for all maps and data tables.
Geographic Source	A number that corresponds to the source which provided the locational and concentration information on a species included in a polygon, line, or point feature.
Seasonality Source	A number that corresponds to the source that provided the seasonality information on a species included in a polygon, line, or point feature. The seasonality source may be the same as the geographic source.

Table 10. Seasonality/life-history data form.

element = **BIRD**

		Seasonal Presence[3]												Life-history Stage and Reproductive Timespans			
SEASON[1] ID#	**SPECIES NAME[2]**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**NESTING[4]**	**LAYING[5]**	**HATCHING[6]**	**FLEDGING[7]**
1	Brown pelican	X	X	X	X	X	X	X	X	X	X	X	X	–	–	–	–
2	Brown pelican						X	X	X	X				JUN-SEP	JUN-JUL	JUL-AUG	AUG-SEP

1 = number code that differentiates polygons in which the same species has different seasonal distributions (see Table 1)
2 = species common name
3 = check the months in which the species/season ID# combination is present
4 = the entire time-span in which eggs/young are present (includes laying, hatching, and fledging)
5 = time period when eggs are being laid and incubated
6 = time period when young are hatching
7 = time period when young are being reared (until they leave the nest)

Table 11. Column descriptions of the Seasonality/Life-history form.

COLUMN	DESCRIPTION
Season ID#	Refers to a code number (e.g., 1, 2, 3.) representing the seasonal distribution of a species within a polygon or group of polygons. The code number, in combination with species name, is linked to the seasonal information given in the Seasonality/Life-history Data forms. When the same species is present in different seasons, different season ID#s are used. For instance, least terns may be present in several different polygons at two different times of the year. They may be listed for wildhab# 01-05 (and other maps and polygons) as being present in spring only, while least terns listed for wildhab# 01-12 are present year-round. In this case, the first listings for least terns would have season ID# "1," and the second listing would have Season ID# "2." Follow this convention throughout the set of maps and data tables.
Species Name	Refers to the common name of a species found within a polygon.
Seasonal Presence	Indicated by checking off the months (JAN, FEB, MAR, etc.) when a species is present. If relative abundances are known for the monthly presence, the following number codes may be used: 1 = No Information 2 = Rare 3 = Common 4 = Abundant 5 = Highly Abundant To date, monthly abundance categories have only been used for ELMR fisheries data. These categories should be clearly defined for each element or subelement in the atlas introductory text and metadata reports.
Life-history Time-Periods	Indicated for certain special or sensitive life-history stages or activities. Sensitive life-history stages and activities differ by element (Table 12). Life-history time-periods are listed as a range in months (i.e., APR-JUL). For atlases published after 1999, five fields are available for listing sensitive time periods, and these fields remain consistent by element for all atlases. Reference the atlas-specific metadata for the definition of life activities listed in older atlases.

Table 12. Life-history time periods for each biological element.

COLUMN	DESCRIPTION
Marine Mammals	The life-history activities for marine mammals are mating, calving, pupping, and molting. Mating refers to the time periods when adults concentrate to mate. Calving (dolphins, whales, and manatees) and pupping (seals, sea lions, and sea otters) refer to when females are giving birth to young. Molting refers to the time when seals and sea lions haul out to shed fur and skin.
Terrestrial Mammals / Habitats	Life-history categories are not typically listed for terrestrial mammals and habitats/rare plants. In certain instances (e.g., coral spawning and juvenile periods), they could be indicated, but must be defined in the atlas introductory text and metadata report.
Birds	The life-history activities for birds are nesting, laying, hatching, and fledging. Nesting refers to the entire period when birds are laying eggs, hatching eggs, and fledging young. Laying, hatching, and fledging are subsets of nesting.
Reptiles	The life-history activities for reptiles are nesting, hatching, inter-nesting, and juvenile. Nesting refers to the deposition of eggs by turtles and the time period when turtle eggs are present. Nesting also refers to the laying and tending of eggs and nests by crocodilians. Hatching refers to the time period when young are hatching and emerging from the nests. Inter-nesting is a special category for sea turtles, defined as the period prior to and during nesting when adult males and females concentrate in nearshore waters. Mating often takes place during this time. Juvenile refers to the period when juveniles are present.
Fish	The life-history activities for fish are spawning, eggs, larvae, juvenile, and adult. Spawning includes the actual spawning act and any spawning-related migration or concentration periods, especially those associated with diadromous or estuarine fishes. Eggs refers to the period when eggs are present. Larvae refers to the period when larval stages are present. Juvenile refers to the time when juveniles are present, and is especially emphasized in nursery areas. Adult indicates the seasons when adult (mature) fish are present.
Invertebrates	The special life-history activities for invertebrates are spawn/mate, eggs, larvae, juveniles, and adults. The descriptions of these activities and life stages are generally the same as for the fish (see above). Mating refers to reproductive activities performed by species with internal fertilization (e.g., blue crab), and can include migratory or other concentrations associated with mating. Spawning typically refers to the release of gametes to the water column, but in species that mate, it can also refer to the mass release of fertilized eggs or larvae to the water column.

Species List

The Atlas Species List (Table 13) is linked to the Biological Resources Table using the SPECIES NAME and ELEMENT fields. The atlas species list provides species common name; scientific name (genus/species), state and federal T/E/C (threatened/endangered/species of special concern) listings, element and sub-element classifications, and Natural Heritage Program (NHP) global conservation status ranking (Table 14). The Nature Conservancy (TNC)/NHP rankings include G1 (critically

imperiled), G2 (imperiled), G3 (vulnerable), G4 (apparently secure), and G5 (secure). Definitions of each category are given in Masters (1991), and are also available from TNC and the state NHP programs. This list is particularly useful where there are multiple common names used for the same or different species, when species have different state or federal T/E listings in different geographic locations, and when a new species needs to be added to the nationwide species list. See Table 14 for column descriptions of the Atlas Species List Table.

Table 13. Atlas species list.

SPECIES[1] ID#	SPECIES NAME[2]	SCIENTIFIC NAME[3]	STATE[4]	S/F[5]	T/E[6]	DATE_ PUB[7]	ELEMENT[8]	SUBELEMENT[9]	NHP[10]
118	Brown pelican	*Pelecanus occidentalis*	DE	S	E	51994	BIRD	DIVING	G4
118	Brown pelican	*Pelecanus occidentalis*	NJ	—	—	21994	BIRD	DIVING	G4

1 = species identification code from the ESI Species ID# Master List
2 = common name
3 = scientific genus and species (Latin name)
4 = indicate state for T/E/C species using the two-letter abbreviation code
5 = protection status for federal and/or state
6 = threatened and/or endangered listing
7 = date of list used to determine listing and NHP status
8 = biological element
9 = biological subelement (see Chapter 2, Table 3)
10 = Natural Heritage Program (NHP) global conservation status ranking

Table 14. Column descriptions for the atlas species list.

COLUMN	DESCRIPTION
Species ID#	A number code used to identify and track species during GIS data processing. There is an ESI Master Species List that contains number codes for all species that have been included in previous ESI atlases. The person compiling biological data for an ESI map must have the most recent copy of the Master List (Appendix A) to enter the species code. New species can be added to the Master Species List as needed.
Species Name	The common name of the species listed in the biology tables. The common name can vary geographically and a new species ID# can be added when the common name does not match the existing master species list.
Scientific Name	The Latin genus and species name of the species. This field is extremely important when there are several common names used for the same species.
State	The two-letter state abbreviation code. For a single-state atlas, enter this code only once for all threatened or endangered species. If an atlas spans more than one state, list each state in which the species is threatened or endangered on a separate line.
S/F	Federal and/or State protection status. Indicate both using S/F or just one using either "F" or "S."
T/E	Threatened (T)/endangered (E) /species of special concern (C) status. Indicate status in the same order as the jurisdictional designation.
Date_Pub	Date of reference used to determine T/E listing or status.
Element	Biological element.
Subelement	Biological subelement.
Natural Heritage Program	Natural Heritage Program global conservation status rankings (e.g., G1, G2) compiled by The Nature Conservancy and the state Natural Heritage Programs. Contact the appropriate state NHP office for a list of rankings by species. If a species is not tracked by the NHP, place a"–"in this field.

Human-Use Resources

Each human-use resource is assigned a feature type and feature code (Table 15). Color codes are not used. Human-use features such as recreational areas, access locations, resource extraction sites, and cultural resources as typically drawn as points, while management areas are drawn as polygons. A leader line is attached to each feature and the map and feature number (socval#) are clearly indicated (e.g., 1-H1 would indicate the first human-use resource on map #1). Where a resource, such as an archaeological site or fishing area, appears multiple times on the same map, the same site number can be given to each point symbol. If *a* resource extends across multiple topographic maps, different socval numbers will be given for the different maps (e.g., 2-H1, 3-H2.). The Human-Use Resources form (Table 16) attributes the mapped human-use features. The headings are described in Table 17.

Table 15. Human-use feature types and codes.

Feature Type	Code
Airport	A
Access Location	A2
Area Boundary	AB
Aquaculture Facility	AQ
Artificial Reef	AR
Archaeological Site	AS
Beach	B
Boat Ramp	BR
Campground	C
Casino	C2
Commercial Fishing	CF
Coast Guard Facility	CG
Designated Critical Habitat	CH
Community	CO
Collection Point	CP
Diving Site	DV
Equipment	EQ
ESI/RSI	ER
Ferry	F
Factory	F2
National Forest	FO
Field Station	FS
Hoist	H
Hatchery	HA

Table 15. Cont.

Feature Type	Code
Heliport	HP
Historical Site	HS
Hazardous Waste Site	HW
International Boundary	IB
Ice Extent	IE
Indian Reservation	IR
Lock and Dam	LD
High Water Leakage Points	LP
Log Storage	LS
Marina	M
Mining	M2
Management Area	MA
Marine Sanctuary	MS
Nature Conservancy	NC
National Park	NP
Oil Facility	OF
State or Regional Park	P
Process Facility	P2
Platform	PF
Pipeline	PL
Recreational Fishing	RF
Road	R
Scenic River	SR
Subsistence	S
Surfing	S2
State Border	SB
Sewage Outfall	SO
Staging Site	ST
State Waters	SW
Well	W
Waste Disposal Site	WD
Water Intake	WI
Wash Over	WO
Wildlife Refuge	WR

Table 16. Human-use resources form.

Site #[1] (Map#-Feat.#)	Resource Type[2]	Resource Name[3]	Geog[4] Source	Attribute[5] Source
001-H01	WR	Wild Goose Chase National Wildlife Refuge	4	4

1 = location of the socio-economic resource
2 = type of human-use resource (access, recreational beach, water intake, etc.)
3 = name of the facility
4 = unique id identifying the source that provided locational information
5 = unique id identifying the source that provided attribute information

Table 17. Column descriptions for the human-use resources form.

COLUMN	DESCRIPTION
Socval# (map#–feature#)	Refers to the location of each human-use resource by map number and feature number. The feature # is always preceded the letter "H" to denote human-use resources.
Resource Type	Refers to the type of human-use resource e.g., wildlife refuge) (Table 15).
Resource Name	Refers to the name of the resource (e.g., Sabine Pass National Wildlife Refuge). Some resource types may not have names.
Contact	Refers to the name of the agency or person who should be contacted in case of an oil spill or other emergency.
Phone	Refers to the phone number of the contact agency or contact person.
Geographic Source	A number that corresponds to the source which provided the location information for the human-use resource included in a polygon or point feature. This number references the sources in the Source Master List.
Attribute Source	A number that corresponds to the source that provided attribute information for the human-use resource, such as the feature name or contact information. This number references the sources in the Source Master List.

Source (Metadata) Documentation

Two forms are used to document source information. The Source Master List (Table 18) provides detailed information on the sources used to compile biological and human-use data. The source information is needed for metadata documentation of the ESI atlas (Table 19). The human-use data require listing all sources that provided spatial (G_source) and attribute (A_source) features. For the biological data, sources for spatial and concentration information (G_source) and seasonality and life-history information (S_source) are documented.

Table 18. Source master list.

SOURCE_ID[1]	ORIGINATOR[2]	DATE or PUB. DATE[3]	TITLE[4]	CONTRIBUTION /COVERAGE NAMES[5]	DATA FORMAT/ GEO PRESENTA-TION[6]	PUBLICATION[7] INFORMATION	SCALE[8]	TIME PERIOD/ CONTENT DATE[9]	CURRENTNESS[10]	SOURCE MEDIA[11]
1	Audubon, C.E. (The Byrd Society, Wingtown, ST)	2001	Pelican nesting sites*	Bird polygons	Expert knowledge	Unpublished	N/A	2001	Date of communication	Personal communi-cation
2	State Natural Resources Agency, City, ST	1998	Turtle Nesting Locations*	Reptile polygons	Digital points	http://www.stateagency.gov/turtlenests.html	Unknown	1965-1997	Dates of surveys	Online
3	Murre, J. and D.Thorough	2000	ACME Atlas of Breeding Birds	Bird polygons and points	Hard-copy text	ACME University Press, Campus City, ST, 12 pp.	N/A	2000	Date of publication	Paper
4	Geographer, J., (USFWS, GIS Director), Washington, D.C.	1999	NWR Boundaries*	Wildlife refuges	Digital polygons	Data contact: J. Geographer, (USFWS, Office of Map Resources, 202/555-3093)	24000	1999	Date of compilation	Floppy disk
5	State Office of Aquaculture	1996	Aquaculture lease beds	Soc_econ points	Digital points	Data contact: S. Johnson, (State Aquaculture, 888/555-3698)	24000	1990-1996	Dates of surveys	Email

1 = unique id for each source in the database
2 = the author, editor, database manager, expert, etc. who produced the original information
3 = publication or release date
4 = title of the source document, map, or database
5 = the biological or human-use elements for which the source provided information
6 = format type (see Table 17 for allowable descriptions)
7 = information that would be needed for a reference citation
8 = original scale at which data were mapped
9 = dates over which the original data were collected, or date to which the information is current
10 = event on which the time period/content date is based
11 = media by which information was attained

Table 19. Column descriptions for the source master list.

COLUMN	DESCRIPTION
Source ID	The unique id for each source in the database, which is assigned sequentially and is referenced by Geographic Source, Attribute Source, and Seasonality Source.
Originator	The author, editor, database manager, agency, department within an agency, or expert who produced the original information used. Originator does not necessarily refer to the person who provided a document or information during ESI data collection, an agency or group that published or funded a study or document, or a person who interpreted an original source during a data collection meeting. For instance, if John Smith of State DNR used the "Atlas of Colonial Breeding Water Buffalo" sent to him by Jane Doe of the USFWS (the project officer for the study), the originator would be neither John nor Jane nor either of the agencies they work for, but rather the author(s) of the Atlas. For persons providing expert knowledge, the agency or affiliation of the originator should be included.
Date	The date of publication or data collection if expert knowledge. If there are multiple dates, then the most recent date is used.
Title	The title of the source document, map, or database. If the source does not have a title, a brief description is used.
Coverage Name	The name should include the specific biological elements (e.g., terrestrial mammal, reptile, habitat) or human-use elements for which information was gathered from this source, and the types of features that were mapped using this source (e.g., polygons, points). Many sources cover a variety of resources. However, only those resources for which information was gathered from the source should be listed. For example, the title of a source book could be "ACME Coastal Resource Guide." This publication might cover birds, fish, invertebrates, marine mammals, commercial fisheries, recreation areas, and archaeological resources. If only fish and invertebrate distributions were derived using this source, "fish and invertebrate polygons" should be the only resource elements listed.
Data Format	The type of source used. Acceptable data formats includ: expert knowledge, hard-copy text, hard-copy map, vector digital data, raster digital data, hard-copy table, and digital table.

Table 19. Cont.

Publication Information	All information that would be needed for a reference or bibliographic citation, except for the author, date, and title that are listed in other fields. Information for this field usually includes the publisher or agency name, city, and state; the journal name, volume, and pages; the report or map number; and the total number of pages. If the source is unpublished, enough information should be provided so that readers would be able to locate the document or database. Agency affiliations listed for persons contributing expert knowledge (listed under originator) should provide information needed by persons interested in contacting expert sources.
Scale	Applies to digital maps, hard-copy maps, and some digital databases. For instance, one common map scale is "1:24,000." Only the scale denominator without commas is entered in this field. If scale does not apply, "N/A" is placed in this field, and if the scale is not known, "Unknown" is used.
Time Period	The dates over which data were collected by a source, the date the source was published, or the expert was contacted. For survey data and some digital databases, this may be a year or range of years (e.g., "1979-1982.") For published documents, the year of publication is typically used. For expert knowledge, the year the source was contacted is usually given as the source time period, indicating the date to which the information was current.
Currentness	Currentness refers to the basis for the entry in the "time period" field. Acceptable terminology for the currentness field includes date of communication, date of survey, date of publication, and date of compilation.
Source Media	Refers to the media that was used to transfer the source information. Acceptable terminology for the source media field includes personal communication, paper, online, CD-ROM, email, and floppy disk.

5 ESI DATABASE ORGANIZATION

ESI data have been compiled digitally since 1994. Early digital versions focused primarily on easing production of hard-copy maps and today's ESI data structure still reflects this objective. As the GIS user community grew, so did efforts to provide more comprehensive and usable data tables. Tables and items within tables have been added to meet the needs of the communities using the atlases, leading to the current ESI data standard. The relational tables are normalized, eliminating the need to enter the same information multiple times, minimizing the likelihood of errors, and easing updates. The tables are also extensible if attributes specific to a geographic area need to be considered. A diagram of the relational database structure is shown in Figure 5. This may be a useful reference when reading through the following chapter, especially those parts pertaining to the biological and human-use data.

The Relational Database Structure –

Base Map Layers

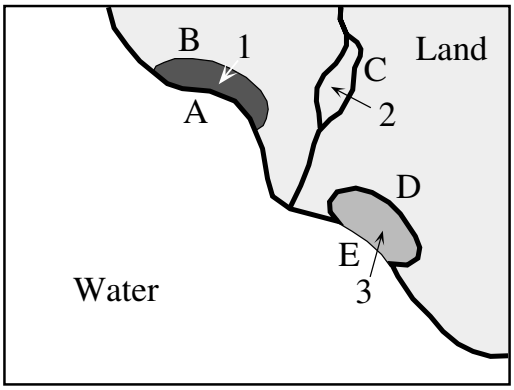
The ESI data can be grouped into three general categories: base-map layers, biological layers, and human-use layers. The base-map layers do not link to any external data tables; rather all their attributes are self-contained. The primary base-map layers are ESI, HYDRO, and INDEX. Additional base map layers may be added for a particular atlas if the local user community has access to the information or has a particular need for a specialized data layer. In the past, such additional layers have included salinity bounds, bathymetric contours, and seasonal ice extents.

The ESI Data Layer

The ESI shoreline classification contains water and land features depicted as polygons and narrow rivers and streams displayed as arcs. The ESI polygon attributes are *ESI* (10, 10, C), *WATER_CODE* (1, 1, C), and *ENVIR* (1,1,C). *ESI* may be populated with any of the standard ESI types (see table 2) where an expanse of area is covered. Most commonly

it is populated with types “7” or “9A” (flats) or types “10A,” “10B,” “10C,” or “10D” (wetlands). When ESI-classified shorelines form polygons that are not classified, for instance around land, the item *ESI* should be populated with “U.” The polygon item *WATER_CODE* should be populated with “L,” land or “W,” water. In most environments, polygons classified as flats (*ESI* = “7” or “9A”) are water (*WATER_CODE* = “W”) and polygons classified as wetlands (*ESI* = “10A,” “10B,” “10C,” or “10D”) are land (*WATER_CODE* = “L”). The polygon item *ENVIR* should be populated with “E,” estuarine, “R,” riverine, “L,” lacustrine, or “P,” palustrine. See Figures 3 and 4, as well as the summary of coding rules at the end of the ESI section.

The ESI arc attributes are *ESI* (10, 10, C), *LINE* (1, 1, C), *SOURCE_ID* (6, 6, I), and *ENVIR* (1, 1, C). Table 21 shows a breakdown of acceptable values for each of these items. The arc item *ESI* contains a value reflecting the shoreline sensitivity to oiling with



Polygons:

Number	ESI	Water_Code
1	10	L
2	U	L
3	7	W

Arcs:

Letter	ESI	Line
A	10/3	S
B	U	M
C	8	H
D	3/7	S
E	U	F

Figure 3. ESI shoreline with wetland (10) and flat (7) polygons

lower numbers reflecting low susceptibility and higher numbers indicating increasingly higher susceptibility. Each number also corresponds to a defined shoreline type (see Table 2). *ESI* may contain up to three shoreline types designating, in order, the landward, Shore, and seaward classifications. If an arc is unclassified, as in the case of the outer bounds of a flat, *ESI* should be assigned a value of “U.”

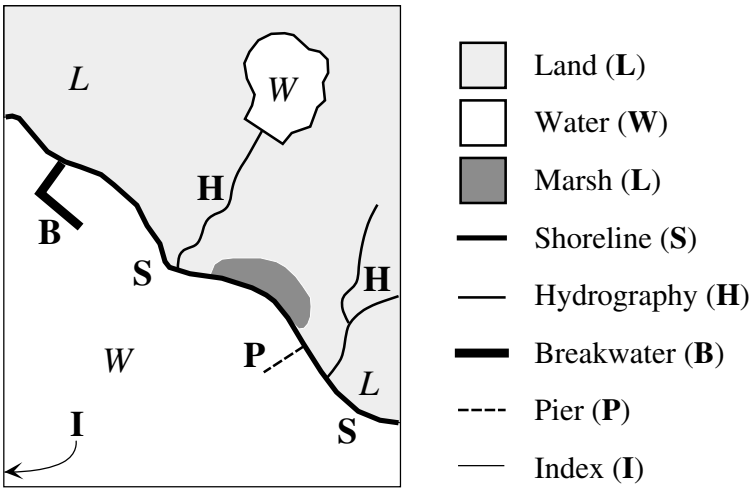


Figure 4. Polygon *WATER_CODE* and arc *LINE* coding rules for HYDRO and ESI.

Table 21. Features of the ESI data layer.

DESCRIPTION	ITEM	VALUE
ESI classification	ESI (10, 10, C)	see Table 2
Type of linear feature	LINE (1, 1, C)	B (breakwater) E (extent) F (flat) G (glacier) H (hydrography) I (index) S (shoreline) M (marsh) P (pier)
Source code	SOURCE_ID (1, 1, I)	1 (original digital information) 2 (low-altitude overflight) 3 (aerial photograph) 4 (digitized from 1:24,000-USGS topographic quadrangle) 5 (digitized from scanned 1:24,000-USGS topographic quadrangle) 6 (National Wetlands Inventory) N (6 plus the number of additional sources)

Table 21. Cont.

Environment	ENVIR (1, 1, C)	E (estuarine) L (lacustrine) R (riverine) P (palustrine)
Water and land polygons	WATER_CODE (1, 1, C)	W (water) L (land)

The ESI arc *LINE* item defines the type of linear feature being mapped. Acceptable values include "B" – breakwater, "E" – study area extent, "F" – flat, "G" – glacier, "H" – hydrography, "I" – index, "S" – shoreline, "M" – marsh, and "P" – pier. The *SOURCE_ID* indicates the originating source of the mapped line. Values are integers ranging from one to N where N is six plus the number of non-standard sources. See Table 21 for definitions. The item *ENVIR* is indicative of the regional environment of the mapped ESI type. Environments mapped include estuarine – "E," lacustrine (lake) – "L," riverine – "R," and palustrine – "P." The ESI shoreline definition may vary slightly, depending on the environment (Table 2).

Summary of coding rules for the ESI attributes:

- ➔ When ESI-classified shorelines form polygons that are unclassified (i.e., land), the *ESI* value for the polygon is "U" for unranked.
- ➔ Unranked arcs not designating shoreline, whose left or right polygon is a flat (*ESI* = "7" or "9A") or marsh (*ESI* = "10A," "10B," "10C,", "10D," or "10E"), have a *LINE* value of "F" or "M" respectively.
- ➔ In most environments, polygons classified as flats (*ESI* = "7" or "9A") are water and have a *WATER_CODE* of "W." They have ESI arc attributes on the inland side of the polygon.
- ➔ In most environments, polygons classified as wetlands (*ESI* = "10A," "10B," "10C," "10D," or "10E") are land and have a *WATER_CODE* of "L." They have ESI arc attributes on the water side of the polygon.
- ➔ Arcs that form the boundary between open water and land are shoreline and have a *LINE* value of "S."
- ➔ Arcs that have land on both sides are hydrography and have a *LINE* value of "H."
- ➔ Arcs that form an inland water polygon have a *LINE* value of "H."
- ➔ Quad/map boundaries have a *LINE* value of "I."

➔ Polygons or arcs that are on the water side of the shoreline have a *LINE* value of "B" (breakwater) or "P" (pier).

In some ESI atlases, National Wetlands Inventory (NWI) data are reclassified to attribute some of the ESI polygons. The interpretation of the NWI data is outlined in Table 22.

Table 22. Reclassification of National Wetlands Inventory data

ESI	NWI DEFINITION	NWI CODE
10A	Estuarine, intertidal, emergent wetland	E2EM
10B	Riverine, tidal, emergent wetland	R1EM
	Riverine, lower perennial, emergent wetland	R2EM
	Lacustrine, littoral, emergent wetland	L2EM
	Palustrine, emergent wetland	PEM
10C	Estuarine, intertidal, forested wetland	E2FO
	Palustrine, forested wetland	PFO
10D	Estuarine, intertidal, scrub-shrub	E2SS
	Palustrine, scrub-shrub	PSS

To ensure that the shoreline is consistent, the ESI layer is the starting point for the HYDRO layer. Arcs defining flat and marsh boundaries are deleted so that only arcs and polygons defining shoreline and hydrography remain. The ESI *LINE, SOURCE_ID,* and *WATER_CODE* attributes are retained in the HYDRO layer.

The HYDRO Data Layer

The HYDRO data layer contains polygons, such as land bodies and lakes, and linear features, such as streams and creeks. As mentioned, the arc attributes *LINE* (1,1,C) and *SOURCE_ID* (6,6,I) and the polygon attribute *WATER_CODE* (1,1,C) are copied from the ESI data layer. Depending on the source information used, the hydrography may extend to all areas of the USGS quads or other base maps, or it may stop where the ESI shoreline classification ends.

The HYDRO layer also contains all annotation used in producing the atlas. The annotation is generally digitized from the USGS quadrangles and is used for producing the hard-copy map product. The annotation features are grouped into three subclasses:

hydro (water body names), geog (geographic places of interest), and soc (parks, city and town names, etc.).

The INDEX Data Layer

The data layer INDEX contains the map boundary polygons for each hard-copy map (usually the USGS 1:24,000 quadrangles) in the atlas. The polygon attributes are *TILE-NAME* (32,32,C), a map number based on the layout of the atlas; *TOPO-NAME* (255,255,C), the USGS map name and latest publication date; *SCALE* (7,7,I), the scale denominator; *MAPANGLE* (4,8,F,3), a cartographic value used to rotate the map so the hard-copy product is straight up and down; and *PAGESIZE* (11,11,C), the width and height of the printed map page. There are no attributes associated with the arcs in the INDEX layer.

Biological Map Layers and Associated Relational Attribute Tables

The biological data layers are generally titled by element, the ESI equivalent of a biological category. Most are mapped with polygons showing the expected geographic extent of an assemblage of species with particular seasonal characteristics and other unique attributes. A typical ESI atlas will include the polygonal layers BIRDS, FISH, HABITATS, INVERT (invertebrates, including shellfish and, occasionally, endangered insects), REPTILES (reptiles and amphibians), T_MAMMAL and M_MAMMAL (terrestrial and marine mammals, respectively). Most atlases also include a biological layer, NESTS, where point objects are used to indicate the general vicinity of bird-nesting areas. Occasionally, it may be appropriate to map some or all locations of other elements as point or even line data. In such cases, the layer name indicates the element and data type. For example, FISHPT would be fish locations mapped as points and FISHL would be fish locations mapped as lines. The atlas-specific metadata will provide a thorough discussion of each map layer, the types of objects it contains, and listings of the mapped species.

Each biological layer has two internal attributes associated with it. These are the items *ID* (10,10,I) and *RARNUM* (9,9,I). *ID* is an identifier that is unique to a polygon across map layers and even atlases. It is a ten-digit number composed of three parts. The first three digits are the atlas id number (see Appendix C), while the next two digits specify the element number (see below), and the final five digits are the polygon id unique to the

layer where the object resides. Elements (including those specific to the socecon layers) have been assigned the following numbers:

1 BIRDS	4 M_MAMMAL	7 INVERT	10 SOCECON
2 FISH	5 NESTS	8 SPECIAL	11 MGT
3 HABITATS	6 REPTILES	9 T_MAMMAL	

If an element that is typically mapped as a polygon is mapped using lines, a value of 20 is added to the element number. Likewise, when an element typically mapped with polygons is mapped using points, a value of 30 is added to the element number. This protocol assures that the *ID* of each map object will remain unique. Some sample *ID* values are shown below.

0360100005 ➔ atlas# 036 | element# 01 | object# 00005
➔ Georgia, *BIRDS,* polygon number 5

0452200036 ➔ atlas# 045 | element# 22 | object# 00036
➔ Massachusetts, *FISHL,* line number 36

0073400106 ➔ atlas# 007 | element# 34 | object# 00106
➔ Northern California, *M_MAMPT,* point number 106

The element *SPECIAL* (8) is used particularly in some of the older atlases where a non-standard biological data layer was included. These are documented in the atlas-specific metadata.

The second attribute associated with the biological layers, *RARNUM*, is the essence of the ESI data structure. A *RARNUM* defines a unique combination of species (all of the same element type), concentrations, seasonalities, and sources. These values may be repeated across multiple polygons within the same data layer. The use of the *RARNUM* helps us produce the hard- copy maps and can reduce redundancy within the data tables when like distribution of species occur at different sites across the atlas.

The item *RARNUM* is also designed to be unique across atlases. It is a nine-digit number where the first three digits again reflect the atlas number (Appendix C) and the last six digits indicate the unique species or resource group within the atlas. Some examples include:

036000007 ➔ atlas# 036 | resource group 7
007000007 ➔ atlas# 007 | resource group 7

In these examples, we show both Georgia and Northern California with the same resource group number (7), but see that the RARNUM remains unique since the atlas number is embedded. This ensures that there is no redundancy when viewing multiple atlases at the same time.

Biology Attribute Tables

The richness of the biological attributes makes the ESI data set a unique and valuable resource, but it also results in the need for a fairly complex data structure. The tables have been arranged to eliminate redundant data entry and allow extension when data specific to a region or atlas needs to be added. Figure 5 provides a graphic of the relationships between tables.

The first step is linking the map objects to the data tables. This may be done in either of two ways. The first entails the use of a lookup table, BIO_LUT, using the item *ID* to link from the map object. This method is provided for those using mapping software that requires a unique map object id and allows for no other internal map object attributes. The BIO_LUT table provides the *RARNUM*, the link to the BIORES table where all supporting attributes and links reside. The item *RARNUM* is also provided as an internal attribute for each of the biological points, polygons, and lines. With mapping software that supports internal map object attributes or, alternatively, does not require unique map object ids, the *RARNUM* can link directly to the *BIORES* table.

BIORES Data Table:

The BIORES table contains the items *RARNUM* (9,9,I), *SPECIES_ID* (5,5,I), *CONC* (20,20,C), *SEASON_ID* (2,2,I), *G_SOURCE* (6,6,I), *S_SOURCE* (6,6,I), *ELEMENT* (10,10,C), *EL_SPE* (6,6,C), and *EL_SPE_SEA* (8,8,C). The *RARNUM*, described above in some detail, ultimately provides the link from the biological map objects.

SPECIES_ID is a NOAA-assigned species number unique within each element. A list of all the current *SPECIES_ID* values is provided in Appendix A, as well as the element, sub-element, and scientific and common names of the species they represent. As additional geographic regions are mapped, the NOAA species list will be updated to include previously unmapped species. The latest version of the species list is always available from the NOAA Office of Response and Restoration website at http://response.restoration.noaa.gov/esi/species.pdf.

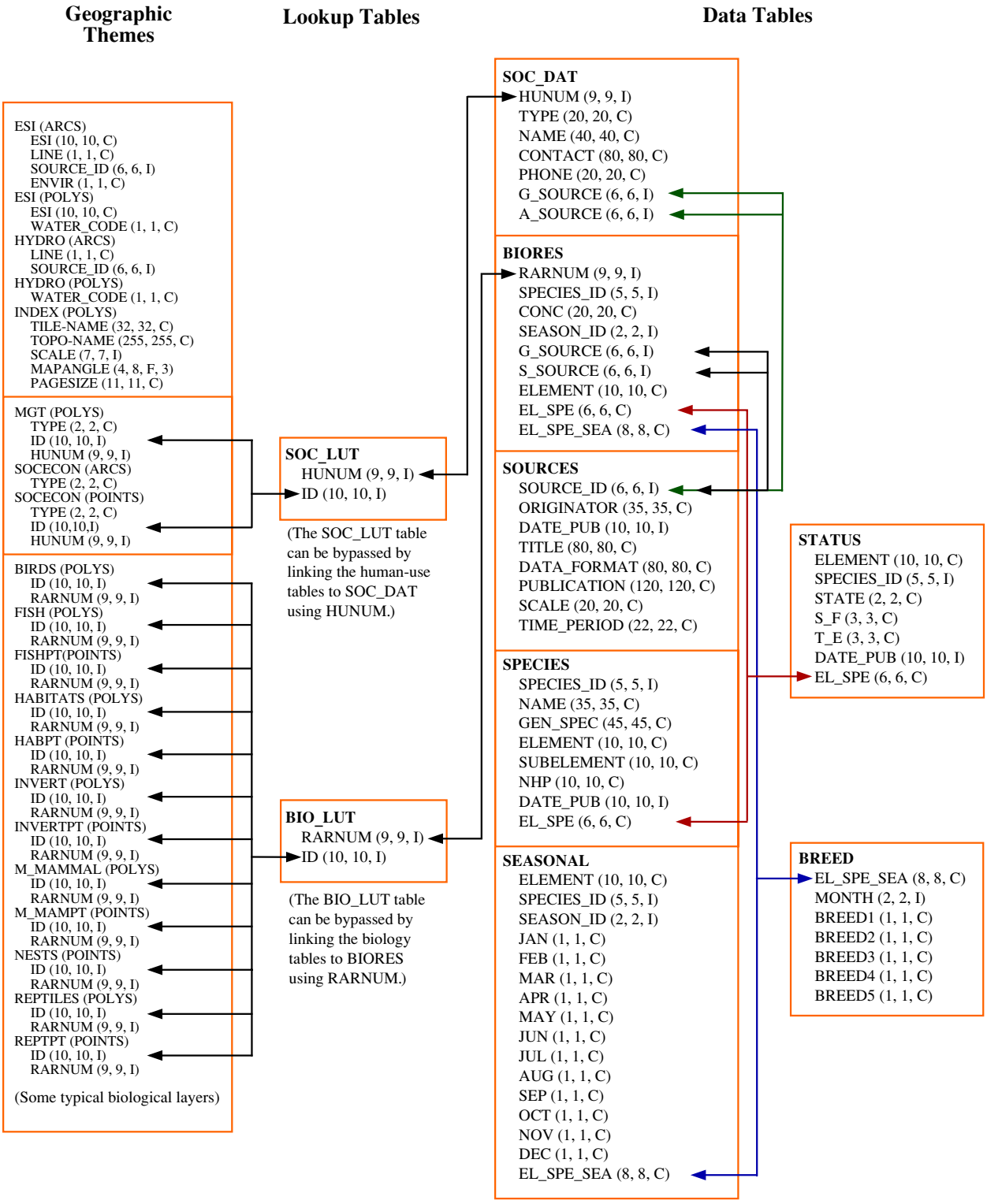


Figure 5. Relationships between spatial data layers and attribute data tables.

The *CONC* item is a 20-character field providing concentration information for that particular species within the mapped objects of the corresponding *RARNUM*. Concentration may be provided qualitatively, such as HIGH, MEDIUM, and LOW, or it may list numeric counts or ranges provided by local experts. The associated metadata should explain concentration values used in each atlas. If no concentration information was available or, as is the case in some of the older atlases, no concentration information was collected, a value of '-' is used to populate this field.

SEASON_ID is an element- and species-specific seasonality reference. Since the seasonal presence or breeding activities of a species may vary from one mapped polygon to another, the *SEASON_ID* is modified to reflect this. *SEASON_ID* is concatenated with *ELEMENT* and *SPECIES_ID* to provide the link to the seasonal and breed tables.

G_SOURCE (geographic source) and *S_SOURCE* (seasonality source) link from the BIORES to the SOURCE table where feature level metadata is provided. These values are atlas-specific. Each source contributing to an atlas is assigned a unique integer value.

The next item in the BIORES table is *ELEMENT*. As mentioned, *ELEMENT* is an ESI biological category. Acceptable values are:

BIRD
FISH
HABITAT (Habitats & Plants)
INVERT (Invertebrates – Shellfish & Insects)
M_MAMMAL (Marine Mammals)
REPTILE (Reptiles & Amphibians)
T_MAMMAL (Terrestrial Mammals)

EL_SPE and *EL_SPE_SEA* are links to other supporting data tables. Both are character items that combine parts of other items defined in the BIORES tables. *EL_SPE* takes the first letter of *ELEMENT* and concatenates it to the five-digit *SPECIES_ID* number. It provides the link from BIORES to the SPECIES and STATUS tables. Likewise, the item *EL_SPE_SEA* takes the first letter of *ELEMENT* and concatenates it with the *SPECIES_ID* and *SEASON_ID*. This is the link from BIORES to the SEASONAL and BREED tables. Some sample *EL_SPE* and *EL_SPE_SEA* values follow.

EL_SPE value
B00005 ➔ *ELEMENT* 'BIRD' | *SPECIES_ID* = 5
F00037 ➔ *ELEMENT* 'FISH' | *SPECIES_ID* = 37

EL_SPE_SEA value
B0000501 ➔ *ELEMENT* 'BIRD' | *SPECIES_ID* = 5 | *SEASON_ID* = 1
F0003703 ➔ *ELEMENT* 'FISH' | *SPECIES_ID* = 37 | *SEASON_ID* = 3

The supporting data tables are SOURCES, SPECIES, SEASONAL, STATUS, and BREED.

SOURCES Data Table:

The SOURCES data table provides feature-specific metadata for both the biology and human-use map layers. In addition to providing citations for the map data, the SOURCES table can help identify local experts.

The item *SOURCE_ID* (6,6,I) links to *G_SOURCE* and *S_SOURCE* in the BIORES table, as well as to *G_SOURCE* and *A_SOURCE* in the SOC_DAT table. *ORIGINATOR* (35,35,C) indicates the person or organization that provided the data. The item *DATE_PUB* gives the production or publication date. If the information is from a published data source, *TITLE* (80,80,C) lists the name of the original publication. If a source is a local expert and doesn't reference any published document, a descriptive phrase citing the type of information provided and geographic extent of expertise is given. *DATA_FORMAT* (80,80,C) provides an indication of the format of the original data. Some likely values include 'text,' 'hard-copy map,' 'digital (arc, polygons, and/or points),' and 'expert,' indicating personal communications between the local source and the data collector. *PUBLICATION* (120,120,C) may cite the document that is referenced or may list 'unpublished' in the case of information gathered verbally from local sources. *SCALE* (20,20,C) lists the denominator of the scale for digital or hard-copy maps, when available. For other source types, this is generally populated by 'N/A.' The final item in the SOURCES table is *TIME_PERIOD*. This field contains the year(s) in which a source was published or the time span over which personal interviews were conducted.

SPECIES Data Table:

The SPECIES data table contains a record for each species found in the ESI atlas. Items include *SPECIES_ID* (5,5,I), *NAME* (35,35,C), *GEN_SPEC* (45,45,C), *ELEMENT* (10,10,C), *SUBELEMENT* (10,10,C), *NHP* (10,10,C), *DATE_PUB* (10,10,I), and *EL_SPE* (6,6,C). *SPECIES_ID* is described above in the BIORES section. *NAME* refers to the common name or a local variation. *GEN_SPEC* lists the scientific name – genus and species – of the mapped biology. *ELEMENT* has been described as an ESI-defined biological grouping. *SUBELEMENT* goes a step further, delineating a logical group of species within an element based on such things as habitat preference or feeding styles.

NHP lists the Natural Heritage Program global ranking. These rankings are not a legal designation, but rather an indicator of a species' rarity throughout its total range. Values range from 'G1' for extremely rare to 'G5', defined as very common. *DATE_PUB* gives the date of the Natural Heritage listing. The final item in the SPECIES table is *EL_SPE,* the link from the BIORES and STATUS tables. *EL_SPE* is described in the BIORES section.

SEASONAL Data Table:

The SEASONAL table contains the monthly presence information for each species. The discussion of the BIORES table explains the first three items, *ELEMENT* (10,10,C), *SPECIES_ID* (5,5,I) and *SEASON_ID* (2,2,I). The next twelve items are the three-letter abbreviations for each month, e.g.,. *JAN* (1,1,C) – *DEC* (1,1,C). These items are populated with 'X' if the species is present in the mapped area during that particular month. Months in which the species is not present are left blank. The last item in SEASONAL is *EL_SPE_SEA* (8,8,C), again the link from BIORES to and from the BREED table. EL_SPE_SEA is further described in the BIORES section.

BREED Data Table:

For each month that a species is listed as present ('X') in the SEASONAL table, there is an associated record entered in the BREED table. The items in the BREED table are *EL_SPE_SEA* (8,8,C), *MONTH* (2,2,I), *BREED1* (1,1,C), *BREED2* (1,1,C), *BREED3* (1,1,C), *BREED4* (1,1,C), and *BREED5* (1,1,C). *EL_SPE_SEA,* described in the BIORES section, provides the link either from BIORES or SEASONAL. The *MONTH* item is populated with the numeric representation for the month described, e.g., January = 1 through December = 12. *BREED1* through *BREED5* indicate life activities specific to each element. A listing of these activities, by element, appears below.

	BREED1	*BREED2*	*BREED3*	*BREED4*	*BREED5*
BIRD	nesting	laying	hatching	fledging	-
FISH	spawning	eggs	larvae	juveniles	adults
HABITAT	-	-	-	-	-
INVERT	spawning	eggs	larvae	juveniles	adults
M_MAMMAL	mating	calving	pupping	molting	-
REPTILE	nesting	hatching	internesting	juveniles	adults
T_MAMMAL	-	-	-	-	-

The *BREED* items are populated with 'Y' when that life activity is occurring during the specified month, 'N' when it is not, or '-' when there is no life activity defined for that breed column for the element referenced. The breeding activities collected for the ESI maps have varied over time. For example, in many of the early atlases, the breeding activities listed for fish were limited to spawning and outmigration. Similarly, the activities recorded for invertebrates were simply mating and spawning. In the Hawaii atlas, it was appropriate to list spawning activity for certain corals. Due to these types of exceptions, we recommend that the atlas-specific metadata be checked for the actual meanings of the breed activity categories on an atlas-by-atlas basis.

STATUS Data Table:

STATUS is the final biology table in the relational database. This table has a record for each species that is listed as threatened or endangered by a state that is mapped in the atlas or by the federal government. The items in the STATUS table are *ELEMENT* (10,10,C), *SPECIES_ID* (5,5,I), *STATE* (2,2,C), *S_F* (3,3,C), *T_E* (3,3,C), *DATE_PUB* (10,10,I), and *EL_SPE* (6,6,C). *ELEMENT* and *SPECIES_ID* have the same definition here as in the BIORES table. *STATE* is populated with the two-letter state abbreviation for the mapped state that lists the species as threatened or endangered. If an atlas spans multiple states and a species is listed by more than one of those states, additional records will be added for each state listing the species. The *S_F* column is populated with 'S' if there is simply a state listing for the species, 'F' if there is only a federal listing, or 'S/F' if it is listed by both the state and federal governments. The *T_E* item indicates whether the species is listed as threatened or endangered. If the *S_F* item is populated with only 'S' or 'F,' only one value will appear in the *T_E* column: 'T' for threatened, 'E' for endangered, or 'C' for species of special concern (a state designation only). These values refer to the agency listed under '*S_.F*. If both the state and federal governments list the species, the listing status for the state will be given first, followed by a slash ('/'), then the federal listing status. Acceptable values include 'T/T,' 'E/T,' 'T/E,' 'E/E,' 'C/E,' and 'C/T.' The DATE_PUB column will give the year, or the month and the year, in which the threatened or endangered status was published.

Figure 6 shows a sample of each of the biology tables and how they are populated. This, as well as the ESI relational table diagram, Figure 5, may be a helpful supplement to the above discussion.

BIRDS.PAT:

ID	RARNUM
650100002	65000102
650100003	65000102
650100004	65000123
650100005	65000105

FISHL.AAT:

ID	RARNUM
652200002	65000306
652200003	65000313
652200004	65000308
652200005	65000306

BIO_LUT:

RARNUM	ID
65000102	650100002
65000102	650100003
65000102	650100010
65000306	652200002

BIORES:

RARNUM	SPECIES_ID	CONC	SEASON_ID	G_SOURCE	S_SOURCE	ELEMENT	EL_SPE	EL_SPE_SEA
65000102	17	-	3	21	9	BIRD	B00017	B0001703
65000103	126	LOW	1	20	20	BIRD	B00126	B0012601
65000103	260	8 PAIR	1	20	20	BIRD	B00260	B0026001
65000104	251	112	1	25	27	BIRD	B00251	B0025101

SPECIES:

SPECIES_ID	NAME	GEN_SPEC	ELEMENT	SUBELEMENT	NHP	DATE_PUB	EL_SPE
17	Northern pintail	Anas acuta	BIRD	waterfowl		0	B00017
126	Brown noddy	Anous stolidus	BIRD	pelagic		0	B00126
260	Red-footed booby	Sula sula	BIRD	pelagic		0	B00260
251	Great frigatebird	Fregata minor	BIRD	pelagic		0	B00251

SEASONAL:

ELEMENT	SPECIES_ID	SEASON_ID	JAN	FEB	MAR	APR	MAY	….	NOV	DEC	EL_SPE_SEA
BIRD	17	3	X	X	X					X	B0001703
BIRD	126	1	X	X	X	X	X	X	X	X	B0012601
FISH	13	2				X	X	X			F0001302

SOURCES:

SOURCE_ID	ORIGINATOR	DATE_PUB	TITLE	DATA_FORMAT	PUBLICATION	SCALE	TIME_PERIOD
9	USGS	0	Topogrraphic Quadrangles	Hard Map	USGS, Denver, CO	24000	Varies
20	Hawaiian Electric Co.	2001	Locations of Water Intakes	EXPERT	Unpublished	N/A	2001

STATUS:

ELEMENT	SPECIES_ID	STATE	S_F	T_E	DATE_PUB	EL_SPE
BIRD	242	HI	S/F	E/E	2001	B00242
BIRD	621	HI	F	T	2001	B00621
HABITAT	534	HI	S/F	T/T	2001	H00534

BREED:

EL_SPE_SEA	MONTH	BREED1	BREED2	BREED3	BREED4	BREED5
B0001703	3	Y	Y	N	N	-
B0012601	1	N	Y	N	N	-
F0001302	5	Y	Y	Y	N	N

Figure 6. Sample biology data for data layers, lookup tables and data tables.

Human-Use Data Tables

The ESI atlases include several human-use features. In the SOCECON layer there are locational points for socioeconomic resources, such as airports, aquacultures, boat ramps, marinas, and water intakes. In the management (MGT) layer there are polygonal boundaries for such things as wildlife refuges, marine sanctuaries, and regional and national parks. These points and polygons are linked to the SOC_DAT table in much the same way as the biological layers are linked to the BIORES table.

Internally, SOCECON and MGT store the attributes *ID* (10,10,I) and *HUNUM* (9,9,I). As with the biological *ID*, the *ID* found in the human-use tables is an identifier that is unique to a point or polygon across map layers and atlases. It is a ten-digit number composed of three parts. The first three digits are the atlas id number (see appendix C); the next two digits specify the element number (or in this case layer number); and the final five digits consist of the polygon or point id value unique to the layer where the object resides. Some sample human-use id values are shown below.

0361000022 ➔ atlas# 036 | layer# 10 | object# 00022
➔ Georgia, *SOCECON,* point number 22

0451100004 ➔ atlas# 045 | layer# 11 | object# 00004
➔ Massachusetts, *MGT,* polygon number 4

The MGT and SOCECON layers also store the *HUNUM* item internally. This item is similar to the biological *RARNUM* in that it is a value that multiple map objects can share. On occasion, a *HUNUM* value may even link to more than one record in the SOC_DAT table in a fashion similar to the grouping of species found with the *RARNUM*. The link to the SOC_DAT table may be made directly from the *HUNUM* attribute, or the link can be made through the SOC_LUT using the unique *ID*.

Both the MGT polygons and SOCECON points also store the attribute *TYPE* (2,2,C). *TYPE* is a one- or two-letter abbreviation of the more explicit *TYPE* item found in SOC_DAT. Following are a few examples that list the internal value for *TYPE*, followed in parentheses by the corresponding *TYPE* value in the SOC_DAT table: “A” (“Airport”), “CG” (“Coast Guard”), “HS” (“Historical Site”), and “WI” (“Water Intake”). Appendix B lists all acceptable values.

Finally, the SOCECON layer may also include some line objects representing things like state boundaries, pipelines, and streets. These objects do not link to the SOC_DAT data table, but they do use the two-character *TYPE* attribute. They are included primarily as cartographic features for the production of the paper maps. For GIS analysis, there are more appropriate sources, such as the U.S. Bureau of the Census TIGER files, for these types of data.

SOC_DAT Data Table:

The SOC_DAT table contains the supporting attribute information for the two socioeconomic map layers. The items include *HUNUM* (9,9,I), *TYPE* (20,20,C), *NAME* (40,40,C), *CONTACT* (80,80,C), *PHONE* (20,20,C), *G_SOURCE* (6,6,I,) and *A_SOURCE* (6,6,I). As explained above, *HUNUM* links to the SOC_DAT table.

In *TYPE,* map objects are classified using standardized values based on function or usage. Sample values include "Airport," "Historical Sit,e, (?) and "Marina." (Appendix B) . The *NAME* field will list a proper name if appropriate, or may be a more descriptive type entry. If it is available, a contact name will be given in the *CONTACT* field. This is used most often for features like aquacultures, water intakes, and managed areas. A contact number may also be given for these types of features in the *PHONE* field. *G_SOURCE* (geographic source) and *A_SOURCE* (attribute source) are links to the same SOURCES data table previously discussed in the biology section.

Summary of the Relational Data Tables

All current ESI atlases use the above data structure and all fields are populated if data are available. For compatibility reasons, we have updated some of the older atlases that used earlier versions of this structure. For these atlases, fields for which data were not collected may be left blank. In these cases, as well as for any other atlas-specific peculiarities, it is always best to reference the corresponding metadata.

The Desktop Database Structure

While the relational structure is robust and well-suited for data collection and updates, it is a complicated structure that can be cumbersome for simple data queries and analysis. For this reason, we have also developed a desktop standard that meets the needs of many users. The following section will focus on the desktop structure. Figure 7 may be helpful for visualizing the links between these files.

The desktop data structure simplifies the complex biological data tables to a flat file format. All of the information found in the relational BIORES, SPECIES, SEASONAL, STATUS, and BREED tables is compressed into the desktop BIOFILE table. There is a one-to-one correspondence between the records in the BIORES and BIOFILE tables. One record is present for each unique *RARNUM, ELEMENT, SPECIES_ID, CONC,* and *SOURCE* combination. The items in BIOFILE are *ELEMENT* (10,10,C), *SUBELEMENT* (10,10,C), *NAME* (35,35,C), *GEN_SPEC* (45,45,C), *S_F* (3,3,C), *T_E* (3,3,C), *NHP* (10,10,C), *DATE_PUB* (10,10,I), *CONC* (20,20,C), *JAN* (1,1,C), *FEB* (1,1,C), *MAR* (1,1,C), *APR* (1,1,C), *MAY* (1,1,C), *JUN* (1,1,C), *JUL* (1,1,C), *AUG* (1,1,C), *SEP* (1,1,C), *OCT* (1,1,C), *NOV* (1,1,C), *DEC* (1,1,C), *BREED1* (8,8,C), *BREED2* (8,8,C), *BREED3* (8,8,C), *BREED4* (8,8,C), *BREED5* (8,8,C), *RARNUM* (9,9,I), *G_SOURCE* (6,6,I), *S_SOURCE* (6,6,I), and *BREED* (4,4,I). Most of these items correspond directly to the definitions described in the relational data section. The *ELEMENT* and *CONC* values in the BIOFILE are the same as those found in the relational table BIORES. *SUBELEMENT*, *NAME, GEN_SPEC, NHP* and *DATE_PUB* are populated with the values found in the SPECIES table. Similarly, the *S_F* and *T_E* fields are filled with the values in the STATUS table, if a corresponding record is present. The abbreviated month columns *JAN-DEC* are filled with 'X' if present, or left blank when not present, as found in the relational *SEASONAL* table.

The *BREED1-BREED5* columns do vary slightly from the items of the same name found in the relational BREED table. In BIOFILE, these fields are populated with a textual monthly summary of the corresponding breeding activity. For example, for an element of 'BIRD,' *BREED2* would be populated with 'FEB-APR' if the *RARNUM* corresponded to a point or polygon where a species of bird was laying in February through April. This summary is useful to the human user but, unfortunately, does not make it easy to query a computer about monthly activities. For this reason, we provide an auxiliary BREED table for the desktop data user. This table is organized in a manner similar to the relational

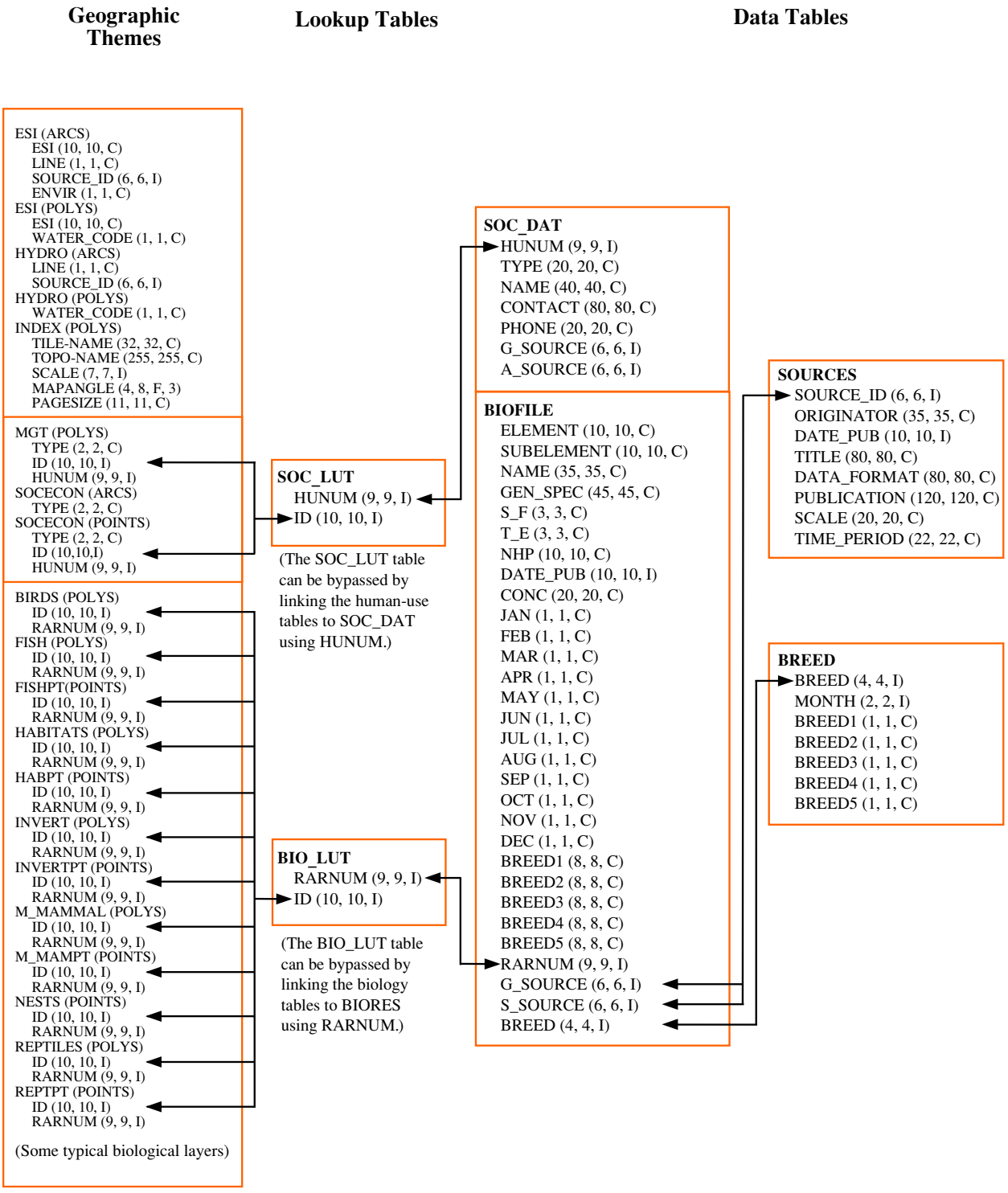


Figure 7. Relationships between spatial data layers and desktop data tables.

BREED table, with a few exceptions. All records in the BIOFILE link to twelve monthly breed summary records, whether or not the species is listed as present for each of the twelve months. This allows many more species to share the same breed records, condensing the size of the desktop BREED table. If a species is not present, all of the relevant breed activities are set to no –'N.' The BIOFILE is linked to the BREED table through the *BREED* item.

We also provide the SOURCE data as an auxiliary table for the desktop structure. The SOURCE table found here is an exact replicate of the relational SOURCE table. It is linked to the BIOFILE through the *SOURCE_ID* back to the *G_SOURCE* and *S_SOURCE* items.

The desktop BIOFILE is useful for those working in an environment where the principal goals are viewing and querying the data. However, if the goal is to update or change the ESI data in any way, these changes should be made first within the relational database, and the desktop files should be updated from that structure.

ESI Distribution Formats

The goal of the ESI digital product is to meet the needs of as many users as possible. To achieve this goal, data are distributed in a number of different formats. Following is a brief description of each format headed by the name of the directory where the data are found on the ESI CDs. All data are provided in Geographic coordinates and in the horizontal datum at which they were collected. The atlas-specific metadata will include datum information.

SOURCE:

Data are provided in double-precision, uncompressed, ARC export format. These data can be imported directly into ARC/INFO or there may be translators that will enable their import into other mapping programs. These files should be used with the relational database files by those responsible for maintenance and updates to the atlas. They may be used with the desktop files by users who simply need to view or query the data.

AVPROJ:

In this directory, data are provided as ArcView shape files together with an ArcView 3.x-project file. The project consists of a single view where each ESI data layer is represented as a theme. Each theme is depicted with the standard ESI colors, symbols, and hash patterns. Biology data layers link to the desktop BIOFILE in .dbf format. The SOURCES and desktop BREED tables are also included as .dbf files and there are menu items in the project that link and unlink these tables. The human use layers, MGT and SOCECON, link to the SOC_DAT table that likewise can be linked to the SOURCES table. At startup, the links to the SOURCES and BREED tables are disabled to optimize response to data queries.

MOSS:

Data are also provided in MOSS file format. This is a non-proprietary, ASCII file format that may be imported directly into MOSS GIS. Its simple text format is also well suited to those who choose to write translators to bring the ESI data into a mapping program that doesn't accept any of the other file formats provided. The attribute associated with the biology data layers is a special version of the *ID* item that embeds the *RARNUM*. It is a fifteen-digit number that can be broken down as follows:

001200360100005 ➔ rarnum 120 | atlas# 036 | element# 01 | object# 00005
➔ Resource group 120, Georgia, *BIRDS,* polygon number 5

000070452200036 ➔ rarnum 7 | atlas# 045 | element# 22 | object# 00036
➔ Resource group 7, Massachusetts, *FISHL,* line number 36

The human use files also use a modified ID value that embeds the *HUNUM* value. Special lookup tables in the MOSS directory should be used in place of the BIO_LUT and SOC_LUT tables found in the DBFILES directory. The *RARNUM* linked to these lookup tables can then be linked to either the standard desktop or relational tables.

ESI_VIEW

This is a free ESI viewer for either the Macintosh or PC platform. Installers create an ESI_VIEW directory that contains a runtime version of the ESI map files and the desktop database files. The viewer uses MARPLOT®, a mapping application produced by NOAA, and a stand-alone version of FileMaker Pro® to handle the data tables. All of the map layers are presented with standard ESI colors, hatch patterns, and symbolization. This is a useful program for those wanting to do simple data queries and analysis,

particularly if they do not have a GIS system in place. A tutorial is included to help users get started with the viewer.

PDF

The ESI data are also distributed in Portable Document Format (PDF). A guide demonstrating the easy navigation of the maps from the index and to the data tables on the back of the map is included. The PDFs may be used on-line or are excellent for printing out individual atlas pages.

6 STANDARDS FOR ESI MAP SYMBOLIZATION

On ESI maps, the distribution of oil-sensitive fish and wildlife is shown by patterns, symbols, and colors representing ecological groupings. There are descriptive data on the back of each map and a key that identifies the colors and patterns used in the atlas.

The back of the map summarizes the GIS data tables discussed in Chapter 4. For example, the back of the map lists only the species' common names, but the scientific names are included in the digital database and the introductory pages of the hard-copy atlas. For endangered or threatened species, a red box surrounds the icons on the maps. The specific state and/or Federal (S/F) threatened and/or endangered (T/E) status is shown on the back of the map. The conservation status information may be listed in the atlas tables, and is included in the databases. See Figure 7 for an example of the tabular data shown on the back of the map.

Shoreline Sensitivity Ranking Index

Over time, the color schemes that represent the shoreline habitats have varied somewhat, but have followed a general trend with least sensitive always dark and most sensitive always red. To standardize the maps, we have modified the color scheme to range in a gradient from cool to hot colors. The numeric ESI values and ESI types associated with each color have varied from atlas to atlas in the past, depending upon the number of subclasses used. The current standard color scheme, from least sensitive to most sensitive, is shown in Table 23.

These colors have been tested and optimized to provide the best contrast and color reproduction using color photocopiers when used as a narrow band of color along the shoreline. These colors are standard on all current NOAA sensitivity maps. If more than fifteen shoreline types are mapped, you may need to use the same color for subclasses on the maps.

In some areas, the shoreline segment will be composed of two or three different ESI types (riprap behind a sand beach). In this situation, the shoreline color must reflect both of these features. Each shoreline combination has a unique line pattern that includes the

BIOLOGICAL RESOURCES:

BIRD:

RAR#	Species	S/F	T/E	Concen	J	F	M	A	M	J	J	A	S	O	N	D	Nesting	Laying	Hatching	Fledging
3	Common loon			MED	X	X	X	X	X						X	X	–	–	–	–
	Northern gannet			MED	X	X	X	x	x	x			X	X	x	x	–	–	–	–
	Red-throated loon			MED	X	X	X	X							X	X	–	–	–	–
	Scoter			MED	X	X	X	X						X	X	X	–	–	–	–
166	American oystercatcher			LOW	X	X	X	X	X	X	X	X	X	X	X	X	–	–	–	–
	Black skimmer						X	X	X	X	X	X	X	X	X	X	–	–	–	–
	Black-bellied plover			LOW	X	X	X	X	X	X	X	X	X	X	X	X	–	–	–	–
	Bonaparte's gull				X	X							X	X	X	X	–	–	–	–
	Caspian tern											X	X	X	X		–	–	–	–
	Least tern			LOW			X	X	X	X	X	X	X				APR-AUG	–	–	–
	Peregrine falcon	S/F	E/E		X	X	X	X					X	X	X	X	–	–	–	–

FISH:

RAR#	Species	S/F	T/E	Concen	J	F	M	A	M	J	J	A	S	O	N	D	Spawning	Outmig.	Larvae	Juveniles	Adults
290	Alewife				2	2	2	2	3	3	3	3	3	3	3	2	–	OCT-NOV	–	JAN-DEC	JAN-SEP
	Bay anchovy				5	5	5	5	5	5	5	5	5	5	5	5	APR-SEP	–	APR-OCT	JAN-DEC	JAN-DEC
	Gray snapper										3	3	3	3	3		–	–	–	JUL-NOV	–
290	Striped bass				2	2	2	2	2	2	2	2	2	2	2	2	–	–	–	JAN-DEC	JAN-DEC
	Striped mullet				3	3	3	3	4	4	4	4	4	4	3	3	–	NOV-DEC	DEC-APR	JAN-DEC	JAN-DEC
	Summer flounder				4	4	4	4	4	4	4	4	4	4	4	4	–	JAN-FEB	DEC-APR	JAN-DEC	JAN-DEC

HABITAT:

RAR#	Species	S/F	T/E	Concen	J	F	M	A	M	J	J	A	S	O	N	D
4	Carolina grasswort	S	T		X	X	X	X	X	X	X	X	X	X	X	X
6	Seabeach amaranth	S/F	T/T		X	X	X	X	X	X	X	X	X	X	X	X

INVERTEBRATE:

RAR#	Species	S/F	T/E	Concen	J	F	M	A	M	J	J	A	S	O	N	D	Spawning	Larvae	Mating	Juveniles	Adults
290	American oystercatcher (eastern)				3	3	3	3	3	3	3	3	3	3	3	3	MAY-NOV	MAY-NOV	–	JAN-DEC	JAN-DEC
	Atlantic bay scallop				4	4	4	4	4	4	4	4	4	4	4	4	–	AUG-DEC	–	JAN-DEC	JAN-DEC
	Blue crab				4	4	5	5	5	5	4	4	4	4	4	4	–	APR-SEP	MAR-OCT	JAN-DEC	JAN-DEC
	Brackishwater clam				4	4	4	4	4	4	4	4	4	4	4	4	MAY-MAY	MAR-JUN	–	JAN-DEC	JAN-DEC

Figure 8. Example of the data associated with the biological resources on the ESI maps.

Table 23. Color scheme used for representing the shoreline habitat rankings on maps.

ESI RANK	COLOR	CMYK	RGB
1A/1B	Dark Purple	56/94/0/13	119/38/105
2A/2B	Light Purple	38/44/0/0	174/153/191
3A/3B	Blue	88/19/0/0	0/151/212
3C/4	Light Blue	50/0/0/0	146/209/241
5	Light Blue Green	50/0/25/0	152/206/201
6A	Green	100/0/100/0	0/149/32
6B	Light Green	22/0/100/0	221/214/0
7	Olive	0/0/100/25	214/186/0
8A	Yellow	0/0/100/0	255/232/0
8B	Peach	0/34/28/0	254/189/170
8C/8D/8E/8F	Light Orange	0/17/81/0	247/205/75
9A/9B/9C	Orange	1/42/99/0	248/163/0
10A	Red	0/100/100/0	214/0/24
10B/10E	Light Magenta	0/50/0/0	245/162/188
10C	Dark Red	0/81/56/13	209/77/80
10D	Brown	0/56/69/25	197/114/70

appropriate colors. That is, when the shoreline is coded as a 6/3, for riprap behind a sand beach, the line pattern is defined as green on the landward half and blue on the seaward half of the shoreline. Some of the ESI features, such as marshes and tidal flats, are polygons. These polygons have either a solid fill pattern of the appropriate color or USGS symbology using the associated color. Only the shoreline-bounding edges of the land polygons have an ESI line type and are color-coded for that particular ESI.

Biological Features Symbolization

The points and polygons representing the animal groups use the same colors as the traditional ESI maps, except for mammals (changed from yellow to brown to be more visible in color copies). The polygons for each element use the following colors and hatch patterns are shown in Table 24.

Table 24. Symbolization for the biological features shown on ESI maps.

ELEMENT	COLOR	HATCH PATTERN ANGLE	SYMBOL	CMYK	RGB
Birds	Green	45		56/0/100/0	136/185/0
Habitats	Violet	90		18/73/5/0	168/0/102
Fish	Cyan	135		100/0/0/0	0/159/230
Invertebrates	Light orange	45		0/31/100/0	255/184/0
Marine mammals	Light brown	0		19/44/88/0	215/153/52
Reptiles and amphibians	Red	135		0/100/56/0	216/0/67
Terrestrial mammals	Light brown	90		19/44/88/0	215/153/52

Polygons representing the distribution of biological resources are filled with a hatched pattern, and icons are placed in or connected to the boundary of the polygon. When more than one biological element (e.g., fish and birds) is included in the same polygon, a black-hatch polygon is used. Figure 8 includes a symbol set for ESI mapping applications.

Widely distributed resources are listed in a box labeled “common throughout.” Otherwise, the maps will be too cluttered. This same convention was used extensively and successfully on the original ESI maps.

Human-Use Features

Nearly all human-use features are represented as points on the map. The only exceptions are managed lands (i.e., parks, preserves, reserves, and refuges), which are shown as polygons, and bridges, international boundaries, and other unclosed polygons which are shown as lines. The symbol for the human-use feature is offset from the feature with a leader line drawn from the symbol to the feature. For polygon and line features, the boundary of the feature is drawn using a dashed line, and the symbol for the feature is placed somewhere inside the boundary. When revealing the exact location may endanger

resources (such as historical and archaeological sites), the maps have icons that typically obscure the location. If there are many points clustered in the same area, either only a few icons are placed on the map products or they are moved in order to display all of the features. In the GIS database, the data provider uses discretion when disclosing location-sensitive resources. In some instances, the data may be displayed on the map products only, with the resources removed from the digital database. Users should consult the ESI atlas introductory pages and GIS metadata to determine the availability of human-use resource information that may be location-sensitive.

Figure 9. ESI symbols that represent biological and human-use resources.

7 REFERENCES CITED

Battista, T.A. and M.E. Monaco. 1996. *ESI/ELMR/NEI integration effort: technical guidelines*. Silver Spring, Maryland: NOAA/NOS/Strategic Environmental Assessments Division. 21 pp.

Bulger, A.J., B.P. Hayden, M.E. Monaco, D.M. Nelson, and G. McCornmick-Ray. 1993. Biologically-based salinity zones derived from multivariate analysis. *Estuaries 16*(2):311-322.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. *Classification of wetlands and deepwater habitats of the United States*. FWS/OBS-79/31. Washington, D.C.: U.S. Fish and Wildlife Service, Office of Biological Services. 103 pp.

Gundlach, E.R. and M.O. Hayes. 1978. Chapter 4: Investigations of beach processes. In: W.N. Hess (Ed.), *The AMOCO CADIZ Oil Spill, A Preliminary Scientific Report*. NOAA/EPA Special Report. Boulder: National Oceanic and Atmospheric Administration. pp. 85-196.

Gundlach, E.R., C.H. Ruby, M.O. Hayes, and A.E. Blount. 1978. The URQUIOLA oil spill, La Coruna, Spain: Impact and reaction on beaches and rocky coasts. *Environmental Geology (2)*3:131-143.

Hayes, M.O. and E.R. Gundlach. 1975. *Coastal geomorphology and sedimentation of the METULA oil spill site in the Strait of Magellan*. Columbia, South Carolina: University of South Carolina, Department of Geology. 103 pp.

Jury, S.H., J.D. Field, S.L. Stone, D.M. Nelson, and M.E. Monaco. 1994. *Distribution and abundance of fishes and invertebrates in North Atlantic estuaries*. ELMR Report No. 13. Silver Spring, Maryland: Strategic Environmental Assessments Division, National Oceanic and Atmospheric Administration. 221 pp.

Lowery, T.A., M.E. Monaco, and A.J. Bulger. 1996. *Mid-Atlantic vs. Northeast Gulf of Mexico salinity zonation delineations based on species/salinity co-occurrences*. ELMR Technical Report Number 14. Silver Spring, Maryland: Strategic Environmental Assessments Division, National Oceanic and Atmospheric Administration. 5 pp.

Michel, J., M.O. Hayes, and P.J. Brown. 1978. Application of an oil spill vulnerability index to the shoreline of lower Cook Inlet, Alaska. *Environmental Geology(2)*2:107-117.

Monaco, M.E. 1995. Comparative analysis of estuarine biophysical characteristics and trophic structure: defining ecosystem function to fishes. Ph.D. Dissertation. Baltimore: University of Maryland. 388 pp.

Monaco, M.E., D.M. Nelson, R.L. Emmett, and S.A. Hinton. 1990. *Distribution and abundance of fishes and invertebrates in West Coast estuaries, Vol. 1: Data summaries*. ELMR Technical Report Number 4. Rockville, Maryland: Strategic Environmental Assessments Division, National Oceanic and Atmospheric Administration. 240 pp.\

Monaco, M.E., S.E. Weisburg, and T.A. Lowery. 1998. Summer habitat affinities of estuarine fish in US Mid-Atlantic coastal systems. *Fisheries Management and Ecology 5*:161-171.

NOAA. 1993. *Evaluation of the condition of Prince William Sound shorelines following the Exxon Valdez oil spill and subsequent shoreline treatment. Volume I: 1991 Geomorphological shoreline monitoring survey*. NOAA Technical Memorandum NOS ORCA 67. Seattle: Hazardous Materials Response and Assessment Division, National Oceanic and Atmospheric Administration. 307 pp.

NOAA. 1995. *Sensitivity mapping of inland areas: Technical support to the Inland Area Planning Committee Working Group. USEPA Region 5*. HAZMAT Report 95-4. Seattle: Hazardous Materials Response and Assessment Division, National Oceanic and Atmospheric Administration. 54 pp. + appendix.

Nelson, D.M., E.A. Irlandi, L.R. Settle, M.E. Monaco, and L. Coston-Clements. 1991. *Distribution and abundance of fishes and invertebrates in southeast estuaries*. ELMR Report No. 9. Silver Spring, Maryland: Strategic Environmental Assessments Division, National Oceanic and Atmospheric Administration. 167 pp.

Appendix A

Master Species List

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
BIRD	alcid	46	Common murre	*Uria aalge*
		47	Pigeon guillemot	*Cepphus columba*
		48	Marbled murrelet	*Brachyramphus marmoratus*
		49	Cassin's auklet	*Ptychoramphus aleuticus*
		50	Rhinoceros auklet	*Cerorhinca monocerata*
		51	Tufted puffin	*Fratercula cirrhata*
		75	Razorbill	*Alca torda*
		78	Atlantic puffin	*Fratercula arctica*
		81	Horned puffin	*Fratercula corniculata*
		84	Parakeet auklet	*Aethia psittacula*
		104	Murre	*Uria sp.*
		105	Thick-billed murre	*Uria lomvia*
		106	Ancient murrelet	*Synthliboramphus antiquus*
		108	Kittlitz's murrelet	*Brachyramphus brevirostris*
		109	Crested auklet	*Aethia cristatella*
		110	Dovekie	*Alle alle*
		111	Least auklet	*Aethia pusilla*
		112	Black guillemot	*Cepphus grylle*
		143	Xantus' murrelet	*Synthliboramphus hypoleucus*
		618	Whiskered auklet	*Aethia pygmaea*
		1023	Puffins	*Fratercula spp.*
		1024	Alcids	
		1025	Murrelets	
BIRD	bird	614	Endangered seabird	
		616	Rare seabird	
		1000	Birds	
		1007	Colonial waterbirds	
BIRD	diving	1	Common loon	*Gavia immer*
		2	Arctic loon	*Gavia arctica*
		3	Red-throated loon	*Gavia stellata*
		4	Red-necked grebe	*Podiceps grisegena*
		5	Horned grebe	*Podiceps auritus*
		6	Eared grebe	*Podiceps nigricollis*
		7	Western grebe	*Aechmophorus occidentalis*
		8	Double-crested cormorant	*Phalacrocorax auritus*
		9	Brandt's cormorant	*Phalacrocorax penicillatus*
		10	Pelagic cormorant	*Phalacrocorax pelagicus*
		31	Pacific loon	*Gavia pacifica*
		79	Cormorant	*Phalacrocorax sp.*
		99	Red-faced cormorant	*Phalacrocorax urile*
		118	Brown pelican	*Pelecanus occidentalis*
		121	Anhinga	*Anhinga anhinga*
		123	Endangered diving bird	
		168	Olivaceous cormorant	*Phalacrocorax olivaceus*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		173	American white pelican	*Pelecanus erythrorhynchos*
		179	Pied-billed grebe	*Podilymbus podiceps*
		239	Clark's grebe	*Aechmophorus clarkii*
		269	Least grebe	*Tachybaptus dominicus*
		275	Great cormorant	*Phalacrocorax carbo*
		282	California brown pelican	*Pelecanus occidentalis californicus*
		325	Neotropic cormorant	*Phalacrocorax brasilianus*
		408	Yellow-billed loon	*Gavia adamsii*
		462	Loons	*Gavia spp.*
		486	Little grebe	*Tachybaptus ruficollis*
		487	Great-crested grebe	*Podiceps cristatus*
		606	Rare diving bird	
		607	Threatened diving bird	
		1006	Diving birds	
		1026	Grebes	
BIRD	gull_tern	36	Glaucous-winged gull	*Larus glaucescens*
		37	Western gull	*Larus occidentalis*
		38	Herring gull	*Larus argentatus*
		39	California gull	*Larus californicus*
		40	Ring-billed gull	*Larus delawarensis*
		41	Mew gull	*Larus canus*
		42	Bonaparte's gull	*Larus philadelphia*
		43	Heermann's gull	*Larus heermanni*
		44	Thayer's gull	*Larus thayeri*
		45	Common tern	*Sterna hirundo*
		80	Arctic tern	*Sterna paradisaea*
		82	Glaucous gull	*Larus hyperboreus*
		85	California least tern	*Sterna antillarum browni*
		86	Least tern	*Sterna antillarum*
		92	Great black-backed gull	*Larus marinus*
		95	Roseate tern	*Sterna dougallii*
		98	Laughing gull	*Larus atricilla*
		101	Aleutian tern	*Sterna aleutica*
		114	Sabine's gull	*Xema sabini*
		127	Sooty tern	*Sterna fuscata*
		133	Black skimmer	*Rynchops niger*
		134	Gull-billed tern	*Sterna nilotica*
		135	Sandwich tern	*Sterna sandvicensis*
		136	Caspian tern	*Sterna caspia*
		137	Royal tern	*Sterna maxima*
		138	Forster's tern	*Sterna forsteri*
		145	Elegant tern	*Sterna elegans*
		193	Black tern	*Chlidonias niger*
		241	Franklin's gull	*Larus pipixcan*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		264	White tern	*Gygis alba*
		283	Bridled tern	*Sterna anaethetus*
		291	Black-headed gull	*Larus ridibundus*
		317	Rare tern	
		318	Threatened tern	
		393	Lesser black-backed gull	*Larus fuscus*
		409	Ross' gull	*Rhodostethia rosea*
		410	Ivory gull	*Pagophila eburnea*
		517	Slender-billed gull	*Larus genei*
		518	Great black-headed gull	*Larus ichthyaetus*
		519	Mediterranean gull	*Larus melanocephalus*
		520	Little gull	*Larus minutus*
		521	Little tern	*Sterna albifrons*
		522	White-winged black tern	*Chlidonias leucopterus*
		524	Armenian gull	*Larus armenicus*
		525	Audouin's gull	*Larus audouinii*
		526	Brown-headed gull	*Larus brunnicephalus*
		527	Persian gulf caspian tern	*Hydroprogne tschegrava*
		537	Grey-headed gull	*Larus cirrocephalus*
		541	Lesser crested tern	*Sterna bengalensis*
		547	Saunder's tern	*Sterna saundersii*
		550	Sooty gull	*Larus hemprichii*
		553	Great crested tern	*Sterna bergii*
		558	White wagtail	*Motacilla alba*
		559	White-cheeked tern	*Sterna repressa*
		560	White-eyed gull	*Larus leucopthlamus*
		563	Yellow-legged herring gull	*Larus cachinnans*
		609	Rare gull	
		610	Endangered tern	
		625	White tern (Oahu nesting group)	*Gygis alba rothschildi*
		1001	Gulls	
		1008	Terns	
BIRD	landfowl	276	Attwater's greater prairie chicken	*Tympanuchus cupido attwateri*
		416	Spruce grouse	*Falcipennis canadensis*
		417	Blue grouse	*Dendrogapus obscurus*
		418	Willow ptarmigan	*Lagopus lagopus*
		419	Rock ptarmigan	*Lagopus mutus*
		421	White-bellied chachalaca	*Ortalis leucogastra*
		430	Crested bobwhite	*Colinus cristatus*
		477	Quail	*Coturnix coturnix*
BIRD	passerine	19	Rock dove	*Columba livia*
		147	Savannah sparrow	*Passerculus sandwichensis*
		151	Saltmarsh common yellowthroat	*Geothlypis trichas sinuosa*
		166	Song sparrow	*Melospiza melodia*
		177	Bank swallow	*Riparia riparia*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		194	Suisun song sparrow	*Melospiza melodia maxillaris*
		207	Tricolored blackbird	*Agelaius tricolor*
		216	Belted kingfisher	*Ceryle alcyon*
		224	Sedge wren	*Cistothorus platensis*
		225	Marsh wren	*Cistothorus palustris*
		226	Red-winged blackbird	*Agelaius phoeniceus*
		228	Brewer's blackbird	*Euphagus cyanocephalus*
		229	Swamp sparrow	*Melospiza georgiana*
		233	San Pablo song sparrow	*Melospiza melodia samuelis*
		235	Long-billed marsh-wren	*Cistothorous palustris*
		236	Short-billed marsh-wren	*Cistothorous platensis*
		259	Alameda song sparrow	*Melospiza melodia pusillula*
		274	Yellow-headed blackbird	*Xanthocephalus xanthocephalus*
		277	Seaside sparrow	*Ammodramus maritimus*
		278	Saltmarsh sharp-tailed sparrow	*Ammodramus caudacutus*
		279	Swainson's warbler	*Limnothlypis swainsonii*
		281	Yellow-bellied sapsucker	*Sphyrapicus varius*
		288	Black swift	*Cypseloides niger*
		294	Cape Sable seaside sparrow	*Ammodramus maritimus mirabilis*
		295	Florida scrub-jay	*Aphelocoma coerulescens*
		297	White-crowned pigeon	*Columba leucocephala*
		305	Red-cockaded woodpecker	*Picoides borealis*
		308	Elfin woods warbler	*Dendroica angelae*
		310	Rare passerine bird	
		311	Endangered passerine bird	
		321	Ringed kingfisher	*Ceryle torquata*
		322	American pygmy kingfisher	*Chloroceryle aenea*
		323	Amazon kingfisher	*Chloroceryle amazona*
		324	Green kingfisher	*Chloroceryle americana*
		327	White-fronted parrot	*Amazona albifrons*
		328	Yellow-naped parrot	*Amazona auropalliata*
		329	Scarlet macaw	*Ara macao*
		330	Orange-fronted parakeet	*Aratinga canicularis*
		331	Green parakeet	*Aratinga holochlora*
		332	Pacific parakeet	*Aratinga strenua*
		333	Orange-chinned parakeet	*Brotogeris jugularis*
		334	Yellow warbler	*Dendroica petechia*
		335	Tropical mockingbird	*Mimus gilvus*
		336	Mangrove swallow	*Tachycineta albilinea*
		337	Mangrove vireo	*Vireo pallens*
		395	Louisiana waterthrush	*Seiurus motacilla*
		411	McKay's bunting	*Plectrophenax hyperboreus*
		420	Mangrove cuckoo	*Coccyzus minor*
		422	Streak-headed woodcreeper	*Lepidocolaptes souleyetti*
		423	Blue ground-dove	*Claravis pretiosa*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		424	Northern potoo	*Nyctibius jamaicensis*
		425	Smoky-brown woodpecker	*Veniliornis fumigatus*
		426	Lineated woodpecker	*Dryocopus lineatus*
		427	Eastern meadowlark	*Sturnella magna*
		428	Squirrel cuckoo	*Piaya cayana*
		429	Black-headed trogon	*Trogon melanocephalus*
		431	Lesser nighthawk	*Chordeiles acutipennis*
		432	Pauraque	*Nyctidromus albicollis*
		433	Ruby-throated hummingbird	*Archilochus columbris*
		434	White-necked puffbird	*Notharchus macrorhynchos*
		435	Violaceus trogon	*Trogon violaceus*
		436	Collard aracari	*Pteroglossus torquatus*
		437	Bushy-crested jay	*Cyanocorax melanocyaneus*
		438	Puerto Rican plain pigeon	*Columba inornata*
		439	Puerto Rican nightjar	*Caprimulgus noctitherus*
		440	Scaly-naped pigeon	*Columba squamosa*
		441	Ladder-backed woodpecker	*Picoides scalaris*
		442	Gray-crowned rosy-finch	*Leucosticte tephrocotis*
		443	Winter wren	*Troglodytes troglodytes*
		446	Yellow-shouldered blackbird	*Agelaius xanthomus*
		448	White-winged dove	*Zenaida asiatica*
		449	Zenaida dove	*Zenaida aurita*
		452	Mourning dove	*Zenaida macroura*
		453	Puerto Rican parrot	*Amazona vittata*
		454	Puerto Rican lizard-cuckoo	*Saurothera vieilloti*
		455	Yellow-billed cuckoo	*Coccyzus americanus*
		456	Puerto Rican bullfinch	*Loxigilla portoricensis*
		457	Key West quail-dove	*Geotrygon chrysia*
		458	Northern waterthrush	*Seiurus noveboracensis*
		564	Common ground-dove	*Columbina passerina*
		565	Brown jay	*Cyanocorax morio*
		566	White-throated magpie-jay	*Calocitta formosa*
		567	Ruddy ground-dove	*Columbina talpacoti*
		568	Aztec parakeet	*Aratinga astec*
		569	Groove-billed ani	*Crotophaga sulcirostris*
		570	Golden-fronted woodpecker	*Melanerpes aurifrons*
		571	Pale-billed woodpecker	*Campephilus guatemalensis*
		572	Great kiskadee	*Pitangus sulphuratus*
		573	Tropical kingbird	*Tyrannus melancholicus*
		574	Streaked-back oriole	*Icterus pustulatus sclateri*
		575	Altamira oriole	*Icterus gularis*
		576	Common tody-flycatcher	*Todirostrum cinereum*
		577	Clay-colored robin	*Turdus grayi*
		578	Melodius blackbird	*Dives dives*
		579	Scissor-tailed flycatcher	*Tyrannus forficatus*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		580	Inca dove	*Columbina inca*
		581	Woodpecker	*Veniliornis sp.*
		582	Barn Swallow	*Hirundo rustica*
		583	Baltimore oriole	*Icterus galbula*
		584	American redstart	*Setophaga ruticilla*
		585	Rufous-browed peppershrike	*Cyclarhis gujanensis*
		586	Yellow-crowned parrot	*Amazona ochrocephala*
		587	Social flycatcher	*Myiozetetes similis*
		588	Banded wren	*Thryothorus pleurostictus*
		589	Tropical gnatcatcher	*Polioptila plumbea*
		590	Black-and-white warbler	*Mniotilta varia*
		591	Striped-headed sparrow	*Aimophila ruficauda*
		592	Cinnamon hummingbird	*Amazilia rutila*
		594	Thicket tinamou	*Crypturellus cinamomeus*
		595	Horned lark	*Eremophila alpestris*
		596	Purple martin	*Progne subis*
		597	Ipswich sparrow	*Passerculus sandwichensis prin*
		598	Grasshopper sparrow	*Ammodramus savannarum*
		599	Whip-poor-will	*Caprimulgus vociferus*
		601	Yellow-breasted chat	*Icteria virens*
		602	Brown thrasher	*Toxostoma rufum*
		605	Vesper sparrow	*Pooecetes gramineus*
		611	Great-tailed grackle	*Quiscalus mexicanus*
		612	Rufous-naped wren	*Campylorhynchus rufinucha*
		613	Endangered passerine-like bird	
		615	Rare passerine-like bird	
		622	Nihoa finch	*Telespiza ultima*
		623	Nihoa millerbird	*Acrocephalus familiaris kingi*
		624	Laysan finch	*Telespiza cantans*
		1011	Migratory songbirds	
		1012	Neotropical migrants	
		1018	Passerine birds	
BIRD	pelagic	35	Parasitic jaeger	*Stercorarius parasiticus*
		83	Kittiwake	*Rissa sp.*
		96	Leach's storm-petrel	*Oceanodroma leucorhoa*
		100	Black-legged kittiwake	*Rissa tridactyla*
		102	Fork-tailed storm-petrel	*Oceanodroma furcata*
		119	Magnificent frigatebird	*Fregata magnificens*
		126	Brown noddy	*Anous stolidus*
		128	Masked (blue-faced) booby	*Sula dactylatra*
		129	Northern fulmar	*Fulmarus glacialis*
		130	Red-legged kittiwake	*Rissa brevirostris*
		144	Ashy storm-petrel	*Oceanodroma homochroa*
		146	Black storm-petrel	*Oceanodroma melania*
		167	Northern gannet	*Morus bassanus*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		199	Pomarine jaeger	*Stercorarius pomarinus*
		200	Sooty shearwater	*Puffinus griseus*
		201	Short-tailed shearwater	*Puffinus tenuirostris*
		202	Pink-footed shearwater	*Puffinus creatopus*
		203	Flesh-footed shearwater	*Puffinus carneipes*
		247	Wedge-tailed shearwater	*Puffinus pacificus*
		248	Bulwer's petrel	*Bulweria bulwerii*
		249	Black noddy	*Anous minutus*
		250	Red-tailed tropicbird	*Phaethon rubricauda*
		251	Great frigatebird	*Fregata minor*
		252	White-tailed tropicbird	*Phaethon lepturus*
		253	Manx shearwater	*Puffinus puffinus*
		254	Laysan albatross	*Phoebastria immutabilis*
		255	Black-footed albatross	*Phoebastria nigripes*
		256	Bonin petrel	*Pterodroma hypoleuca*
		257	Tristram's storm-petrel	*Oceanodroma tristrami*
		258	Christmas shearwater	*Puffinus nativitatis*
		260	Red-footed booby	*Sula sula*
		261	Brown booby	*Sula leucogaster*
		262	Gray-backed tern	*Sterna lunata*
		263	Blue-gray noddy	*Procelsterna cerulea*
		287	Audubon's shearwater	*Puffinus lherminieri*
		312	Endangered pelagic bird	
		326	Jaegers	*Stercorarius spp.*
		338	South polar skua	*Catharacta maccormicki*
		339	Band-rumped storm-petrel	*Oceanodroma castro*
		340	Markham's storm-petrel	*Oceanodroma markhami*
		341	Wedge-rumped storm-petrel	*Oceanodroma tethys*
		342	Red-billed tropicbird	*Phaethon aethereus*
		343	Long-tailed jaeger	*Stercorarius longicaudus*
		344	Blue-footed booby	*Sula nebouxii*
		345	Storm-petrels	*Oceanodroma spp.*
		346	Boobies	*Sula spp.*
		412	Short-tailed albatross	*Phoebastria albatrus*
		445	Wilson's storm-petrel	*Oceanites oceanicus*
		529	Cory's shearwater	*Calonectris diomedea*
		548	Schlegel's petrel	*Pterodroma incerta*
		554	Swinhoe's storm-petrel	*Oceanodroma monorhis*
		603	Black-capped petrel	*Pterodroma hasitata*
		620	Dark-rumped petrel	*Pterodroma phaeopygia sandwichensis*
		621	Newell's shearwater	*Puffinus auricularis newelli*
		1009	Shearwaters	
		1010	Pelagic birds	
		1022	Seabirds	

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
BIRD	raptor	76	Bald eagle	*Haliaeetus leucocephalus*
		77	Osprey	*Pandion haliaetus*
		107	Peregrine falcon	*Falco peregrinus*
		113	Gyrfalcon	*Falco rusticolus*
		131	White-tailed kite	*Elanus leucurus*
		140	Threatened raptor	
		174	Golden eagle	*Aquila chrysaetos*
		175	Northern spotted owl	*Strix occidentalis caurina*
		176	Short-eared owl	*Asio flammeus*
		181	Northern harrier	*Circus cyaneus*
		182	American kestrel	*Falco sparverius*
		183	Snowy owl	*Nyctea scandiaca*
		218	Red-shouldered hawk	*Buteo lineatus*
		219	Sharp-shinned hawk	*Accipiter striatus*
		220	Merlin	*Falco columbarius*
		221	Cooper's hawk	*Accipiter cooperii*
		222	Barred owl	*Strix varia*
		230	Red-tailed hawk	*Buteo jamaicensis*
		231	Broad-winged hawk	*Buteo platypterus*
		232	Rough-legged hawk	*Buteo lagopus*
		240	Goshawk	*Accipiter gentilis*
		280	Swallow-tailed kite	*Elanoides forficatus*
		285	Arctic peregrine falcon	*Falco peregrinus tundrius*
		296	Florida snail kite	*Rostrhamus sociabilis plumbeus*
		313	Rare raptor	
		314	Endangered raptor	
		347	Bicolored hawk	*Accipiter bicolor*
		348	Striped owl	*Pseudoscops clamator*
		349	Burrowing owl	*Athene cunicularia hypugea*
		350	Great horned owl	*Bubo virginianus*
		351	Black-collared hawk	*Busarellus nigricollis*
		352	White-tailed hawk	*Buteo albicaudatus*
		353	Zone-tailed hawk	*Buteo albonotatus*
		354	Short-tailed hawk	*Buteo brachyurus*
		355	Roadside hawk	*Buteo magnirostris*
		356	Gray hawk	*Buteo nitidus*
		357	Swainson's hawk	*Buteo swainsoni*
		358	Mangrove black-hawk	*Buteogallus subtilis*
		359	Great black-hawk	*Buteogallus urubitinga*
		360	Turkey vulture	*Cathartes aura*
		361	Lesser yellow-headed vulture	*Cathartes burrovianus*
		362	Hook-billed kite	*Chondrohierax uncinatus*
		363	Black and white owl	*Ciccaba nigrolineata*
		364	Mottled owl	*Ciccaba virgata*
		365	Black vulture	*Coragyps atratus*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		366	Red-throated caracara	*Daptrius americanus*
		368	Orange-breasted falcon	*Falco deiroleucus*
		369	Aplomado falcon	*Falco femoralis*
		370	Bat falcon	*Falco rufigularis*
		371	Crane hawk	*Geranospiza caerulescens*
		372	Ferruginous pygmy owl	*Glaucidium brasilianum*
		373	Double-toothed kite	*Harpagus bidentatus*
		374	Laughing falcon	*Herpetotheres cachinnans*
		375	Mississippi kite	*Ictinia mississippiensis*
		376	Plumbeous kite	*Ictinia plumbea*
		377	Gray-headed kite	*Leptodon cayanensis*
		378	Collared forest-falcon	*Micrastur semitorquatus*
		379	Pacific screech-owl	*Otus cooperi*
		380	Harris' hawk	*Parabuteo unicinctus*
		381	Crested caracara	*Caracara plancus*
		382	Spectacled owl	*Pulsatrix perspicillata*
		383	King vulture	*Sarcoramphus papa*
		384	Ornate hawk-eagle	*Spizaetus ornatus*
		385	Common barn owl	*Tyto alba*
		386	Accipiter hawks	*Accipiter spp.*
		387	Buteo hawks	*Buteo spp.*
		388	Falcons	*Falco spp.*
		389	Owls	*Strigidae spp.*
		450	Puerto Rican sharp-shinned hawk	*Accipiter striatus venator*
		451	Puerto Rican broad-winged hawk	*Buteo platypterus brunnescens*
		459	Florida burrowing owl	*Speotyto cunicularia floridana*
		460	Audubon's crested caracara	*Polyborus plancus audubonii*
		461	Southeastern American kestrel	*Falco sparverius paulus*
		470	Honey buzzard	*Pernis apivorus*
		471	Black kite	*Milvus migrans*
		472	Short-toed eagle	*Circaetus gallicus*
		473	Sparrowhawk	*Accipter nisus*
		474	Buzzard	*Buteo buteo*
		475	Eleonora's falcon	*Falco eleonorae*
		476	Eurasian kestrel	*Falco tinnunculus*
		496	Marsh harrier	*Circus aeruginosus*
		516	Common black hawk	*Buteogallus anthracinus*
		552	Steppe eagle	*Aquila nipalensis*
		593		*Otus sp.*
		600	Long-eared owl	*Asio otus*
		604	Eastern screech owl	*Otus asio*
		626	American peregrine falcon	*Falco peregrinus anatum*
		1005	Raptors	
BIRD	shorebird	52	Wilson's phalarope	*Phalaropus tricolor*
		53	Red-necked (Northern) phalarope	*Phalaropus lobatus*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		55	Whimbrel	*Numenius phaeopus*
		56	Spotted sandpiper	*Actitis macularia*
		57	Wandering tattler	*Heteroscelus incanus*
		58	Greater yellowlegs	*Tringa melanoleuca*
		59	Lesser yellowlegs	*Tringa flavipes*
		60	Red knot	*Calidris canutus*
		61	Pectoral sandpiper	*Calidris melanotos*
		62	Least sandpiper	*Calidris minutilla*
		63	Dunlin	*Calidris alpina*
		64	Short-billed dowitcher	*Limnodromus griseus*
		65	Long-billed dowitcher	*Limnodromus scolopaceus*
		66	Western sandpiper	*Calidris mauri*
		67	Sanderling	*Calidris alba*
		68	Black oystercatcher	*Haematopus bachmani*
		69	Semipalmated plover	*Charadrius semipalmatus*
		70	Killdeer	*Charadrius vociferus*
		71	Black-bellied plover	*Pluvialis squatarola*
		72	Surfbird	*Aphriza virgata*
		73	Ruddy turnstone	*Arenaria interpres*
		74	Black turnstone	*Arenaria melanocephala*
		139	Snowy plover	*Charadrius alexandrinus*
		141	American avocet	*Recurvirostra americana*
		142	Black-necked stilt	*Himantopus mexicanus*
		152	American oystercatcher	*Haematopus palliatus*
		153	Piping plover	*Charadrius melodus*
		154	Wilson's plover	*Charadrius wilsonia*
		155	Willet	*Catoptrophorus semipalmatus*
		156	Semipalmated sandpiper	*Calidris pusilla*
		160	Red phalarope	*Phalaropus fulicaria*
		161	Rock sandpiper	*Calidris ptilocnemis*
		164	American golden-plover	*Pluvialis dominica*
		165	Bar-tailed godwit	*Limosa lapponica*
		196	Common snipe	*Gallinago gallinago*
		209	Long-billed curlew	*Numenius americanus*
		210	Marbled godwit	*Limosa fedoa*
		213	Stilt sandpiper	*Calidris himantopus*
		214	Solitary sandpiper	*Tringa solitaria*
		223	Upland sandpiper	*Bartramia longicauda*
		227	Threatened shorebird	
		234	Purple sandpiper	*Calidris maritima*
		237	Baird's sandpiper	*Calidris bairdii*
		238	White-rumped sandpiper	*Calidris fuscicollis*
		270	Western snowy plover	*Charadrius alexandrinus nivosus*
		284	Buff-breasted sandpiper	*Tryngites subruficollis*
		286	Dowitchers	*Limnodromus spp.*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		289	Hudsonian godwit	*Limosa haemastica*
		290	Peep	*Calidris spp.*
		292	Sharp-tailed sandpiper	*Calidris acuminata*
		293	Yellowlegs	*Tringa spp.*
		303	Curlew sandpiper	*Calidris ferruginea*
		315	Rare shorebird	
		316	Endangered shorebird	
		390	Double-striped thick-knee	*Burhinus bistriatus*
		391	Collared plover	*Charadrius collaris*
		394	Plovers	*Charadrius spp.*
		396	Phalaropes	*Phalaropus spp.*
		413	Bristle-thighed curlew	*Numenius tahitiensis*
		414	Eskimo curlew	*Numenius borealis*
		498	Caspian plover	*Charadrius asiaticus*
		499	Little ringed plover	*Charadrius dubius*
		500	Ringed plover	*Charadrius hiaticula*
		501	Sociable plover	*Chettusia gregaria*
		502	White-tailed plover	*Chettusia leucura*
		503	Lapwing	*Vanellus vanellus*
		504	Little stint	*Calidris minuta*
		505	Broad-billed sandpiper	*Limicola falcinellus*
		506	Ruff and reeve	*Philomachus pugnax*
		507	Great snipe	*Gallinago media*
		508	Black-tailed godwit	*Limosa limosa*
		509	Spotted redshank	*Tringa erythropus*
		510	Wood sandpiper	*Tringa glareola*
		511	Greenshank	*Tringa nebularia*
		512	Green sandpiper	*Tringa ochropus*
		513	Marsh sandpiper	*Tringa stagnatilis*
		514	Redshank	*Tringa totanus*
		515	Common sandpiper	*Actitis hypoleucos*
		528	Eurasian common sandpiper	*Tringa hypoleucos*
		530	Eurasian curlew	*Numenius arquata*
		531	Dotterel	*Eudromias morinellus*
		532	Greater golden-plover	*Pluvialis apricaria*
		533	Great knot	*Calidris tenuirostris*
		534	Greater sand plover	*Charadrius leschenaultii*
		536	Grey phalarope	*Phalaropus fulicarius*
		539	Jack snipe	*Lymnocryptes minimus*
		540	Kittlitz's sand plover	*Charadrius pecuarius*
		542	Eurasian oystercatcher	*Haematopus ostralegus*
		543	Pacific golden plover	*Pluvialis fulva*
		544	Pin-tailed snipe	*Gallinago stenura*
		551	Spur-winged plover	*Vanellus spinosus*
		555	Temminck's stint	*Calidris temminckii*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		556	Terek sandpiper	*Tringa cinereus*
		562	Eurasian woodcock	*Scolopax rusticola*
		1002	Shorebirds	
		1017	Sandpipers	
		1028	Curlew	*Numenius spp..*
BIRD	wading	54	Great blue heron	*Ardea herodias*
		87	Little blue heron	*Egretta caerulea*
		88	Great egret	*Ardea alba*
		89	Snowy egret	*Egretta thula*
		90	Black-crowned night-heron	*Nycticorax nycticorax*
		91	Glossy ibis	*Plegadis falcinellus*
		93	Cattle egret	*Bubulcus ibis*
		94	Tricolored heron	*Egretta tricolor*
		97	Green heron	*Butorides virescens*
		115	White ibis	*Eudocimus albus*
		116	Roseate spoonbill	*Ajaia ajaja*
		117	Great white heron	*Ardea occidentalis*
		120	Yellow-crowned night-heron	*Nyctanassa violacea*
		122	Scarlet ibis	*Eudocimus ruber*
		125	Clapper rail	*Rallus longirostris*
		132	Wood stork	*Mycteria americana*
		149	White-faced ibis	*Plegadis chihi*
		150	Black rail	*Laterallus jamaicensis*
		163	Reddish egret	*Egretta rufescens*
		172	Sandhill crane	*Grus canadensis*
		178	Least bittern	*Ixobrychus exilis*
		184	King rail	*Rallus elegans*
		185	American bittern	*Botaurus lentiginosus*
		187	Virginia rail	*Rallus limicola*
		188	Sora	*Porzana carolina*
		189	Yellow rail	*Coturnicops noveboracensis*
		195	American woodcock	*Scolopax minor*
		204	California clapper rail	*Rallus longirostris obsoletus*
		205	Light-footed clapper rail	*Rallus longirostris levipes*
		206	California black rail	*Laterallus jamaicensis coturniculus*
		208	Dark ibis	*Plegadis spp.*
		242	Hawaiian stilt	*Himantopus mexicanus knudseni*
		265	Whooping crane	*Grus americana*
		271	Rails	
		298	Mississippi sandhill crane	*Grus canadensis pulla*
		304	Mangrove clapper rail	*Rallus longirostris insularum*
		306	Limpkin	*Aramus guarauna*
		309	Florida sandhill crane	*Grus canadensis pratensis*
		319	Rare wading bird	

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		320	Endangered wading bird	
		367	Greater flamingo	*Phoenicopterus ruber*
		392	Northern jacana	*Jacana spinosa*
		397	Rufous-necked wood-rail	*Aramides axillaris*
		398	Gray-necked wood-rail	*Aramides cajanea*
		399	Pinnated bittern	*Botaurus pinnatus*
		400	Boat-billed heron	*Cochlearius cochlearius*
		401	Jabiru	*Jabiru mycteria*
		402	Ruddy crake	*Laterallus ruber*
		403	Spotted rail	*Pardirallus maculatus*
		404	Yellow-breasted crake	*Porzana flaviventer*
		405	Bare-throated tiger-heron	*Tigrisoma mexicanum*
		463	Bittern	*Botarus stellaris*
		464	Little bittern	*Ixobrychus minutus*
		465	Great white egret	*Egretta alba*
		466	Little egret	*Egretta garzetta*
		467	White stork	*Ciconia ciconia*
		468	Black stork	*Ciconia nigra*
		478	Water rail	*Rallus aquaticus*
		479	Little crake	*Porzana parva*
		480	Spotted crake	*Porzana porzana*
		481	Baillon's crake	*Porzana pusilla*
		482	Corncrake	*Crex crex*
		484	Black-winged stilt	*Himantopus himantopus*
		485	Avocet	*Recurvirostra avosetta*
		488	Squacco heron	*Ardeola ralloides*
		489	Gray heron	*Ardea cinerea*
		497	Rufescent tiger-heron	*Tigrisoma lineatum*
		535	Striated heron	*Butorides striatus*
		545	Purple heron	*Ardea purpurea*
		557	Western reef heron	*Egretta gularis*
		608	Threatened wading bird	
		617	White-faced or Glossy ibis	*Plegadis spp.*
		1004	Wading birds	
		1015	Egrets	
		1016	Heron	
BIRD	waterfowl	11	Tundra (whistling) swan	*Cygnus columbianus*
		12	Canada goose	*Branta canadensis*
		13	Brant	*Branta bernicla*
		14	Greater white-fronted goose	*Anser albifrons*
		15	Snow goose	*Chen caerulescens*
		16	Mallard	*Anas platyrhynchos*
		17	Northern pintail	*Anas acuta*
		18	Green-winged teal	*Anas crecca*
		20	Northern shoveler	*Anas clypeata*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		21	Canvasback	*Aythya valisineria*
		22	Greater scaup	*Aythya marila*
		23	Lesser scaup	*Aythya affinis*
		24	Common goldeneye	*Bucephala clangula*
		25	Barrow's goldeneye	*Bucephala islandica*
		26	Bufflehead	*Bucephala albeola*
		27	Long-tailed duck	*Clangula hyemalis*
		28	Harlequin duck	*Histrionicus histrionicus*
		29	White-winged scoter	*Melanitta fusca*
		30	Surf scoter	*Melanitta perspicillata*
		32	Common merganser	*Mergus merganser*
		33	Red-breasted merganser	*Mergus serrator*
		34	American coot	*Fulica americana*
		103	Common eider	*Somateria mollissima*
		124	Redhead	*Aythya americana*
		148	Ruddy duck	*Oxyura jamaicensis*
		157	Emperor goose	*Chen canagica*
		158	King eider	*Somateria spectabilis*
		159	Steller's eider	*Polysticta stelleri*
		162	Gadwall	*Anas strepera*
		169	American wigeon	*Anas americana*
		170	Trumpeter swan	*Cygnus buccinator*
		171	Dusky Canada goose	*Branta canadensis occidentalis*
		180	Ring-necked duck	*Aythya collaris*
		186	American black duck	*Anas rubripes*
		190	Blue-winged teal	*Anas discors*
		191	Wood duck	*Aix sponsa*
		192	Common moorhen	*Gallinula chloropus*
		197	Black (common) scoter	*Melanitta nigra*
		198	Hooded merganser	*Lophodytes cucullatus*
		211	Mottled duck	*Anas fulvigula*
		212	Purple gallinule	*Porphyrula martinica*
		215	Aleutian Canada goose	*Branta canadensis leucopareia*
		217	Mute swan	*Cygnus olor*
		243	Hawaiian coot	*Fulica alai*
		244	Hawaiian duck	*Anas wyvilliana*
		245	Hawaiian common moorhen	*Gallinula chloropus sandvicensis*
		246	Laysan duck	*Anas laysanensis*
		266	Black-bellied whistling-duck	*Dendrocygna autumnalis*
		267	Fulvous whistling-duck	*Dendrocygna bicolor*
		268	Masked duck	*Nomonyx dominicus*
		272	Teals	*Anas sp.*
		273	Geese	
		299	Scaup	*Aythya spp.*
		300	Goldeneye	*Bucephala spp.*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		301	Mergansers	
		302	Scoters	*Melanitta spp.*
		307	Caribbean coot	*Fulica caribaea*
		406	Cinnamon teal	*Anas cyanoptera*
		407	Muscovy duck	*Cairina moschata*
		415	Spectacled eider	*Somateria fischeri*
		444	White-cheeked pintail	*Anas bahamensis*
		447	West Indian whistling-duck	*Dendrocygna arborea*
		483	Eurasian coot	*Fulica atra*
		490	Eurasian wigeon	*Anas penelope*
		491	Garganey	*Anas querquedula*
		492	Red-crested pochard	*Netta rufina*
		493	Common pochard	*Aythya ferina*
		494	Tufted duck	*Aythya fuligula*
		495	Ferruginous duck	*Aythya nyroca*
		538	Greylag goose	*Anser anser*
		546	Ruddy shelduck	*Tadorna ferruginea*
		549	Common shelduck	*Tadorna tadorna*
		561	White-headed duck	*Oxyura leucocephala*
		619	Hawaiian goose	*Branta sandvicensis*
		1003	Waterfowl	
		1013	Dabbling ducks	
		1014	Diving ducks	
		1019	Sea ducks	
		1020	Eiders	*Somateria spp.*
		1021	Ducks	
		1027	Swans	*Cygnus spp.*
FISH	anadromous	697	Whitefish	
		698	Sheefish	*Stendous leucichthys nelma*
FISH	diadromous	43	White sturgeon	*Acipenser transmontanus*
		44	Green sturgeon	*Acipenser medirostris*
		45	Coastal Cutthroat trout	*Oncorhynchus clarkii clarkii*
		68	Chinook salmon	*Oncorhynchus tshawytscha*
		69	Coho salmon (silver)	*Oncorhynchus kisutch*
		70	Pink salmon (humpy)	*Oncorhynchus gorbuscha*
		71	Sockeye salmon (red)	*Oncorhynchus nerka*
		72	Chum salmon (dog)	*Oncorhynchus keta*
		73	Cherry salmon	*Oncorhynchus masou*
		74	Rainbow trout (steelhead)	*Oncorhynchus mykiss*
		77	Eulachon	*Thaleichthys pacificus*
		83	Salmon	
		85	Alewife	*Alosa pseudoharengus*
		86	Blueback herring	*Alosa aestivalis*
		87	American shad	*Alosa sapidissima*
		98	American eel	*Anguilla rostrata*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		100	Brown trout	*Salmo trutta*
		101	Shortnose sturgeon	*Acipenser brevirostrum*
		102	Atlantic sturgeon	*Acipenser oxyrinchus*
		104	Striped bass	*Morone saxatilis*
		105	Hickory shad	*Alosa mediocris*
		135	Dolly varden	*Salvelinus malma*
		144	Atlantic salmon	*Salmo salar*
		163	Gizzard shad	*Dorosoma cepedianum*
		172	Longfin smelt	*Spirinchus thaleichthys*
		189	Arctic char	*Salvelinus alpinus*
		219	Pacific lamprey	*Lampetra tridentata*
		233	Ninespine stickleback	*Pungitius pungitius*
		289	Skipjack herring	*Alosa chrysochloris*
		319	Gulf sturgeon	*Acipenser oxyrinchus desotoi*
		333	Herring and shad	*Alosa spp.*
		364	Endangered anadromous fish	
		367	Alabama shad	*Alosa alabamae*
		382	Mountain mullet	*Agonostomus monticola*
		462	Hybrid striped bass	*Morone sp.*
		490	Chinook salmon (fall)	*Oncorhynchus tshawytscha (fall)*
		491	Chinook salmon (late fall)	*Oncorhynchus tshawytscha (late fall)*
		492	Chinook salmon (winter)	*Oncorhynchus tshawytscha (winter)*
		493	Chinook salmon (spring)	*Oncorhynchus tshawytscha (spring)*
		500	Sea lamprey	*Petromyzon marinus*
		501	Brown trout (sea run)	*Salmo trutta (sea run)*
		502	Brook trout (sea run)	*Salvelinus fontinalis (sea run)*
		504	Hog-nosed mullet	*Joturus pichardi*
		524	Sirajo goby (seti)	*Sicydium plumieri*
		622	'O'opu akupa (goby)	*Eleotris sandwicensis*
		623	'O'opu alamo'o (goby)	*Lentipes concolor*
		624	'O'opu nakea (goby)	*Awaous guamensis*
		625	'O'opu naniha (goby)	*Stenogobius hawaiiensis*
		626	'O'opu nopili (goby)	*Sicyopterus stimpsoni*
		1006	Native stream fish	
		1022	Anadromous fish	
		1059	Native gobies	
FISH	e_nursery	11	English sole	*Pleuronectes vetulus*
		12	Starry flounder	*Platichthys stellatus*
		18	Plainfin midshipman	*Porichthys notatus*
		51	Pacific staghorn sculpin	*Leptocottus armatus*
		65	Bluefish	*Pomatomus saltatrix*
		66	Pacific herring	*Clupea pallasi*
		67	Northern anchovy	*Engraulis mordax*
		88	Winter flounder	*Pleuronectes americanus*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		106	California grunion	*Leuresthes tenuis*
		107	Spotted seatrout	*Cynoscion nebulosus*
		108	Summer flounder	*Paralichthys dentatus*
		109	Red drum	*Sciaenops ocellatus*
		110	Black sea bass	*Centropristis striata*
		111	Southern flounder	*Paralichthys lethostigma*
		112	Gulf flounder	*Paralichthys albigutta*
		113	Bay anchovy	*Anchoa mitchilli*
		115	Atlantic menhaden	*Brevoortia tyrannus*
		116	Striped mullet	*Mugil cephalus*
		117	Pinfish	*Lagodon rhomboides*
		120	Pigfish	*Orthopristis chrysoptera*
		121	Spot	*Leiostomus xanthurus*
		122	Black drum	*Pogonias cromis*
		123	Atlantic croaker	*Micropogonias undulatus*
		124	Southern kingfish (whiting)	*Menticirrhus americanus*
		130	Scaled sardine	*Harengula jaguana*
		131	Great barracuda	*Sphyraena barracuda*
		133	Snapper	*Lutjanus spp.*
		137	Sheepshead	*Archosargus probatocephalus*
		138	Weakfish	*Cynoscion regalis*
		140	Ladyfish	*Elops saurus*
		141	Common snook	*Centropomus undecimalis*
		143	Tarpon	*Megalops atlanticus*
		145	White perch	*Morone americana*
		146	Atlantic herring	*Clupea harengus*
		150	Scup (porgy)	*Stenotomus chrysops*
		151	Northern puffer	*Sphoeroides maculatus*
		153	Northern kingfish	*Menticirrhus saxatilis*
		160	Windowpane flounder	*Scophthalmus aquosus*
		173	White mullet	*Mugil curema*
		177	Leopard shark	*Triakis semifasciata*
		193	Jacksmelt	*Atherinopsis californiensis*
		207	Sea catfish	*Galeichthyes felis*
		213	Gulf menhaden	*Brevoortia patronus*
		214	Gulf kingfish	*Menticirrhus littoralis*
		215	Sand seatrout	*Cynoscion arenarius*
		217	Gafftopsail catfish	*Bagre marinus*
		225	California halibut	*Paralichthys californicus*
		258	Hawaiian anchovy	*Encrasicholina purpurea*
		262	California corbina	*Menticirrhus undulatus*
		263	Shortfin corvina	*Cynoscion parvipinnis*
		264	Yellowfin croaker	*Umbrina roncador*
		265	Spotfin croaker	*Roncador stearnsii*
		268	Silver seatrout	*Cynoscion nothus*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		273	Star drum	*Stellifer lanceolatus*
		275	Least puffer	*Sphoeroides parvus*
		281	Seatrout	*Cynoscion sp.*
		282	Mullet	*Mugil spp.*
		285	California barracuda	*Sphyraena argentea*
		287	Hardhead catfish	*Arius felis*
		299	Rainwater killifish	*Lucania parva*
		300	Sailfin molly	*Poecilia latipinna*
		306	Gray snapper	*Lutjanus griseus*
		307	Lane snapper	*Lutjanus synagris*
		317	Bull shark	*Carcharhinus leucas*
		318	Atlantic sharpnose shark	*Rhizoprionodon terraenovae*
		321	Atlantic cutlassfish	*Trichiurus lepturus*
		324	Bighead searobin	*Prionotus tribulus*
		326	Bonnethead shark	*Sphyrna tiburo*
		341	River goby	*Awaous tajasica*
		343	Yellow jack	*Caranx bartholomaei*
		344	Bar jack	*Caranx ruber*
		355	Red porgy	*Pagrus pagrus*
		359	Longspine porgy	*Stenotomus caprinus*
		366	Hogchoker	*Trinectes maculatus*
		368	Yellowfin menhaden	*Brevoortia smithi*
		370	Finescale menhaden	*Brevoortia gunteri*
		392	Amarillo snapper	*Lutjanus argentiventris*
		409	Longspine snook	*Centropomus armatus*
		410	Blackfin snook	*Centropomus medius*
		411	Yellowfin snook	*Centropomus robalito*
		414	Catfish	*Arius sp.*
		416	Mojarras	*Diapterus spp.*
		434	Yellowfin corvina	*Cynoscion stolozmanni*
		435	Highfin corvina, Tailfin croaker	*Micropogonias altipinnis*
		436	Striped corvina	*Cynoscion reticulatus*
		446	Peruvian mojarra	*Diapterus peruvianus*
		488	Smooth flounder	*Pleuronectes putnami*
		494	White croaker	*Genyonemus lineatus*
		508	Snook	*Centropomus spp.*
		514	Mutton snapper	*Lutjanus analis*
		515	Yellowtail snapper	*Ocyurus chrysurus*
		518	Jewfish	*Epinephelus itajara*
		520	White grunt	*Haemulon plumieri*
		525	Bonefish	*Albula vulpes*
		575		*Ariopsis sp.*
		579	Blus bobo	*Polydactylus approximans*
		585	Jacks	*Hemicaranx sp.*
		589		*Diapterus brevimanus*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		590	Colorado snapper	*Lutjanus colorado*
		591		*Lutjanus novemfasciatus*
		592		*Lobotes pacificus*
		597		*Stellifer sp.*
		627	Smooth hammerhead	*Sphyrna zygaena*
		628	Yellowstripe goatfish	*Mulloidicthys flavolineatus*
		630	Hawaiian ladyfish	*Elops hawaiensis*
		682	Stripebelly puffer	*Arothron hispidus*
		1004	Nursery fish	
		1008	Jacks	
		1017	Grunts	
		1018	Porgies	
		1019	Snappers	
		1057	Gray mullets	
FISH	e_resident	60	White seaperch	*Phanerodon furcatus*
		91	Threespine stickleback	*Gasterosteus aculeatus*
		92	Fourspine stickleback	*Apeltes quadracus*
		93	Striped killifish	*Fundulus majalis*
		94	Atlantic silverside	*Menidia menidia*
		95	Mummichog	*Fundulus heteroclitus*
		119	Silver perch	*Bairdiella chrysoura*
		259	Freshwater goby	*Awaous sp.*
		269	Gulf killifish	*Fundulus grandis*
		270	Longnose killifish	*Fundulus similis*
		271	Inland silverside	*Menidia beryllina*
		274	Sheepshead minnow	*Cyprinodon variegatus*
		283	Killifish	*Fundulus spp.*
		296	Diamond killifish	*Adinia xenica*
		297	Marsh killifish	*Fundulus confluentus*
		298	Saltmarsh topminnow	*Fundulus jenkinsi*
		301	Rough silverside	*Membras martinica*
		330	Goby	
		335	Silversides	
		369	Code goby	*Gobiosoma robustum*
		374	Naked goby	*Gobiosoma bosci*
		377	Gulf toadfish	*Opsanus beta*
		379	Pipefish	*Syngnathus spp.*
		380	Texas pipefish	*Syngnathus affinis*
		413	Pacific foureyed fish	*Anableps dovii*
		415	Catfish	*Bagre sp.*
		417	Catfish	*Galeichthys spp.*
		418	Jordan's catfish	*Galeichthys jordani*
		419		*Atherinella guatamalensis*
		433	Gulf pipefish	*Syngnathus scovelli*
		437	Chihuil	*Bagre panamensis*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		442	Porthole livebearer	*Poeciliopsis gracilis*
		443	Black molly	*Poecilia sphenops*
		475	Delta smelt	*Hypomesus transpacificus*
		478	Goby	*Gobiosoma spp.*
		479	Grubby	*Myoxocephalus aenaeus*
		482	Northern pipefish	*Syngnathus fuscus*
		485	Oyster toadfish	*Opsanus tau*
		496	Flagfin mojarra	*Eucinostomus melanopterus*
		527	Mangrove molly	*Poecilia orri*
		571	Atlantic piquitinga	*Lile piquitinga*
		581	Mexican snook	*Centropomus poeyi*
		609	Red sea catfish	*Bagre pinnimaculatus*
		611	Lined sole	*Achirus lineatus*
		613	Tidewater silverside	*Menidia peninsulae*
		614	Roughtail stingray	*Dasyatis centroura*
		615	Violet goby	*Gobioides broussoneti*
		629	Goldspot herring	*Herklotsichthys quadrimaculatus*
		681	Anchialine muraenid eel	*Gymnothorax hilonis*
		1024	Baitfish	
FISH	fish	365	Rare fish	
		620	Endangered fish	
		621	Threatened fish	
		1000	Fish	
		1011	Forage fish	
FISH	freshwater	76	Alligator gar	*Lepisosteus spatula*
		82	Bantam sunfish	*Lepomis symmetricus*
		84	Rainbow smelt	*Osmerus mordax*
		103	Threadfin shad	*Dorosoma petenense*
		125	Bigmouth buffalo	*Ictiobus cyprinellus*
		152	Yellow perch	*Perca flavescens*
		159	Banded killifish	*Fundulus diaphanus*
		161	Lake sturgeon	*Acipenser fulvescens*
		162	Common carp	*Cyprinus carpio*
		164	Cisco	*Coregonus spp.*
		165	Lake whitefish	*Coregonus clupeaformis*
		166	Brook trout	*Salvelinus fontinalis*
		167	Lake trout	*Salvelinus namaycush*
		168	Spottail shiner	*Notropis hudsonius*
		169	Blackchin shiner	*Notropis heterodon*
		170	Blacknose shiner	*Notropis heterolepis*
		171	Fathead minnow	*Pimephales promelas*
		174	Longnose sucker	*Catostomus catostomus*
		175	White sucker	*Catostomus commersoni*
		176	Yellow bullhead	*Ameiurus natalis*
		178	Rock bass	*Ambloplites rupestris*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		179	Largemouth bass	*Micropterus salmoides*
		180	Smallmouth bass	*Micropterus dolomieu*
		181	Black crappie	*Pomoxis nigromaculatus*
		182	Bluegill	*Lepomis macrochirus*
		183	Green sunfish	*Lepomis cyanellus*
		184	Grass pickerel	*Esox americanus*
		185	Northern pike	*Esox lucius*
		186	Muskellunge	*Esox masquinongy*
		187	Sauger	*Stizostedion canadense*
		188	Walleye	*Stizostedion vitreum vitreum*
		190	White bass	*Morone chrysops*
		191	Shorthead redhorse	*Moxostoma macrolepidotum*
		200	Blue catfish	*Ictalurus furcatus*
		201	Channel catfish	*Ictalurus punctatus*
		202	White crappie	*Pomoxis annularis*
		203	Warmouth	*Lepomis gulosus*
		204	Redear sunfish	*Lepomis microlophus*
		205	Freshwater drum	*Aplodinotus grunnieus*
		206	Spotted sunfish	*Lepomis punctatus*
		208	Northern squawfish	*Ptychocheilus oregonensis*
		209	Peamouth	*Mylocheilus caurinus*
		210	Largescale sucker	*Catostomus macrocheilus*
		211	Brown bullhead	*Ameiurus nebulosus*
		212	Pumpkinseed	*Lepomis gibbosus*
		216	Black buffalo	*Ictiobus niger*
		218	Bowfin	*Amia calva*
		220	Sand Roller	*Percopsis transmontana*
		221	Chiselmouth	*Acrocheilus alutaceus*
		222	Mottled sculpin	*Cottus bairdi*
		227	Prickly sculpin	*Cottus asper*
		229	River redhorse	*Moxostoma carinatum*
		230	Pygmy whitefish	*Prosopium coulteri*
		231	Tadpole madtom	*Noturus gyrinus*
		232	Trout perch	*Percopsis omiscomaycus*
		234	Johnny darter	*Etheostoma nigrum*
		235	Lake herring	*Coregonus artedi*
		236	Crappie	*Pomoxis spp.*
		237	Burbot	*Lota lota*
		238	Round whitefish (menomonee)	*Prosopium cylindraceum*
		239	Splake	*Salvelinus namaycush + fontinalis*
		240	Greater redhorse	*Moxostoma valenciennesi*
		241	Striped shiner	*Luxilus chrysocephalus*
		242	Redfin shiner	*Lythrurus umbratilis*
		243	Longear sunfish	*Lepomis megalotis*
		244	Golden redhorse	*Moxostoma erythrurum*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		245	Silver redhorse	*Moxostoma anisurum*
		246	Black bullhead	*Ameiurus melas*
		247	Emerald shiner	*Notropis atherinoides*
		248	Common shiner	*Luxilus cornutus*
		249	Logperch	*Percina caprodes*
		250	Ruffe	*Gymnocephalus cernuus*
		251	Tiger muskellunge	*Esox masquinongy x lucius*
		252	Yellow bass	*Morone mississippiensis*
		257	Flathead catfish	*Pylodictis olivaris*
		276	Red shiner	*Cyprinella lutrensis*
		277	Paddlefish	*Polyodon spathula*
		279	Blue sucker	*Cycleptus elongatus*
		280	Hybrid sunfish	*Lepomis spp.*
		291	Shiners	*Notropis spp.*
		292	Chain pickerel	*Esox niger*
		322	Flier	*Centrarchus macropterus*
		328	Gar	*Lepisosteus spp.*
		329	Grass carp	*Ctenopharyngodon idella*
		336	Pearl darter	*Percina aurora*
		337	Freckled darter	*Percina lenticula*
		338	Frecklebelly madtom	*Noturus munitus*
		339	Bluenose shiner	*Pteronotropis welaka*
		340	Dusky shiner	*Notropis cummingsae*
		342	Snail bullhead	*Ameiurus brunneus*
		353	Golden shiner	*Notemigonus crysoleucas*
		408	Gar	*Atracrosteus tropicus*
		423	Goldfish	*Carassius auratus*
		447	Threespot cichlid	*Cichlasoma trimaculatum*
		448		*Chichlasoma motaguense*
		449	Jaguar guapote	*Chichlasoma managuense*
		450		*Chichlasoma guttulatum*
		451		*Atherinella guija*
		452	Guatemalen chulin	*Rhamdia guatemalensis*
		453	Convict cichlid	*Cichlasoma nigrofasciatum*
		454	Banded astyanax	*Astyanax fasciatus*
		455		*Roeboides salvadoris*
		456	Blue sea catfish	*Arius guatamalensis*
		457		*Chichlasoma guija*
		458	Tilapia	*Oreochromis spp.*
		463	Lake chubsucker	*Erimyzon sucetta*
		464	Longnose gar	*Lepisosteus osseus*
		465	Madtoms	*Noturus spp.*
		466	Minnows	
		468	Orangespotted sunfish	*Lepomis humilis*
		469	Pirate perch	*Aphredoderus sayanus*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		470	Smallmouth buffalo	*Ictiobus bubalus*
		471	Spotted bass	*Micropterus punctulatus*
		472	Spotted gar	*Lepisosteus oculatus*
		474	Sacramento splittail	*Pogonichthys macrolepidotus*
		476	Sacramento perch	*Archoplites interruptus*
		498	Bullhead catfish	*Ameiurus spp.*
		503	Arctic grayling	*Thymallus arcticus*
		505	Peacock bass	*Cichla ocellaris*
		506	White catfish	*Ameiurus catus*
		507	Tilapia	*Tilapia spp.*
		616	Quillback	*Carpiodes cyprinus*
		617	River carpsucker	*Carpiodes carpio*
		618	Spotted sucker	*Minytrema melanops*
		619	Shortnose gar	*Lepisosteus platostomus*
		647	Shovelnose sturgeon	*Scaphirhynchus platorynchus*
		648	Chubsucker	*Erimyzon sp.*
		649	Silver carp	*Hypopthalmichthys molitrix*
		650	Bighead carp	*Hypopthalmichthys nobilis*
		1005	Reservoir fish	
		1012	Catfish	
		1013	Darters	
FISH	m_benthic	1	Sablefish (blackcod)	*Anoplopoma fimbria*
		2	Lingcod	*Ophiodon elongatus*
		3	Pacific sanddab	*Citharichthys sordidus*
		4	Arrowtooth flounder	*Atheresthes stomias*
		5	Petrale sole	*Eopsetta jordani*
		6	Rex sole	*Errex zachirus*
		7	Pacific halibut	*Hippoglossus stenolepis*
		8	Butter sole	*Pleuronectes isolepis*
		9	Rock sole	*Lepidopsetta bilineata*
		10	Dover sole	*Microstomus pacificus*
		13	C-O sole	*Pleuronichthys coenosus*
		14	Curlfin sole	*Pleuronichthys decurrens*
		15	Sand sole	*Psettichthys melanostictus*
		16	Flathead sole	*Hippoglossoides elassodon*
		17	Slender sole	*Lyopsetta exilis*
		19	Pacific cod	*Gadus macrocephalus*
		20	Pacific hake	*Merluccius productus*
		21	Pacific tomcod	*Microgadus proximus*
		22	Walleye pollock	*Theragra chalcogramma*
		23	Wolf-eel	*Anarrhichthys ocellatus*
		24	Pacific ocean perch	*Sebastes alutus*
		25	Silvergray rockfish (short spine)	*Sebastes brevispinis*
		26	Copper rockfish	*Sebastes caurinus*
		27	Puget Sound rockfish	*Sebastes emphaeus*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		29	Black rockfish	*Sebastes melanops*
		30	Bocaccio	*Sebastes paucispinis*
		31	Yelloweye rockfish	*Sebastes ruberrimus*
		32	Canary rockfish (orange)	*Sebastes pinniger*
		33	Chilipepper	*Sebastes goodei*
		34	Redbanded rockfish (flag)	*Sebastes babcocki*
		35	Rougheye rockfish	*Sebastes aleutianus*
		36	Splitnose rockfish	*Sebastes diploproa*
		37	Greenstriped rockfish	*Sebastes elongatus*
		38	Brown rockfish	*Sebastes auriculatus*
		39	Redstripe rockfish	*Sebastes proriger*
		40	Big skate	*Raja binoculata*
		41	Longnose skate	*Raja rhina*
		42	Spotted ratfish	*Hydrolagus colliei*
		46	Kelp greenling	*Hexagrammos decagrammus*
		47	Rock greenling	*Hexagrammos lagocephalus*
		48	Whitespotted greenling	*Hexagrammos stelleri*
		49	Buffalo sculpin	*Enophrys bison*
		50	Red Irish lord	*Hemilepidotus hemilepidotus*
		52	Tidepool sculpin	*Oligocottus maculosus*
		53	Cabezon	*Scorpaenichthys marmoratus*
		56	Shiner perch	*Cymatogaster aggregata*
		61	Penpoint gunnel	*Apodichthys flavidus*
		62	Saddleback gunnel	*Pholis ornata*
		63	Crescent gunnel	*Pholis laeta*
		64	Quillback rockfish	*Sebastes maliger*
		80	Pacific sand lance	*Ammodytes hexapterus*
		89	Cunner	*Tautogolabrus adspersus*
		90	White hake	*Urophycis tenuis*
		96	Sanddab	*Citharichthys sp.*
		97	Tautog	*Tautoga onitis*
		99	Atlantic tomcod	*Microgadus tomcod*
		114	Florida pompano	*Trachinotus carolinus*
		118	Yellowfin mojarra	*Gerres cinereus*
		132	Groupers	
		148	Silver hake	*Merluccius bilinearis*
		149	Atlantic cod	*Gadus morhua*
		154	Pollock	*Pollachius virens*
		155	Red hake	*Urophycis chuss*
		156	American sand lance	*Ammodytes americanus*
		157	Goosefish	*Lophius americanus*
		192	Topsmelt	*Atherinops affinis*
		196	Blue rockfish	*Sebastes mystinus*
		197	Grass rockfish	*Sebastes rastrelliger*
		198	Brown Irish lord	*Hemilepidotus spinosus*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		199	Rock gunnel	*Pholis gunnellus*
		223	Rockfish	*Sebastes spp.*
		226	Tidewater goby	*Eucyclogobius newberryi*
		253	Butterfly fish	*Chaetodon sp.*
		254	Surgeon fish	*Acanthurus sp.*
		255	Damselfish	*Chromis sp.*
		256	Wrasse	*Thalassoma sp.*
		260	Barred sand bass	*Paralabrax nebulifer*
		261	Spotted sand bass	*Paralabrax maculatofasciatus*
		266	Kelp bass	*Paralabrax clathratus*
		267	Opaleye	*Girella nigricans*
		278	Little tunny	*Euthynnus alletteratus*
		284	Flounder	*Paralichthys sp.*
		286	Sole	
		293	Southern hake	*Urophycis floridana*
		294	Spotted hake	*Urophycis regia*
		302	Gag	*Mycteroperca microlepis*
		303	Permit	*Trachinotus falcatus*
		305	Red snapper	*Lutjanus campechanus*
		308	Rock sea bass	*Centropristis philadelphica*
		309	Spotfin mojarra	*Eucinostomus argenteus*
		310	Atlantic spadefish	*Chaetodipterus faber*
		314	Broad flounder	*Paralichthys squamilentus*
		323	Atlantic stingray	*Dasyatis sabina*
		325	Blackcheek tonguefish	*Symphurus plagiusa*
		345	Spotfin butterflyfish	*Chaetodon ocellatus*
		348	Spottail pinfish	*Diplodus holbrooki*
		350	Tomtate	*Haemulon aurolineatum*
		351	Slippery dick	*Halichoeres bivittatus*
		352	Blue angelfish	*Holacanthus bermudensis*
		354	Scamp	*Mycteroperca phenax*
		357	Belted sandfish	*Serranus subligarius*
		358	Cocoa damselfish	*Pomacentrus variabilis*
		360	Sand perch	*Diplectrum formosum*
		362	Southern stingray	*Dasyatis americana*
		363	Inshore lizardfish	*Synodus foetens*
		373	Silver jenny	*Eucinostomus gula*
		375	Bay whiff	*Citharichthys spilopterus*
		376	Fringed flounder	*Etropus crossotus*
		381	Cusk eels	*Ophidion spp.*
		383	Panamic sergeant major	*Abudefduf troschelii*
		384	Spotted eagle ray	*Aetobatus narinari*
		385	Threeband butterflyfish	*Chaetodon humeralis*
		386	Balloonfish	*Diodon holocanthus*
		387	Porcupinefish	*Diodon hystrix*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		388	Flag cabrilla	*Epinephelus labriformis*
		389	Nassau grouper	*Epinephelus striatus*
		390	Panamic green moray	*Gymnothorax castaneus*
		391	Chamelion wrasse	*Halichoeres dispilus*
		393	Dusky sergeant major	*Nexilarius concolor*
		394	Pacific snake eel	*Ophichthus triserialis*
		395	Cortez angelfish	*Pomacanthus zonipectus*
		396	Banded wrasse	*Psuedojulis notospilus*
		397	Bumphead parrotfish	*Scarus perrico*
		398	Orangeside triggerfish	*Sufflamen verres*
		399	Sharpnose lizardfish	*Synodus scituliceps*
		400	Cortez rainbow wrasse	*Thalassoma lucasanum*
		412	Mojarra	*Eucinostomus sp.*
		420	Convict tang	*Acanthurus triostegus*
		421	Yellowfin surgeonfish	*Acanthurus xanthopterus*
		422	Tailspot cardinalfish	*Apogon dovii*
		424	Vermiculate electric ray	*Narcine vermiculatus*
		425	Equatorial ray	*Raja equatoralis*
		426	Tinsel squirrelfish	*Sargocentron suborbitalis*
		427	Acapulco damselfish	*Stegastes acapulcoensis*
		431	Spotted cabrilla	*Epinephelus analogus*
		444	Panamanian grunt	*Pomadasys panamensis*
		445	Blackmouth croaker	*Umbrina xanti*
		459	Alaska plaice	*Pleuronectes quadrituberculatus*
		460	Greenland halibut (turbot)	*Reinhardtius hippoglossoides*
		461	Yellowfin sole	*Pleuronectes asper*
		467	American plaice	*Hippoglossoides platessoides*
		473	Bat ray	*Myliobatis californica*
		477	Cownose ray	*Rhinoptera bonasus*
		480	Haddock	*Melanogrammus aeglefinus*
		481	Longhorn sculpin	*Myoxocephalus octodecemspinosus*
		483	Northern searobin	*Prionotus carolinus*
		484	Ocean pout	*Macrozoarces americanus*
		486	Shorthorn sculpin	*Myoxocephalus scorpius*
		487	Skates	*Raja spp.*
		489	Yellowtail flounder	*Pleuronectes ferrugineus*
		495	Gray triggerfish	*Balistes capriscus*
		497	Sergeant major	*Abudefduf saxatilis*
		509	Red hind	*Epinephelus guttatus*
		510	Yellowfin grouper	*Mycteroperca venenosa*
		511	Tiger grouper	*Mycteroperca tigris*
		512	Coney	*Epinephelus fulvus*
		513	Pacific seahorse	*Hippocampus ingens*
		516	Margate	*Haemulon album*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		519	Silk snapper	*Lutjanus vivanus*
		528	Common guitarfish	*Rhinobatus rhinobatus*
		533	Dispar toothcarp	*Aphanius dispar*
		536	Seahorse	*Hippocampus hippocampus*
		537	Common seahorse	*Hippocampus ramulosus*
		538	Brown pipefish	*Syngnathus abaster*
		539	Silver sillago / whiting	*Sillago sinama*
		540	White sea bream	*Diplodus sargus*
		541	Striped sea bream	*Lithognathus mormyrus*
		547	Lesser weever	*Echiichthys vipera*
		548	Red-speckled blenny	*Parablennius sanguinoletus*
		549	Dragonet	*Callionymus filamentosus*
		550	Buccich's goby	*Gobius bucchichi*
		551	Giant goby	*Gobius cobites*
		552	Rock goby	*Gobius paganelus*
		553	Goby sp.	*Monishia ochetia*
		554	Dusky spinefoot	*Siganus luridus*
		555	Marbled spinefoot	*Siganus rivulatus*
		556	Wide-eyed flounder	*Bothus podas*
		557	Mediterranean sand sole	*Solea lascaris*
		558	Marbled goby	*Pomatoschistus marmoratus*
		559	Common torpedo	*Torpedo torpedo*
		560	Common sole	*Solea solea*
		561	Angelfish	
		562	Barracuda	
		564	Jacks and pompanos	
		565	Seabass	
		567	Sculpin	*Cottidae*
		580	Tarpon snook	*Centropomus pectinatus*
		583		*Pseudobalistes sp.*
		593		*Anisotremus sp.*
		595		*Pomadasys macracanthus*
		596		*Haemulon scuderi*
		599		*Paralonchurus sp.*
		608		*Pareques viola*
		610	Panama spadefish	*Parapsettus panamensis*
		612	Speckled worm eel	*Myrophis punctatus*
		634	Bigeye emperor	*Monotaxis grandoculis*
		639	Lavender tang	*Acanthurus nigrofuscus*
		640	Blackfin chromis	*Chromis vanderbilti*
		641	Gold-ring surgeonfish	*Ctenochaetus strigosus*
		642	Saddle wrasse	*Thalassoma duperrey*
		643	Yellow tang	*Zebrasoma flavescens*
		644	Hawaiian silverside	*Atherinomorus insularum*
		646	Whitetip reef shark	*Triaenodon obesus*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		651	Achilles surgeonfish	*Acanthurus achilles*
		652	Big-scale soldierfish	*Myripristis berndti*
		653	Blueline surgeonfish	*Acanthurus nigroris*
		654	Bluespine unicornfish	*Naso unicornis*
		655	Bullethead parrotfish	*Scarus sordidus*
		656	Eyestripe surgeonfish	*Acanthurus dussumieri*
		657	Hawaiian domino damselfish	*Dascyllus albisella*
		658	Hawaiian garden eel	*Gorgasia hawaiiensis*
		659	Longnose butterflyfish	*Forcipiger longirostris*
		660	Manybar goatfish	*Parupeneus multifasciatus*
		661	Moorish idol	*Zanclus cornutus*
		662	Multiband butterflyfish	*Chaetodon multicinctus*
		663	Ornate butterflyfish	*Chaetodon ornatissimus*
		664	Orangespine unicornfish	*Naso lituratus*
		665	Pacific gregory	*Stegastes fasciolatus*
		666	Potter's angelfish	*Centropyge potteri*
		667	Regal parrotfish	*Scarus dubius*
		668	Ringtail wrasse	*Cheilinus unifasciatus*
		669	Sleek unicornfish	*Naso hexacanthus*
		670	Spectacled parrotfish	*Chlorurus perspicillatus*
		671	Spotted unicornfish	*Naso brevirostris*
		672	Threespot chromis	*Chromis verater*
		673	White ulua	*Carangoides ajax*
		674	Whitebar surgeonfish	*Acanthurus leucopareius*
		675	Whitespotted surgeonfish	*Acanthurus guttatus*
		676	White-tail damselfish	*Chromis leucurus*
		677	Yellowfin moray	*Gymnothorax flavimarginatus*
		678	Orangeband surgeonfish	*Acanthurus olivaceus*
		680	Hawaiian black grouper	*Epinephelus quernus*
		684	Manyray flatfish	*Bothus mancus*
		686	Thornback cowfish	*Lactoria fornasini*
		687	Giant trevally	*Caranx ignobilis*
		688	Dusky frillgoby	*Bathygobius fuscus*
		689	Native goby	*Oxyurichthys lonchotus*
		690	Gracile lizardfish	*Saurida gracilis*
		1001	Blennies	
		1002	Reef fish	
		1007	Parrotfish	
		1009	Damselfish	
		1010	Wrasses	
		1015	Rays	
		1016	Skates	
		1023	Eels	
		1025	Butterflyfish	
		1026	Cardinalfish	

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		1027	Filefish	
		1028	Goatfish	
		1029	Gobies	
		1030	Hawkfish	
		1031	Moray eels	
		1032	Puffers	
		1033	Squirrelfish	
		1034	Surgeonfish	
		1035	Triggerfish	
		1036	Trunkfish	
		1037	Rudderfish	
		1038	Bigeyes	
		1039	Boxfish	
		1040	Moorish idols	
		1041	Trumpetfish	
		1044	Conger eels	
		1045	Scorpionfish	
		1046	Flying fish	
		1048	Porcupinefish	
		1050	Cornetfish	
		1051	Soldierfish	
		1052	Knifejaws	
		1053	Lizardfish	
		1054	Yellowfin goatfish	*Mulloidichthys vanicolensis*
		1055	Manta rays	
FISH	m_pelagic	28	Yellowtail rockfish	*Sebastes flavidus*
		54	Redtail surfperch	*Amphistichus rhodoterus*
		55	Kelp perch	*Brachyistius frenatus*
		57	Striped seaperch	*Embiotoca lateralis*
		58	Walleye surfperch	*Hyperprosopon argenteum*
		59	Pile perch	*Rhacochilus vacca*
		75	Surf smelt	*Hypomesus pretiosus*
		78	Capelin	*Mallotus villosus*
		79	White seabass	*Atractoscion nobilis*
		81	Spiny dogfish	*Squalus acanthias*
		126	King mackerel	*Scomberomorus cavalla*
		127	Spanish mackerel	*Scomberomorus maculatus*
		128	Blue runner	*Caranx crysos*
		129	Atlantic thread herring	*Opisthonema oglinum*
		134	Cobia	*Rachycentron canadum*
		136	Dolphin	*Coryphaena hippurus*
		139	Spanish sardine	*Sardinella aurita*
		142	Crevalle jack	*Caranx hippos*
		147	Atlantic mackerel	*Scomber scombrus*
		158	Butterfish	*Peprilus triacanthus*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		194	Whitebait smelt	*Allosmerus elongatus*
		195	Silver surfperch	*Hyperprosopon ellipticum*
		224	Surfperch	
		228	Night smelt	*Spirinchus starksi*
		272	Rainbow runner	*Elagatis bipinnulata*
		288	Tripletail	*Lobotes surinamensis*
		290	Striped anchovy	*Anchoa hepsetus*
		295	Halfbeak	*Hyporhamphus unifasciatus*
		304	Rough scad	*Trachurus lathami*
		311	Atlantic bonito	*Sarda sarda*
		312	Harvestfish	*Peprilus alepidotus*
		313	Gulf butterfish	*Peprilus burti*
		315	Blacktip shark	*Carcharhinus limbatus*
		316	Spinner shark	*Carcharhinus brevipinna*
		320	Atlantic bumper	*Chloroscombrus chrysurus*
		327	Dwarf seahorse	*Hippocampus zosterae*
		331	Sharks	
		332	Tiger shark	*Galeocerdo cuvier*
		334	Finetooth shark	*Carcharhinus isodon*
		346	Mackerel scad	*Decapterus macarellus*
		347	Round scad	*Decapterus punctatus*
		349	Cubbyu	*Equetus umbrosus*
		356	Greater amberjack	*Seriola dumerili*
		361	Pearly razorfish	*Hemipteronotus novacula*
		371	Atlantic threadfin	*Polydactylus octonemus*
		372	Leatherjacket	*Oligoplites saurus*
		378	Atlantic needlefish	*Strongylura marina*
		401	Green jack	*Caranx caballus*
		402	Pacific crevalle jack	*Caranx caninus*
		403	Oceanic whitetip shark	*Carcharhinus longimanus*
		404	Black skipjack	*Euthynnus lineatus*
		405	Deepbody thread herring	*Opisthonema libertate*
		406	Pacific sierra	*Scomberomorus sierra*
		407	California needlefish	*Strongylura exilis*
		428	Anchovies	*Anchovia sp.*
		429	Mexican moonfish	*Selene orestedii*
		430	Lookdown	*Selene vomer*
		432	Butterfish	*Peprilus spp.*
		438	Scalloped hammerhead	*Sphyrna lewini*
		439	Silky shark	*Carcharhinus falciformis*
		440	Whitenose shark	*Nasolamia velox*
		441	Smalltail shark	*Carcharhinus porosus*
		499	Mackerels	*Scomberomorus spp.*
		517	Dwarf herring (blue fry)	*Jenkinsia lamprotaenia*
		521	Blue marlin	*Makaira nigricans*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		522	Yellowfin tuna	*Thunnus albacares*
		523	Swordfish	*Xiphias gladius*
		526	Longbill spearfish	*Tetrapturus pfluegeri*
		529	Rainbow sardine	*Dussumieria acuta*
		530	Spotted herring	*Herklotsichthys punctatus*
		531	Spotted halfbeak	*Hemiramphus far*
		532	Mediterranean halfbeak	*Hyporhampus picarti*
		534	Boyer's silverside	*Atherina boyri*
		535	Hardyhead silverside	*Atherinomorus lacunosus*
		542	Thicklip grey mullet	*Chelon labrosus*
		543	Golden grey mullet	*Liza aurata*
		544	Thinlip grey mullet	*Liza ramada*
		545	Pacific sharpnose shark	*Rhizoprionodon longurio*
		546	Boxlip grey mullet	*Oedalechilus labeo*
		563	Bluefish spp.	
		566	Tunas	
		568		*Urotrygon asterias*
		569	Stingray	*Dasyatis spp.*
		570	Machete	*Elops affinis*
		572	Caribbean longfin herring	*Odontognathus compressus*
		573	American coastal pellona	*Pellona harroweri*
		574	Milkfish	*Chanos chanos*
		576		*Tylosurus raphidoma*
		577	Timuca	*Strongylura timuca*
		578	Guaguanche	*Sphyraena guachancho*
		582	Venezuelan grouper	*Mycteroperca cidi*
		584		*Batrachoides surinamensis*
		586	Cocinero	*Caranx vinctus*
		587		*Dormitator maculatus*
		588	Pacific spadefish	*Chaetodipeterus zonatus*
		594		*Genuatremus sp.*
		598	Anchovies	*Anchoa sp.*
		600		*Menticirrhus nasus*
		601	Mexican barracuda	*Sphyraena ensis*
		602		*Sphoeroides sp.*
		603	Galapagos shark	*Carcharhinus galapagensis*
		604	Weakfish	*Cynoscion squamipinnis*
		605	Cachema weakfish	*Cynoscion phoxocephalus*
		606	Whitefin weakfish	*Cynoscion albus*
		607		*Cynoscion nannus*
		631	Bigeye scad	*Selar crumenopthalmus*
		632	Hawaiian flagtail	*Kuhlia sandvicensis*
		633	Pink snapper	*Pristipomoides filamentosus*
		635	Threadfin	*Polydactylus sexfilis*
		636	Atka mackerel	*Pleurogrammus monopterygius*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		637	Sharpnose mullet	*Neomyxus leuciscus*
		638	Wahoo	*Acanthocybium solandri*
		645	Heller's barracuda	*Sphyraena helleri*
		679	Gray reef shark	*Carcharhinus amblyrhynchos*
		683	Leatherback	*Scomberoides lysan*
		691	Masked angelfish	*Genicanthus personatus*
		692	Yellowspotted jack	*Carangoides orthogrammus*
		693	Bluefin trevally	*Caranx melampygus*
		694	Bigeye jack	*Caranx sexfasciatus*
		695	Golden trevally	*Gnathanodon speciosus*
		696	Thicklipped jack	*Pseudocaranx dentex*
		1003	Pelagic fish	
		1042	Needlefish	
		1043	Sprat	
		1047	Marlins	
		1049	Scad	
		1056	Moonfish	
		1058	Emperors	
FISH	m_resident	685	Eyebar goby	*Gnatholepis anjerensis*
HABITAT	algae	287	Umbrella algae	*Acetabularia sp.*
		288	Sea ferns	*Bryopsis spp.*
		289	Grape and Feather algae	*Caulerpa*
		290	Green fleece	*Codium sp.*
		291	Bone algae	*Galaxaura sp.*
		292	Common disk or Segmented algae	*Halimeda sp.*
		293	Petticoat algae	*Padina sp.*
		294	Saragassum	*Sargassum liebmanii*
		317	Saragassum	*Sargassum spp.*
		398	Gracilaria	*Gracilaria sp.*
		412	Caulerpa	*Caulerpa spp.*
		1028	Algae	
		1054	Algal reef	
HABITAT	coral	147	Coral community	
		295	Gorgonid	*Gorgonidae*
		296		*Pacificigorgia sp.*
		297		*Balanophyllia bairdiana*
		298		*Isis hippuris*
		299		*Pasiopora damicornis*
		300		*Pocillopora damicornis*
		301	Doughnut coral	*Scolymia australis*
		302	Sun coral	*Tubastrea faulkneri*
		303		*Upsella sp.*
		314	Lobe coral	*Porites lobata*
		315		*Pacificigorgia pacifici*
		316		*Pacificigorgia adamsii*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		518	Black coral	*Antipathes spp.*
		519	Finger coral	*Porites compressa*
		520	Table coral	*Acropora cytheria*
		601	Wire coral	*Cirrhipathes anguina*
		603	Sinularia molokaiensis (soft coral)	*Sinularia molokaiensis*
		1030	Coral reef	
		1033	Shelf-edge reef	
		1034	Coral patch reef	
		1039	High live coral cover	
		1040	Massive coral colonies	
		1041	Rare coral	
		1042	Reef pinnacle	
		1043	Soft coral	
		1044	Structural coral reef	
		1047	Mushroom corals	
		1048	Submerged barrier reef	
		1049	Coralline algal apron reef	
		1050	High coral diversity	
		1052	Coral reef habitat	
		1055	Octocoral bed	
HABITAT	fav	46	Horned bladderwort	*Utricularia cornuta*
		51	Spotted pondweed	*Potamogeton pulcher*
		89	Banana water lily	*Nymphaea mexicana*
		105	Pondweed	*Potamogeton spp.*
		116	Water lotus	*Nelumbo lutea*
		118	White water-lily	*Nymphaea odorata*
		165	Featherfoil	*Hottonia inflata*
		166	Floating pennywort	*Hydrocotyle ranunculoides*
		174	Lesser bladderwort	*Utricularia minor*
		176	Minute duckweed	*Lemna perpusilla*
		193	Small yellow pond lily	*Nuphar lutea pumila*
		215	Water lettuce	*Pistia stratiotes*
		216	Spatterdock	*Nuphar lutea*
		217	Water hyacinth	*Eichhornia crassipes*
		218	Duck weed	*Lemna spp.*
		219	Water lily	*Nymphaea spp.*
		221	Floating aquatic vegetation	
		403	Slender-leaved pondweed	*Potamogeton filiformis*
HABITAT	hardbottom	148	Hardbottom community	
		252	Hardbottom reef ledge	
		253	Hardbottom reef	
		305	Anemones	
		306		*Bunodactis mexicana*
		307	Green velvet anemone	*Palythoa ignotha*
		1031	Hardground	

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		1032	Rock reef	
HABITAT	kelp	2	Bull kelp	*Nereocystis luetkeana*
		9	Giant kelp	*Macrocystis pyrifera*
		413	Kelp	*Laminaria saludoncula*
HABITAT	plant	59	Endangered plant	
		60	Threatened plant	
		61	Butterwort	*Pinguicula vulgaris*
		102	Maliciae	*Maliciae*
		214	Rare plant	
		254	Rare community	
		409	Bailey's ballmoss	*Tillandsia baileyi*
		521	Achyranthes splendens rotundata	*Achyranthes splendens rotundata*
		522	Charpentiera densiflora	*Charpentiera densiflora*
		523	Nototrichium humile	*Nototrichium humile*
		524	Peucedanum sandwicense	*Peucedanum sandwicense*
		525	Ochrosia haleakalae	*Ochrosia haleakalae*
		526	Ochrosia kauaiensis	*Ochrosia kauaiensis*
		527	Pteralyxia kauaiensis	*Pteralyxia kauaiensis*
		528	Munroidendron racemosum	*Munroidendron racemosum*
		529	Bidens molokaiensis	*Bidens molokaiensis*
		530	Gnaphalium s. molokaiense	*Gnaphalium sandwicensium molokaiense*
		531	Lipochaeta lobata lobata	*Lipochaeta lobata lobata*
		532	Lipochaeta tenuifolia	*Lipochaeta tenuifolia*
		533	Tetramolopium sylvae	*Tetramolopium sylvae*
		534	Tetramolopium rockii calcisabulorum	*Tetramolopium rockii calcisabulorum*
		535	Tetramolopium rockii rockii	*Tetramolopium rockii rockii*
		536	Wilkesia hobdyi	*Wilkesia hobdyi*
		537	Lepidium arbuscula	*Lepidium arbuscula*
		538	Lepidium bidentatum o-waihiense	*Lepidium bidentatum o-waihiense*
		539	Lepidium serra	*Lepidium serra*
		540	Brighamia insignis	*Brighamia insignis*
		541	Brighamia rockii	*Brighamia rockii*
		542	Lobelia niihauensis	*Lobelia niihauensis*
		543	Schiedea apokremnos	*Schiedea apokremnos*
		544	Schiedea globosa	*Schiedea globosa*
		545	Schiedea kealiae	*Schiedea kealiae*
		546	Schiedea ligustrina	*Schiedea ligustrina*
		547	Schiedea lydgatei	*Schiedea lydgatei*
		548	Schiedea stellarioides	*Schiedea stellarioides*
		549	Schiedea menziesii	*Schiedea menziesii*
		550	Bonamia menziesii	*Bonamia menziesii*
		551	Capparis sandwichiana	*Capparis sandwichiana*
		552	Chamaesyce celastroides kaenana	*Chamaesyce celastroides kaenana*
		553	Chamaesyce celastroides stokesii	*Chamaesyce celastroides stokesii*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		554	Chamaesyce celastroides laehiensis	*Chamaesyce celastroides laehiensis*
		555	Chamaesyce celastroides tomentella	*Chamaesyce celastroides tomentella*
		556	Chamaesyce s. skottsbergii	*Chamaesyce skottsbergii skottsbergii*
		557	Chamaesyce s. vaccinioides	*Chamaesyce skottsbergii vaccinioides*
		558	Chamaesyce kuwaleana	*Chamaesyce kuwaleana*
		559	Acacia koaia	*Acacia koaia*
		560	Canavalia molokaiensis	*Canavalia molokaiensis*
		561	Canavalia napaliensis	*Canavalia napaliensis*
		562	Canavalia pubescens	*Canavalia pubescens*
		563	Sesbania tomentosa	*Sesbania tomentosa*
		564	Vigna o-wahuensis	*Vigna o-wahuensis*
		565	Kanaloa kahoolawensis	*Kanaloa kahoolawensis*
		566	Centaurium sebaeoides	*Centaurium sebaeoides*
		567	Scaevola coriacea	*Scaevola coriacea*
		568	Labordia helleri	*Labordia helleri*
		569	Abutilon menziesii	*Abutilon menziesii*
		570	Hibiscus arnottianus immaculatus	*Hibiscus arnottianus immaculatus*
		571	Hibiscus b. brackenridgei	*Hibiscus brackenridgei brackenridgei*
		572	Hibiscus kokio kokio	*Hibiscus kokio kokio*
		573	Hibiscus kokio saintjohnianus	*Hibiscus kokio saintjohnianus*
		574	Hibiscus waimeae hannerae	*Hibiscus waimeae hannerae*
		575	Pittosporum napaliense	*Pittosporum napaliense*
		576	Portulaca sclerocarpa	*Portulaca sclerocarpa*
		577	Portulaca villosa	*Portulaca villosa*
		578	Portulaca molokiniensis	*Portulaca molokiniensis*
		579	Bobea sandwicensis	*Bobea sandwicensis*
		580	Gardenia brighamii	*Gardenia brighamii*
		581	Hedyotis elatior	*Hedyotis elatior*
		582	Hedyotis fluviatilis	*Hedyotis fluviatilis*
		583	Hedyotis littoralis	*Hedyotis littoralis*
		584	Hedyotis st.-johnii	*Hedyotis st.-johnii*
		585	Nothocestrum breviflorum	*Nothocestrum breviflorum*
		586	Solanum nelsonii	*Solanum nelsonii*
		587	Alectryon macrococcus macrococcus	*Alectryon macrococcus macrococcus*
		588	Pritchardia affinis	*Pritchardia affinis*
		589	Pritchardia lowreyana	*Pritchardia lowreyana*
		590	Cyperus trachysanthos	*Cyperus trachysanthos*
		591	Mariscus p. pennatiformis	*Mariscus p. pennatiformis*
		592	Fimbristylis hawaiiensis	*Fimbristylis hawaiiensis*
		593	Ischaemum byrone	*Ischaemum byrone*
		594	Panicum beecheyi	*Panicum beecheyi*
		595	Panicum fauriei carteri	*Panicum fauriei carteri*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		596	Panicum niihauense	*Panicum niihauense*
		597	Panicum lineale	*Panicum lineale*
		598	Marsilea villosa	*Marsilea villosa*
		599	Ophioglossum concinnum	*Ophioglossum concinnum*
		602	Pseudognaphalium s. molokaiense	*Pseudognaphalium s. molokaiense*
		604	Pritchardia remota	*Pritchardia remota*
		605	Schiedea verticillata	*Schiedea verticillata*
		606	Amaranthus brownii	*Amaranthus brownii*
		1007	Aquatic vegetation	
		1053	Native coastal strand vegetation	
HABITAT	reef	411	Reef	
HABITAT	sav	1	Eelgrass	*Zostera marina*
		7	Surfgrass	*Phyllospadix sp.*
		48	Whorled water-milfoil	*Myriophyllum verticillatum*
		55	Flatleaf pondweed	*Potamogeton robbinsii*
		78	Turtle grass	*Thalassia testudinum*
		79	Shoal grass	*Halodule beaudettei*
		80	Widgeon grass	*Ruppia maritima*
		81	Manatee grass	*Syringodium filiforme*
		82	Southern naiad	*Najas guadalupensis*
		83	Water celery	*Vallisneria americana*
		84	Dwarf seagrass	*Halophila engelmannii*
		85	Seagrass	
		138	Coontail	*Ceratophyllum demersum*
		139	Egeria	*Egeria densa*
		140	Water stargrass	*Heteranthera dubia*
		141	Hydrilla	*Hydrilla verticillata*
		142	Eurasian water-milfoil	*Myriophyllum spicatum*
		143	Pondweed	*Potamogeton sp.*
		163	Cut-leaved water-milfoil	*Myriophyllum pinnatum*
		192	Slender water-milfoil	*Myriophyllum tenellum*
		213	Submersed aquatic vegetation	
		456	Spiny naiad	*Najas marina*
		1025	Algal flats	
		1036	Macroalgae	
		1045	Rare algae	
		1046	Red algae	
HABITAT	upland	3	Menzies wallflower	*Erysimum menziesii*
		4	Beach layia	*Layia carnosa*
		8	Clover lupine	*Lupinus tidestromii*
		11	Sand (Monterey) gilia	*Gilia tenuiflora arenaria*
		12	Pitcher's thistle (Dune thistle)	*Cirsium pitcheri*
		13	Clustered broomrape	*Orobanche fasciculata*
		15	Spurge	*Euphorbia polygonifolia*
		16	Rock sandwort	*Minvartia michauxii michauxii*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		20	Wild bean	*Strophostyles helvola*
		21	Sea rocket	*Cakile edentula*
		22	Ginseng	*Panax quinquefolius*
		23	Broadleaf sedge	*Carex platphylla*
		24	Thickspike wheatgrass	*Agropyron dasystachyum*
		26	Sand reed	*Calamovilfa longifolia*
		29	Northern comandra	*Geocaulon lividum*
		30	Pale false foxglove	*Agalinis skinneriana*
		31	Dwarf lake iris	*Iris lacustris*
		35	Lake Huron tansy	*Tanacetum bipinnatum huronense*
		38	Beach peavine	*Lathyrus japonicus maritimus*
		42	Sand-heather	*Hudsonia tomentosa*
		44	Prairie fame-flower	*Talinum rugospermum*
		50	Sticky goldenrod	*Solidago simplex randii*
		52	Beach sumac	*Rhus aromatica var. arenaria*
		53	Black-fruit mountain-ricegrass	*Piptatherum racemosa*
		54	Chamomile grape-fern	*Botrychium matricariifolium*
		56	Clinton lily	*Clintonia borealis*
		62	Beautiful sedge	*Carex concinna*
		64	Spike trisetum	*Trisetum spicatum*
		69	Marin bent grass	*Agrostis blasdalei marinensis*
		71	Howells spineflower	*Chorizanthe howellii*
		74	Surf thistle	*Cirsium rhothophilum*
		75	Beach spectacle pod	*Dithyrea maritima*
		95	Chinese tallow	*Sapium sebiferum*
		120	Coastal gay-feather	*Liatris bracteata*
		121	Live oak	*Quercus virginiana*
		122	Pecan	*Carya illinoinensis*
		124	Grand prairie evening primrose	*Oenothera pilosella sessilis*
		125	Houston machaeranthera	*Machaeranthera aurea*
		126	Little bluestem	*Schizachyrium scoparium*
		127	Brownseed paspalum	*Paspalum plicatulum*
		128	Long-sepaled false dragonhead	*Physostegia longisepala*
		130	Scarlet catchfly	*Silene subciliata*
		131	Sea oats	*Uniola paniculata*
		132	Bitter panicum	*Panicum amarum*
		133	Seacoast bluestem	*Schizachyrium scoparium littoralis*
		136	Texas windmill-grass	*Chloris texensis*
		137	Threeflower broomweed	*Thurovia triflora*
		149	American chaffseed	*Schwalbea americana*
		159	Bristling panic grass	*Dichanthelium aciculare*
		184	Robin-run-away	*Dalibarda repens*
		186	Rough flatsedge	*Cyperus retrofractus*
		187	Sea-beach knotweed	*Polygonum glaucum*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		189	Sea-side evening primrose	*Oenothera humifusa*
		207	Carolina goldenrod	*Solidago pulchra*
		210	Carolina spleenwort	*Asplenium heteroresiliens*
		211	Southern three-awned grass	*Aristida simpliciflora*
		212	Pine barren ruellia	*Ruellia pedunculata pinetorum*
		222	Florida privet	*Forestiera segregata*
		223	Tiny leaved buckthorn	*Sageretia minutiflora*
		226	Ashe's savory	*Calamintha ashei*
		229	Curtiss' milkweed	*Asclepias curtissii*
		231	Florida bonamia	*Bonamia grandiflora*
		232	Gulf hammock indian plantain	*Hasteola robertiorum*
		233	Florida mountain-mint	*Pycnanthemum floridanum*
		234	Florida three-awned grass	*Aristida rhizomophora*
		240	Okeechobee gourd	*Cucurbita okeechobeensis*
		244	Scrub holly	*Ilex opaca*
		255	Rare terrestrial plant	
		256	Threatened terrestrial plant	
		263	Huisache	*Acacia farnesiana*
		265	Mesquite	*Prosopis glandulosa*
		267	Cane bluestem	*Bothriochloa barbinodis*
		271	False rhodesgrass	*Chloris pluriflora*
		272	Morning glories	*Ipomoea spp.*
		273	Granjeno	*Celtis pallida*
		274	Blackbrush	*Acacia rigidula*
		278	Welder machaeranthera	*Psilactis heterocarpa*
		279	Elmendorf's onion	*Allium elmendorfii*
		280	Wright's yellowshow	*Amoreuxia wrightii*
		281	Plains gumweed	*Grindelia oolepis*
		282	Texas stonecrop	*Lenophyllum texanum*
		283	Lila de los llanos	*Echeandia chandleri*
		284	South Texas ambrosia	*Ambrosia cheiranthifolia*
		304	Polystichum calderonense	*Polystichum calderonense*
		308	Seaside heliotrope	*Heliotropium curassavicum*
		309	Beach morning glory	*Ipomoea pescaprea*
		310		*Jouvea pilosa*
		311	Cinchweed	*Pectis arenaria*
		312	Spikegrass	*Uniola pittieri*
		313	Aleutian shield-fern	*Polystichum aleuticum*
		318	Sandplain gerardia	*Agalinis acuta*
		319	Bushy rockrose	*Helianthemum dumosum*
		320	Dune grassland	
		326	Big tarplant	*Blepharizonia plumosa plumosa*
		330	San Mateo woolly sunflower	*Eriophyllum latilobum*
		331	San Francisco gumplant	*Grindelia hirsutula maritima*
		332	Diablo helianthella	*Helianthella castanea*

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		333	Congdon's tarplant	*Hemizonia parryi congdonii*
		334	Santa Cruz tarplant	*Holocarpha macradenia*
		335	Carquinez goldenbush	*Isocoma arguta*
		337	Tamalpais lessingia	*Lessingia micradenia micradenia*
		338	Crystal Springs lessingia	*Lessingia arachnoidea*
		339	San Francisco lessingia	*Lessingia germanorum*
		340	Showy madia	*Madia radiata*
		341	Santa Cruz microseris	*Stebbinsoseris decipiens*
		342	White-rayed pentachaeta	*Pentachaeta bellidiflora*
		343	Rayless ragwort	*Senecio aphanactis*
		345	Contra Costa wallflower	*Erysimum capitatum angustatum*
		346	Most beautiful jewelflower	*Streptanthus albidus peramoenus*
		347	Tamalpais jewelflower	*Streptanthus batrachopus*
		348	Mt. Tamalpais jewelflower	*Streptanthus glandulosus pulchellus*
		349	Tiburon jewelflower	*Streptanthus niger*
		353	San Francisco campion	*Silene verecunda verecunda*
		354	San Joaquin saltbush	*Atriplex joaquiniana*
		355	Brittlescale	*Atriplex depressa*
		357	Mt. Diablo manzanita	*Arctostaphylos auriculata*
		358	Presidio manzanita	*Arctostaphylos hookeri ravenii*
		359	Mt. Tamalpais manzanita	*Arctostaphylos hookeri montana*
		360	San Bruno Mtn. manzanita	*Arctostaphylos imbricata*
		361	Montara manzanita	*Arctostaphylos montaraensis*
		362	Pacific manzanita	*Arctostaphylos pacifica*
		363	Pallid manzanita	*Arctostaphylos pallida*
		364	Marin manzanita	*Arctostaphylos virgata*
		367	Showy indian clover	*Trifolium amoenum*
		368	San Mateo thornmint	*Acanthomintha duttonii*
		369	Brewer's western flax	*Hesperolinon breweri*
		370	Marin western flax	*Hesperolinon congestum*
		373	Santa Clara red ribbons	*Clarkia concinna automixa*
		374	Presidio clarkia	*Clarkia franciscana*
		375	Antioch dunes evening-primrose	*Oenothera deltoides howellii*
		376	Diamond-petaled California poppy	*Eschscholzia rhombipetala*
		377	San Francisco Bay spineflower	*Chorizanthe cuspidata cuspidata*
		378	Robust spineflower	*Chorizanthe robusta*
		379	Sonoma spineflower	*Chorizanthe valida*
		380	Marin knotweed	*Polygonum marinense*
		383	Yellow larkspur	*Delphinium luteum*
		384	Kellogg's horkelia	*Horkelia cuneata sericea*
		385	Thin-lobed horkelia	*Horkelia tenuiloba*
		387	Round-headed Chinese houses	*Collinsia corymbosa*
		390	San Francisco owl's-clover	*Triphysaria floribunda*
		391	Western leatherwood	*Dirca occidentalis*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		392	Mt. Diablo fairy-lantern	*Calochortus pulchellus*
		393	Tiburon mariposa lily	*Calochortus tiburonensis*
		394	Hillsborough chocolate lily	*Fritillaria biflora ineziana*
		395	Fragrant fritillary	*Fritillaria liliacea*
		401	Marin checker lily	*Fritillaria affinis tristulis*
		407	Texas ebony	*Pithecellobium flexicaule*
		410	Lundell's whitlow-wort	*Paronychia lundelliorum*
		414	Banara vanderbiltii	*Banara vanderbiltii*
		418	Eugenia woodburyana	*Eugenia woodburyana*
		420	Goetzea elegans	*Goetzea elegans*
		421	Harrisia portoricensis	*Harrisia portoricensis*
		422	Lyonia truncata proctorii	*Lyonia truncata proctorii*
		423	Myrcia paganii	*Myrcia paganii*
		424	Ottoschulzia rhodoxylon	*Ottoschulzia rhodoxylon*
		426	Schoepfia arenaria	*Schoepfia arenaria*
		427	Solanum drymophilum	*Solanum drymophilum*
		429	Vernonia proctorii	*Vernonia proctorii*
		430	Zanthoxylum thomasianum	*Zanthoxylum thomasianum*
		431	Adiantum vivesii	*Adiantum vivesii*
		432	Aristida chaseae	*Aristida chaseae*
		433	Aristida portoricensis	*Aristida portoricensis*
		434	Auerodendron pauciflorum	*Auerodendron pauciflorum*
		435	Buxus vahlii	*Buxus vahlii*
		436	Calyptranthes thomasiana	*Calyptranthes thomasiana*
		437	Cornutia obovata	*Cornutia obovata*
		438	Cyathea dryopteroides	*Cyathea dryopteroides*
		439	Daphnopsis hellerana	*Daphnopsis hellerana*
		440	Elaphoglossum serpens	*Elaphoglossum serpens*
		441	Eugenia haematocarpa	*Eugenia haematocarpa*
		444	Juglans jamaicensis	*Juglans jamaicensis*
		445	Lepanthes eltoroensis	*Lepanthes eltoroensis*
		446	Leptocereus grantianus	*Leptocereus grantianus*
		448	Mitracarpus maxwelliae	*Mitracarpus maxwelliae*
		449	Mitracarpus polycladus	*Mitracarpus polycladus*
		450	Peperomia wheeleri	*Peperomia wheeleri*
		451	Polygala cowellii	*Polygala cowellii*
		452	Styrax portoricensis	*Styrax portoricensis*
		455	Trichilia triacantha	*Trichilia triacantha*
		457	Chamaecrista glandulosa mirabilis	*Chamaecrista glandulosa mirabilis*
		462	Malpighia woodburyana	*Malpighia woodburyana*
		463	Brassavola cucullata	*Brassavola cucullata*
		464	Tillandsia lineatispica	*Tillandsia lineatispica*
		465	Psychilis macconelliae	*Psychilis macconelliae*
		466	West Indian treefern	*Cyathea arborea*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		468	Manilkara bidentata	*Manilkara bidentata*
		469	Schoepfia schreberi	*Schoepfia schreberi*
		471	Black calabash	*Amphitecna latifolia*
		472	Machaonia woodburyana	*Machaonia woodburyana*
		473	Malpighia sp.	*Malpighia sp.*
		474	Eugenia sp.	*Eugenia sp.*
		475	Byrsonima sp.	*Byrsonima sp.*
		476	Psidium sp.	*Psidium sp.*
		477	Apocynacae	*Apocynacae sp.*
		478	Peperomia myrtifolia	*Peperomia myrtifolia*
		480	Erythrina eggersii	*Erythrina eggersii*
		481	Galactia eggersii	*Galactia eggersii*
		482	Malpighia linearis	*Malpighia linearis*
		483	Ilex urbaniana	*Ilex urbaniana*
		484	Solanum mucronatum	*Solanum mucronatum*
		485	False mastic	*Sideroxylon foetidissimum*
		486	Malpighia infestissima	*Malpighia infestissima*
		487	Myrcianthis	*Myrcianthis fragerense*
		488	West Indian satinwood	*Zanthoxylum flavum*
		489	Wingleaf soapberry	*Sapindus saponaria*
		490	Zapote de costa	*Manilkara pleeana*
		491	Whitewood	*Coccoloba krugii*
		492	Guajacum officinale	*Guajacum officinale*
		493	Catesbaea melanocarpa	*Catesbaea melanocarpa*
		494	Maytenus cymosa	*Maytenus cymosa*
		495	Agave eggersiana	*Agave eggersiana*
		496	Nashia inaguensis	*Nashia inaguensis*
		497	Sloe	*Reynosia uncinata*
		498	West Indian falsebox	*Gyminda latifolia*
		499	Cranichis ricartii	*Cranichis ricartii*
		500	Tectaria estremerana	*Tectaria estremerana*
		501	Mammilaria nivosa	*Mammilaria nivosa*
		504	Coastal dune grassland	
		505	Coastal dune scrub thicket	
		506	Coastal live oak-hackberry forest	
		507	Coastal prairie	
		508	Longleaf pine savannah	
		509	Hardwood slope forest	
		510	Live oak forest	
		511	Pine flatwoods	
		512	Pine savannah	
		513	Prairie terrace loess forest	
		514	Salt dome	
		515	Slash pine/post oak forest	
		517	Spruce pine-hardwood mesic	

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
			flatwood	
		1012	Stabilized interior dunes	
		1013	Northern maritime chaparral	
		1014	Coastal terrace prairie	
		1015	Valley needlegrass grassland	
		1016	Serpentine bunchgrass	
		1018	Valley oak woodland	
		1022	Ruderal bayland	
		1023	Farmed/Grazed bayland	
HABITAT	wetland	5	Salt marsh bird's-beak	*Cordylanthus maritimus maritimus*
		6	Western lily	*Lilium occidentale*
		10	Coastal dunes milkvetch	*Astragalus tener titi*
		14	Smartweed	*Polygonum careyi*
		17	Bald-rush	*Psilocarya scirpoides*
		18	Clubmoss	*Lycopodium appressum*
		19	Crimsoneyed rosemallow	*Hibiscus mocheutos mocheutos*
		25	Moonwort	*Botrychium lunaria*
		27	Garber's sedge (Elk sedge)	*Carex garberi*
		28	Chestnut sedge	*Fimbristylis puberula*
		32	Smooth phlox	*Phlox glaberrima*
		33	Seaside crowfoot	*Ranunculus cymbalaria*
		34	Sand dune willow	*Salix cordata*
		36	False asphodel	*Tofieldia glutinosa*
		37	Houghton's goldenrod	*Solidago houghtonii*
		39	Small floating manna-grass	*Glyceria borealis*
		40	Silverweed	*Potentilla anserina*
		41	Scirpus-like rush	*Juncus scirpoides*
		43	Reticulated nutrush	*Scleria reticularis*
		45	Leafy northern green orchis	*Platanthera hyperborea*
		47	Zigzag bladderwort	*Utricularia subulata*
		49	Variegated horsetail	*Equisetum variegatum*
		57	Brown-fruited rush	*Juncus pelocarpus*
		58	Capitate spikerush	*Eleocharis geniculata*
		63	Lenticular sedge	*Carex lenticularis*
		65	Grass-of-parnassus	*Parnassia palustris*
		66	Coast sedge	*Carex exilis*
		67	Michaux's sedge	*Carex michauxiana*
		68	Lake cress	
		70	Pt. Reyes blennosperma	*Blennosperma nanum robustum*
		72	Soft bird's-beak	*Cordylanthus mollis mollis*
		73	Tamarack Swamp community	
		76	Mangrove	
		77	Intermittent coastal wetlands	
		86	Alligatorweed	*Alternanthera philoxeroides*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		87	Arrowhead	*Sagittaris spp.*
		88	Bald cypress	*Taxodium distichum*
		90	Black needlerush	*Juncus roemerianus*
		91	Bull-tongue	*Sagittaria lancifolia*
		92	Bulrush	*Scirpus spp.*
		93	California bulrush	*Scirpus californicus*
		94	Cattails	*Typha spp.*
		96	Common reed	*Phragmites australis*
		97	Cordgrass	*Spartina spp.*
		98	Cutgrass	*Leersia oryzoides*
		99	Dwarf spikerush	*Eleocharis parvula*
		100	Glasswort	*Salicornia spp.*
		101	High-tide bush	*Iva frutescens*
		103	Olney's three-square	*Scirpus americanus*
		104	Dwarf palmetto	*Sabal minor*
		106	Rushes	*Juncus spp.*
		107	Salt grass	*Distichlis spicata*
		108	Salt marsh bulrush	*Scirpus robustus*
		109	Salt meadow cordgrass (wiregrass)	*Spartina patens*
		110	Saltwort	*Batis maritima*
		111	Seashore paspalum	*Paspalum vaginatum*
		112	Smooth cordgrass	*Spartina alterniflora*
		113	Spikerushes	*Eleocharis spp.*
		114	Sundews	*Drosera spp.*
		115	Tupelo	*Nyssa spp.*
		117	Water oak	*Quercus nigra*
		119	Giant cutgrass (Southern wild rice)	*Zizaniopsis miliacea*
		123	Correll's false dragon-head	*Physostegia correllii*
		129	Runyon's waterwillow	*Justicia runyonii*
		134	Gulfdune paspalum	*Paspalum monostachyum*
		135	Smooth blue-star	*Amsonia glaberrima*
		144	Carolina grasswort	*Lilaeopsis carolinensis*
		145	Seabeach amaranth	*Amaranthus pumilus*
		146	Yellow fringeless orchid	*Platanthera integra*
		150	Bur-marigold	*Bidens bidentoides*
		151	Seaside alder	*Alnus maritima*
		152	American cupscale	*Sacciolepis striata*
		153	Awl-leaved rush	*Juncus coriaceus*
		154	Barton's St. John's-wort	*Hypericum adpressum*
		155	Black-based quillwort	*Isoetes melanopoda*
		156	Black-fruited spikerush	*Eleocharis melanocarpa*
		157	Bog asphodel	*Narthecium americanum*
		158	Boykin's lobelia	*Lobelia boykinii*
		160	Britton's spikerush	*Eleocharis brittonii*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		161	Clustered beaked rush	*Rhynchospora glomerata*
		162	Coast flatsedge	*Cyperus polystachyos*
		164	Cypress-swamp sedge	*Carex joorii*
		167	Fog fruit	*Phyla lanceolata*
		168	Glade spurge	*Euphorbia purpurea*
		169	Grass-like beaked rush	*Rhynchospora globularis*
		170	Knieskern's beaked rush	*Rhynchospora knieskernii*
		171	Koehn's tooth-cup	*Ammannia latifolia*
		172	Lace-lip ladies'-tresses	*Spiranthes laciniata*
		173	Larger buttonweed	*Diodia virginiana*
		175	Long's bulrush	*Scirpus longii*
		177	Delta mudwort	*Limosella subulata*
		178	New Jersey rush	*Juncus caesariensis*
		179	Pine Barren boneset	*Eupatorium resinosum*
		180	Pumpkin Ash	*Fraxinus profunda*
		181	Puttyroot	*Aplectrum hyemale*
		182	Rare-flowering beaked rush	*Rhynchospora rariflora*
		183	Red goosefoot	*Chenopodium rubrum*
		185	Rough cottongrass	*Eriophorum tenellum*
		188	Sea-beach milkwort	*Glaux maritima*
		190	Virginia joint-vetch	*Aeschynomene virginica*
		191	Short-fruited rush	*Juncus brachycarpus*
		194	Small-headed beaked rush	*Rhynchospora microcephala*
		195	Snowy orchid	*Platanthera nivea*
		196	Stinking fleabane	*Pluchea foetida*
		197	Stout smartweed	*Polygonum densiflorum*
		198	Swamp-pink	*Helonias bullata*
		199	Thread-leaved beaked rush	*Rhynchospora filifolia*
		200	Twisted spikerush	*Eleocharis tortilis*
		201	Virginia thistle	*Cirsium virginianum*
		202	Walter's St. John's-wort	*Triadenum walteri*
		203	Whorled nut rush	*Scleria verticillata*
		204	Wrinkled jointgrass	*Coelorachis rugosa*
		205	Alabama canebrake pitcher-plant	*Sarracenia rubra ssp. alabamensis*
		206	Saltmarsh spikerush	*Eleocharis halophila*
		208	Godfrey's sandwort	*Minuartia godfreyi*
		209	Spring flowering goldenrod	*Solidago verna*
		220	Prairie white-fringed orchid	*Platanthera leucophaea*
		224	Greenfly orchid	*Epidendrum conopseum*
		225	Dense-flowered groundsel-tree	*Baccharis glomeruliflora*
		227	Bartram's ixia	*Sphenostigma coelestina*
		228	Chapman's sedge	*Carex chapmanii*
		230	Fall-flowering pleat-leaf	*Nemastylis floridana*
		235	Florida willow	*Salix floridana*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		236	Florida hartwrightia	*Hartwrightia floridana*
		237	Lake-side sunflower	*Helianthus carnosus*
		238	Large-flowered grass-of-parnassus	*Parnassia grandifolia*
		239	Ocala vetch	*Vicia ocalensis*
		241	Piedmont jointgrass	*Mnesithea tuberculosa*
		242	Pond spice	*Litsea aestivalis*
		243	Scrub bay	*Persea humilis*
		245	Slender-leaved dragon-head	*Physostegia leptophylla*
		246	Southern milkweed	*Asclepias viridula*
		247	Catesby's lily	*Lilium catesbaei*
		248	Spoon-flower	*Peltandra sagittifolia*
		249	St. John's susan	*Rudbeckia nitida*
		250	Yellow star anise	*Illicium parviflorum*
		251	Variable-leaf crownbeard	*Verbesina heterophylla*
		257	Rare wetland/aquatic plant	
		258	Threatened wetland/aquatic plant	
		259	Gulf cordgrass	*Spartina spartinae*
		260	Key grass (shoregrass)	*Monanthochloe littoralis*
		261	Sea ox-eye daisy	*Borrichia frutescens*
		262	Groundsel tree	*Baccharis halimifolia*
		264	Sea-blite	*Suaeda spp.*
		266	Black mangrove	*Avicennia germinans*
		268	Salt marsh bulrush	*Scirpus maritimus*
		269	Sea lavender	*Limonium carolinianum*
		270	Coastal dropseed	*Sporobolus virginicus*
		275	Redbay	*Persea borbonia*
		276	Marshelder dodder	*Cuscuta attenuata*
		277	Roughseed sea-purslane	*Sesuvium trianthemoides*
		285	Camphor daisy	*Machaeranthera phyllocephala*
		286	Sea purslane	*Sesuvium portulacastrum*
		321	Cypress tupelo swamp	
		322	Mason's lilaeopsis	*Lilaeopsis masonii*
		323	Adobe sanicle	*Sanicula maritima*
		324	Suisun marsh aster	*Aster lentus*
		325	Sonoma sunshine	*Blennosperma bakeri*
		327	Fountain thistle	*Cirsium fontinale fontinale*
		328	Suisun thistle	*Cirsium hydrophilum hydrophilum*
		329	Mt. Tamalpais thistle	*Cirsium hydrophilum vaseyi*
		336	Contra Costa goldfields	*Lasthenia conjugens*
		344	San Francisco popcorn-flower	*Plagiobothrys diffusus*
		350	Dwarf downingia	*Downingia pusilla*
		351	Legenere	*Legenere limosa*
		352	Marsh sandwort	*Arenaria paludicola*
		356	California seablite	*Suaeda californica*
		365	Alkali milk-vetch	*Astragalus tener tener*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		366	Delta tule pea	*Lathyrus jepsonii jepsonii*
		371	Point Reyes checkerbloom	*Sidalcea calycosa rhizomata*
		372	Marin checkerbloom	*Sidalcea hickmanii viridis*
		381	Baker's navarretia	*Navarretia leucocephala bakeri*
		382	Marin County navarretia	*Navarretia rosulata*
		386	Tiburon indian paintbrush	*Castilleja affinis neglecta*
		388	Point Reyes bird's-beak	*Cordylanthus maritimus palustris*
		389	Hispid bird's-beak	*Cordylanthus mollis hispidus*
		396	Yellowray goldfields	*Lasthenia glabrata*
		397	Ambiguous indian paintbrush	*Castilleja ambigua*
		399	Nootka alkaligrass	*Puccinellia nutkaensis*
		400	Mojave seablite	*Suaeda moquinii*
		402	North coast semaphore grass	*Pleuropogon hooverianus*
		404	Texas palmetto	*Sabel mexicana*
		405	Black willow	*Salix nigra*
		406	Anacua	*Ehretia anacua*
		408	Snake-eyes	*Phaulothamnus spinescens*
		415	Callicarpa ampla	*Callicarpa ampla*
		416	Calyptronoma rivalis	*Calyptronoma rivalis*
		417	Crescentia portoricensis	*Crescentia portoricensis*
		419	Gesneria pauciflora	*Gesneria pauciflora*
		425	Pterocarpus swamp	*Pterocarpus officinalis*
		428	Stahlia monosperma	*Stahlia monosperma*
		442	Ilex cookii	*Ilex cookii*
		443	Ilex sintenisii	*Ilex sintenisii*
		447	Lunania ekmanii	*Lunania ekmanii*
		453	Ternstroemia luquillensis	*Ternstroemia luquillensis*
		454	Ternstroemia subsessilis	*Ternstroemia subsessilis*
		458	Thelypteris verecunda	*Thelypteris verecunda*
		459	Pleodendron macranthum	*Pleodendron macranthum*
		460	Thelypteris inabonensis	*Thelypteris inabonensis*
		461	Thelypteris yaucoensis	*Thelypteris yaucoensis*
		467	Inland leatherfern	*Acrostichum danaeifolium*
		470	Pond apple	*Annona glabra*
		479	Cypselea humifusa	*Cypselea humifusa*
		502	Eastern gamagrass	*Tripsarum dactyloides*
		503	Sea pink	*Sabatia stellaris*
		516	Slash pine-cypress/hardwood forest	
		600	Whorled milkwort	*Polygala verticillata*
		1001	Salt-brackish marsh	
		1002	Freshwater marsh	
		1003	Forested wetland	
		1004	Rice field	
		1005	Palustrine scrub-shrub	

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		1006	Estuarine scrub-shrub	
		1008	Intermediate marsh	
		1009	Brackish marsh	
		1010	Salt marsh	
		1011	Willow grove (sausal)	
		1017	Vernal pool	
		1019	Tidal marsh	
		1020	Muted tidal marsh	
		1021	Diked marsh	
		1024	Managed marsh	
		1026	Salt pond	
		1027	Storage/Treatment pond	
		1029	Vernal pool plants	
		1035	Sea level fen	
		1037	Freshwater tidal marsh	
		1038	Maritime holly forest	
		1051	Scrub-shrub wetland	
INVERT	barnacle	282	Ribbed barnacles	*Tetraclita spp.*
INVERT	bivalve	1	Washington clam	*Saxidomus nuttallii*
		18	Pismo clam	*Tivela stultorum*
		19	Blue mussel	*Mytilus edulis*
		20	California mussel	*Mytilus californianus*
		21	Washington butter clam	*Saxidomus giganteus*
		22	Common egg cockel	*Laevicardium laevigatum*
		23	Horse clam	*Tresus capax*
		24	Gaper clam	*Tresus nuttallii*
		25	Softshell clam	*Mya arenaria*
		26	Japanese littleneck clam	*Tapes philippinarum*
		27	Flat-tipped piddock (rock)	*Penitella penita*
		28	Pacific razor clam	*Siliqua patula*
		29	Pacific littleneck	*Protothaca staminea*
		32	Geoduck	*Panope generosa*
		33	Spiny scallop	*Chlamys hastata*
		34	Sea scallop	*Placopecten magellanicus*
		35	Rock scallop	*Hinnites multirugosus*
		36	Reddish scallop	*Chlamys rubida*
		38	Native Pacific oyster	*Ostrea lurida*
		41	Bay scallop	*Argopecten irradians*
		42	Northern quahog (hard clam)	*Mercenaria mercenaria*
		43	Eastern oyster	*Crassostrea virginica*
		48	Arctic surfclam	*Mactromeris polynyma*
		52	Bean clam	*Donax gouldii*
		56	Wart-necked piddock	
		58	Sunset clam	*Gari californica*
		59	Rough-sided little-necked clam	*Palphia staminea*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		66	California jackknife clam	*Tagelus californianus*
		67	Spiny cockle	*Cardium quadrigenarium*
		68	Clipped semele clam	*Semele sp.*
		76	Nuttall cockle	*Clinocardium nuttallii*
		77	Atlantic jackknife clam	*Ensis directus*
		79	Pacific oyster	*Crassostrea gigas*
		80	Ribbed mussel	*Geukensia demissa*
		81	Nothern horsemussel	*Modiolus modiolus*
		82	Brackishwater clam	*Rangia cuneata*
		89	Speckled scallop	*Argopectin circularis*
		94	Southern quahog (hard clam)	*Mercenaria campechiensis*
		95	Dwarf surf clam	*Mulinia lateralis*
		98	Mussel	*Lithophaga sp.*
		100	Quahog (hard clam)	*Mercenaria spp.*
		102	Calico scallop	*Argopecten gibbus*
		104	Mississippi pigtoe	*Pleurobema beadleanum*
		105	White heelsplitter	*Lasmigona complanata complanata*
		106	Alabama spike	*Elliptio arca*
		107	Squawfoot	*Strophitus undulatus*
		108	Alabama hickorynut	*Obovaria unicolor*
		117	St. Johns elephantear	*Elliptio monroensis*
		118	Florida lance	*Elliptio waltoni*
		125	Coquinas	*Donax spp.*
		131	Oysters	*Ostrea spp.*
		132	Pearl oyster	*Pinctada mazatlanica*
		134		*Anadara grandis*
		135		*Anadara similis*
		136		*Anadara tuberculosa*
		137		*Brachydontes semilaevis*
		139	Mussel	*Mytella sp.*
		140		*Mytella guyanensis*
		141		*Mytella strigata*
		142		*Ostrea corteziensis*
		143		*Ostrea iridescens*
		144		*Ostrea palmula*
		173	Disjunct cleftclam	*Conchocele disjuncta*
		174	Broad yoldia	*Yoldia thraciaeformis*
		175	Crisscrossed yoldia	*Yoldia scissurata*
		176	Trenched nutclam	*Nuculana fossa*
		177	Elegant softshell clam	*Mya elegans*
		178	Truncate softshell clam	*Mya truncata*
		179	False softshell clam	*Mya pseudoarenaria*
		180	Siberia softshell clam	*Mya uzenensis*
		181	Alaska razor clam	*Siliqua alta*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		182	Arctic roughmya	*Panomya arctica*
		183	Ample roughmya	*Panomya ampla*
		184	Arctic hiatella	*Hiatella arctica*
		185	Crenulate astarte	*Astarte crenata*
		186	Boreal tridonta	*Tridonta borealis*
		187	Alaska great tellin	*Tellina lutea*
		188	Bent-nose macoma	*Macoma nasuta*
		189	Chalky macoma	*Macoma calcarea*
		190	Heavy macoma	*Macoma brota*
		191	Flat macoma	*Macoma moesta*
		257	Black mussel	*Musculus niger*
		258	Discordant mussel	*Musculus discors*
		259	Weathervane scallop	*Patinopectin caurinus*
		260	Arctic pink scallop	*Chlamys pseudislandica*
		278	Edible brown mussel	*Perna perna*
		286	Ocean quahog	*Arctica islandica*
		287	Atlantic surfclam	*Spisula solidissima*
		312	Dark falsemussel	*Mytilopsis leucophaeata*
		339	Many-ribbed arc	*Anadara multicostata*
		340	Blood arc	*Anadara nux*
		355		*Chama frondosa*
		358		*Ostrea angelica*
		359		*Ostrea columbiensis*
		360		*Ostrea conchaphila*
		361		*Ostrea fisheri*
		362		*Ostrea megodon*
		363		*Chama echinata*
		364		*Chama buddiana*
		367	Eastern pondmussel	*Ligumia nasuta*
		377	Tidewater mucket	*Leptodea ochracea*
		380	Rare freshwater mussel	
		381	Threatened freshwater mussel	
		401	Rock oyster	*Chama iostoma*
		410	Hawaiian mussel	*Brachidontes crebristriatus*
		413	Black-lipped pearl oyster	*Pinctada margaritifera*
		426	False 'opihi	*Siphonaria normalis*
		427	Hawaiian oyster	*Ostrea sandvicensis*
		432	Macoma spp.	*Macoma spp.*
		433	Spiny oyster	*Spondylus nicobaricus*
		1013	Bivalves	
		1015	Mussels	
		1044	Endangered bivalve	
INVERT	cephalopod	30	Octopus	*Octopus spp.*
		37	Pacific Coast squid	*Loligo opalescens*
		73	Longfin squid	*Loligo pealeii*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		119	Bay squid	*Lolliguncula brevis*
		123	Two-spotted octopus	*Octopus bimaculatus*
		124	Common Atlantic octopus	*Octopus vulgaris*
		145		*Octopus chierchiae*
		170	Eastern Pacific bobtail squid	*Rossia pacifica*
		171	Magistrate armhook squid	*Berryteuthis magister*
		172	Giant octopus	*Octopus dofleini*
		281	Dart squid	*Loliolopsis diomedeae*
		322	Squid	*Loligo spp.*
		382	Day octopus	*Octopus cyanea*
		1030	Octopus	
INVERT	chordate	146		*Urochordata*
INVERT	crab	13	Flame-streaked box crab	*Calappa flammea*
		14	Dungeness crab	*Cancer magister*
		15	Striped shore crab	*Pachygrapsus crassipes*
		16	Puget Sound king crab	*Paralithodes sp.*
		17	Northern kelp crab	*Pugettia producta*
		39	Red king crab	*Paralithodes camtschaticus*
		40	Tanner crab	*Chionoecetes bairdi*
		44	Horseshoe crab	*Limulus polyphemus*
		49	Blue crab	*Callinectes sapidus*
		53	Red rock crab	*Cancer productus*
		57	Pacific rock crab	*Cancer antennarius*
		70	Purple shore crab	*Hemigrapsus nudus*
		74	Stone crab	*Menippe spp.*
		75	Golden king crab	*Lithodes aequispina*
		88	Samoan crab	*Scylla serrata*
		91	Rock crabs	
		96	Ghost crab	*Ocypode quadrata*
		99	Surf crab	*Arenaeus cribrarius*
		120	Gulf stone crab	*Menippe adina*
		121	Lesser blue crab	*Callinectes similis*
		126	Blue crabs	*Callinectes spp.*
		127	Blackback land crab	*Gecarcinus lateralis*
		147	Giant land crab	*Cardisoma crassum*
		148		*Menippe frontalis*
		149	Mangrove crab	*Ucides occidentalis*
		192	Blue king crab	*Paralithodes platypus*
		193	Scarlet king crab	*Lithodes couesi*
		194	Brown box crab	*Lopholithodes foraminatus*
		195	Red box crab	*Lopholithodes mandtii*
		196	Rhinoceros crab	*Rhinolithodes wosnessenskii*
		197	Flatspine triangle crab	*Phyllolithodes papillosus*
		198	Fuzzy crab	*Acantholithodes hispidus*
		199	Soft crab	*Hapalogaster grebnitzkii*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		200	Scaled crab	*Placetron wosnessenskii*
		201	Pinch bug	*Munida quadrispina*
		202	Snow crab	*Chionoecetes opilio*
		203	Grooved tanner crab	*Chionoecetes tanneri*
		204	Triangle tanner crab	*Chionoecetes angulatus*
		205	Graceful kelp crab	*Pugettia gracilis*
		206	Arctic lyre crab	*Hyas coarctatus*
		207	Pacific lyre crab	*Hyas lyratus*
		208	Pygmy rock crab	*Cancer oregonensis*
		209	Hair crab	*Erimacrus isenbeckii*
		210	Helmet crab	*Telmessus cheiragonus*
		211	Graceful decorator crab	*Oregonia gracilis*
		212	Splendid hermit	*Labidochirus splendescens*
		213	Wideband hermit	*Elassochirus tenuimanus*
		214	Purple hermit	*Elassochirus cavimanus*
		215	Pacific red hermit	*Elassochirus gilli*
		216	Aleutian hermit	*Pagurus aleuticus*
		217	Alaskan hermit	*Pagurus ochotensis*
		218	Hermit crab	*Pagurus spp.*
		284	Brown king	
		303	Atlantic rock crab	*Cancer irroratus*
		304	Green crab	*Carcinus maenas*
		305	Jonah crab	*Cancer borealis*
		308	Gulf grassflat crab	*Dyspanopeus texana*
		309	Freshwater crab	*Epilobocera sinuatifrons*
		313	Swamp ghost crab (zambuco)	*Ucides cordatus*
		314	Blue land crab	*Cardisoma guanhumi*
		320	Swimming crab	*Charybdis longicollis*
		324	Purple land crab	*Gecarcinus ruricola*
		332		*Calappa convexa*
		333	Armed box crab	*Mursia gaudichaudii*
		334		*Arenaeus mexicanus*
		335		*Enphylax dovii*
		336		*Eurytium affine*
		337		*Gecarcinus quadratus*
		338		*Clibanarius panamensis*
		345	Arched swimming crab	*Callinectes arcuatus*
		346		*Callinectes toxotes*
		347		*Portunus panamensis*
		348		*Panopeus herbstedii*
		350		*Lithodes panamensis*
		352		*Cancer johngarthi*
		353		*Coenobita compressa*
		354	Pacific sand crab	*Emerita analoga*
		357		*Emerita rathbunae*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		383	Blood-spotted swimming crab	*Portunus sanguinolentus*
		411	Kona crab	*Ranina ranina*
		412	Thin-shelled rock crab	*Grapsus tenuicrustatus*
		1001	Crabs	
		1014	Land crabs	
		1024	Hermit crabs	
		1025	Swimming crabs	
		1038	Xanthid crabs	
INVERT	crayfish	78	Western Pacific crayfish	*Pacifastacus leniusculus*
		83	White river crawfish	*Procambarus acutus*
		84	Red swamp crawfish	*Procambarus clarkii*
		85	Pacific river crayfish	*Pacifistacus trowbridgil*
		103	Camp Shelby burrowing crawfish	*Fallicambarus gordoni*
		109	Black Creek crayfish	*Procambarus pictus*
		110	Big-cheeked cave crayfish	*Procambarus delicatus*
		116	Silver Glen Springs cave crayfish	*Procambarus attiguus*
		379	Rare crayfish	
INVERT	echinoderm	86	Red sea urchin	*Strongylocentrotus franciscanus*
		128	Impatient sea cucumber	*Holothuria impatiens*
		129	Panama brittle star	*Ophioderma panamense*
		150	Basket stars	*Astrodictyum spp.*
		151		*Diadema mexicanum*
		152		*Echinometra vanbrunti*
		153		*Holothuria inhabilis*
		154		*Mellitella sp.*
		155		*Mellitella stokesii*
		156		*Ophiocoma aethiops*
		157		*Ophiocoma alexandri*
		159		*Pharia pyramidata*
		160		*Phataria unifascialis*
		161	Sulfur sea cucumber	*Selenkothuria lubrica*
		162	Central Gulf sea urchin	*Toxopneustes roseus*
		219	Green urchin	*Strongylocentrotus droebachiensis*
		220	Fragile urchin	*Allocentrotus fragilis*
		221	Heart urchin	*Brisaster latifrons*
		283		*Encope micropora*
		307	Lined sea star	*Luidia clathrata*
		384	Banded urchin	*Echinothrix calamaris*
		385	Blue-black urchin	*Echinothrix diadema*
		386	Collector urchin	*Tripneustes gratilla*
		387	Cushion star	*Culcita novaeguineae*
		388	Helmet urchin	*Colobocentrotus atratus*
		389	Long-spined urchin	*Diadema paucispinum*
		390	Rock-boring urchin	*Echinometra mathaei*
		391	Needle-spined urchin	*Echinostrephus aciculatus*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		392	Ten-lined urchin	*Eucidaris metularia*
		428	Oblong urchin	*Echinometra oblonga*
		429	Pebble collector urchin	*Pseudoboletia indiana*
		430	Red pencil urchin	*Heterocentrotus mammillatus*
		434	Crown-of-thorns starfish	*Acanthaster planci*
		1009	Sea urchins	
		1010	Echinoderms	
		1012	Sea cucumbers	
		1032	Starfish	
INVERT	gastropod	31	Japanese abalone	*Haliotis kamtschatkana*
		46	Channeled whelk	*Busycon canaliculatum*
		47	Knobbed whelk	*Busycon carica*
		55	Wavy top snail	*Astraea undosa*
		60	Abalone	*Haliotis spp.*
		61	Red abalone	*Haliotis rufescens*
		62	Black abalone	*Haliotis cracherodii*
		63	Green abalone	*Haliotis fulgens*
		64	White abalone	*Haliotis sorenseni*
		65	Pink abalone	*Haliotis corrugata*
		87	California brackishwater snail	*Tryonia imitator*
		90	Lightning whelk	*Busycon contrarium*
		101	Queen conch	*Strombus gigas*
		111	Blue Spring hydrobe	*Aphaostracon asthenes*
		112	Blue Spring siltsnail	*Cincinnatia parva*
		113	Dense hydrobe	*Aphaostracon pycnus*
		114	Enterprise siltsnail	*Cincinnatia monroensis*
		130	California sea hare	*Aplysia californica*
		163		*Acanthina brevidentada*
		164		*Fasciolaria princeps*
		165	Rock shells	*Purpura spp.*
		222	Great slippersnail	*Crepidula grandis*
		223	Arctic moonsnail	*Natica clausa*
		224	Rusty moonsnail	*Natica russa*
		225	Pale moonsnail	*Polinices pallidus*
		226	Oregon triton	*Fusitriton oregonensis*
		227	Alaska volute	*Arctomelon stearnsii*
		228	Oblique whelk	*Colus hypolispus*
		229	Hall's colus	*Colus halli*
		230	Keeled aforia	*Aforia circinata*
		231	Dall's drill	*Eupleura muriciformis*
		232	Polar whelk	*Buccinum polare*
		233	Angular whelk	*Buccinum angulosum*
		234	Sinuous whelk	*Buccinum plectrum*
		235	Ladder whelk	*Buccinum scalariforme*
		236	Helmut whelk	*Neptunea magna*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		237	Lyre whelk	*Neptunea lyrata*
		238	Pribilof whelk	*Neptunea pribiloffensis*
		239	Fat whelk	*Neptunea ventricosa*
		240	Northern neptune	*Neptunea heros*
		241	Little neptune	*Neptunea communis*
		242	Warped whelk	*Volutopsius deformis*
		243	Left-handed whelk	*Volutopsius harpa*
		244	Large melon whelk	*Volutopsius melonis*
		245	Fragile whelk	*Volutopsius fragilis*
		246	Tulip whelk	*Volutopsius middendorffii*
		247	Shouldered whelk	*Volutopsius stefanssoni*
		248	Volute whelk	*Volutopsius castaneus*
		249	Threaded whelk	*Volutopsius filosus*
		250	Kennicott's beringius	*Beringius kennicottii*
		251	Northern beringius	*Beringius beringii*
		252	Stimpson's beringius	*Beringius stimpsoni*
		253	Friele's beringius	*Beringius frielei*
		254	Kroyer's plicifis	*Plicifusus kroyeri*
		255	Thick-ribbed whelk	*Colus spitzbergensis*
		256	Thin-ribbed whelk	*Colus herendeenii*
		302	Bridges' coast range shoulderband	*Helminthoglypta nickliniana bridgesi*
		311	West Indian topsnail (whelk)	*Cittarium pica*
		317	Florida tree snail	*Liguus fasciatus*
		341		*Strombus galeatus*
		342		*Strombus glacilior*
		343		*Strombus peruvianus*
		349		*Melongena patula*
		366	Woodland pondsnail	*Stagnicola catascopium*
		368	Virginia river snail	*Elimia virginica*
		369	Turret snail	*Valvata tricarinata*
		393	Hihiwai (snail)	*Neritina granosa*
		394	Newcomb's snail	*Errina newcombi*
		402	Hapawai (snail)	*Neritina vespertina*
		404	Pipiwai (snail)	*Theodoxus cariosus*
		406	Ancylid	*Ferrissia sharpi*
		407	Red-rim melania	*Melanoides tuberculatus*
		423	Anchialine pool snail	*Neritilia hawaiiensis*
		424	Anchialine pool snail	*Neritilia sp 1*
		425	Anchialine pool snail	*Neritilia sp B*
		1029	Limpets	
		1031	Lymnaied snails	
		1033	Neretid snails	
		1034	Purse shells	
		1036	Sea slugs	

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		1037	Sea snails	
		1041	Gastropods	
INVERT	insect	115	Scrub tiger beetle	*Cicindela scabrosa*
		285	Northeastern beach tiger beetle	*Cicindela dorsalis dorsalis*
		291	Bumblebee scarab beetle	*Lichnanthe ursina*
		292	Antioch efferian robberfly	*Efferia antiochi*
		293	Antioch andrenid bee	*Perdita scituta antiochensis*
		294	San Bruno elfin butterfly	*Incisalia mossii bayensis*
		295	Mission blue butterfly	*Icaricia icariodes missionensis*
		296	Lange's metalmark butterfly	*Apodemia mormo langei*
		297	Callippe silverspot butterfly	*Speyeria callippe callippe*
		298	Bay checkerspot butterfly	*Euphydryas editha bayensis*
		299	Middlekauf's shieldback katydid	*Idiostatus middlekaufi*
		300	Tiburon micro-blind harvestman	*Microcina tiburona*
		301	Edgewood blind harvestman	*Calicina minor*
		316	Water boatman	*Trichorixa reticulata*
		370	Maritime sunflower borer	*Papaipema maritima*
		371	Mottled duskywing	*Erynnis martialis*
		372	Goldenrod stem borer	*Papaipema duovata*
		373	Claybanks tiger beetle	*Cicindela limbalis*
		374	Saltmarsh tiger beetle	*Cicindela marginata*
		375	Puritan tiger beetle	*Cicindela puritana*
		376	Tiger beetle	*Cicindela tranquebarica*
		378	Rare insect	
		405	Blackburn's sphinx moth	*Manduca blackburni*
INVERT	invert	93	Crustaceans	
		158	Tomales isopod	*Caecidotea tomalensis*
		400	Feather duster worm	*Sabellastarte sanctijosephi*
		431	Vagabond boring sponge	*Spirastrella vagabunda*
		1003	Molluscs	
		1004	Cnidarians	
		1005	Ctenophores	
		1006	Amphipods	
		1007	Polychaetes	
		1008	Bryozoans	
		1026	Endangered invertebrate	
		1027	Sponges	
		1028	Tidepool invertebrates	
		1039	Intertidal invertebrates	
		1040	Blue sponge	
		1042	Unique invertebrate assemblage	
		1043	Invertebrates	
		1046	Zoanthids	
		1047	Rare sponges	
INVERT	lobster	45	American lobster	*Homarus americanus*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		54	California spiny lobster	*Panulirus interruptus*
		72	Caribbean spiny lobster	*Panulirus argus*
		166	Spiny lobster	*Panulirus gracilis*
		323	Blue spiny lobster	*Panulirus inflatus*
		344		*Panulirus spp.*
		356	Squat lobster	*Munida sp.*
		365	Squat lobster	*Munidopsis sp.*
		395	Banded spiny lobster	*Panulirus marginatus*
		403	Tufted spiny lobster	*Panulirus penicillatus*
		414	Ridgeback slipper lobster	*Scyllarides haanii*
		415	Scaly slipper lobster	*Scyllarides squammosus*
		1045	Slipper lobsters	
INVERT	shellfish	1002	Shellfish	
INVERT	shrimp	2	Vernal pool tadpole shrimp	*Lepidurus packardi*
		3	California bay shrimp	*Crangon franciscorum*
		4	Pink shrimp	*Penaeus duorarum*
		5	Ocean pink shrimp	*Pandalus jordani*
		6	Northern shrimp	*Pandalus borealis*
		7	Sidestripe shrimp	*Pandalopsis dispar*
		8	Spot shrimp	*Pandalus platyceros*
		9	Blacktail bay shrimp	*Crangon nigricauda*
		10	Humpy shrimp	*Pandalus goniurus*
		11	Dock shrimp	*Pandalus danae*
		12	Broken-back shrimp	*Heptacarpus spp.*
		50	White shrimp	*Penaeus setiferus*
		51	Brown shrimp	*Penaeus aztecus*
		69	Bay ghost shrimp	*Callianassa californiensis*
		71	Rock shrimp	*Sicyonia brevirostris*
		92	Penaeid shrimp	*Penaeus spp.*
		97	Grass shrimp	*Palaemonetes spp.*
		122	Mantis shrimp	*Squilla empusa*
		133	Blue shrimp	*Penaeus stylirostris*
		138	Vernal pool fairy shrimp	*Branchinecta lynchi*
		167		*Atya crassa*
		168		*Macrobrachium tenellum*
		169	White shrimp	*Penaeus vannamei*
		261	Coonstriped shrimp	*Pandalus hypsinotus*
		262	Yellowleg pandalid	*Pandulus tridens*
		263	Shortscale eualid	*Eualus suckleyi*
		264	Arctic eualid	*Eualus fabricii*
		265	Greenland shrimp	*Eualus macilentus*
		266	Circumpolar eualid	*Eualus gaimardii*
		267	Barbed eualid	*Eualus barbatus*
		268	Stiletto coastal shrimp	*Heptacarpus stylus*
		269	Stout coastal shrimp	*Heptacarpus brevirostris*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		270	Spiny lebbeid	*Lebbeus groenlandicus*
		271	Polar lebbeid	*Lebbeus polaris*
		272	Arctic argid	*Argis dentata*
		273	Kuro shrimp	*Argis lar*
		274	Twospine crangon	*Crangon communis*
		275	Ridged crangon	*Crangon dalli*
		276	Sevenspine bay shrimp	*Crangon septemspinosa*
		277	Sculptured shrimp	*Sclerocrangon boreas*
		279		*Xiphopenaeus riveti*
		280	Roughback shrimp	*Trachypenaeus similis pacificus*
		288	Florida stone crab	*Menippe mercenaria*
		289	Daggerblade grass shrimp	*Palaemonetes pugio*
		290	California freshwater shrimp	*Syncaris pacifica*
		306	Ghost shrimp	*Callianassa spp.*
		310	Mona Island shrimp	*Typhlatya monensis*
		315	Southern pink shrimp	*Penaeus notialis*
		318	Kuruma prawn	*Penaeus japonicus*
		319	Penaeus monoceros	*Penaeus monoceros*
		321	Caramote prawn	*Penaeus kerathurus*
		325	Pink shrimp	*Penaeus brevirostris*
		326	Yellowleg shrimp	*Penaeus californiensis*
		327	Western white shrimp	*Penaeus occidentalis*
		328	Carabali shrimp	*Trachypenaeus byrdi*
		329	Indio shrimp	*Trachypenaeus faoe*
		330	Pinto shrimp	*Trachypenaeus fuscina*
		331	Chilean knife shrimp	*Haliporoides diomedeae*
		351	Cauque river prawn	*Macrobrachium americanum*
		396	'O'pae kala'ole (shrimp)	*Atyoida bisulcata*
		397	Mantis shrimp	*Gonadactylus falcatus*
		398	'O'pae 'oeha'a (prawn)	*Macrobrachium grandimanus*
		399	Tahitian prawn	*Macrobrachium lar*
		408	River shrimp	*Macrobrachium sp.*
		409	Banded coral shrimp	*Stenopus hispidus*
		416	Anchialine pool shrimp	*Antecaridina lauensis*
		417	Anchialine pool shrimp	*Halocaridina palahemo*
		418	Anchialine pool shrimp	*Procaris hawaiana*
		419	Anchialine pool shrimp	*Vetericaris chaceorum*
		420	Anchialine pool shrimp	*Calliasmata pholidota*
		421	Anchialine pool shrimp	*Palaemonella burnsi*
		422	Anchialine pool shrimp	*Metabetaeus lohena*
		1011	Native stream shrimp	
		1035	Saltwater shrimp	
M_MAMMAL	dolphin	6	Harbor porpoise	*Phocoena phocoena*
		17	Bottlenose dolphin	*Tursiops truncatus*
		20	Northern right-whale dolphin	*Lissodelphis borealis*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		21	Atlantic spotted dolphin	*Stenella plagiodon*
		45	Pacific white-sided dolphin	*Lagenorhynchus obliquidens*
		46	Risso's dolphin	*Grampus griseus*
		47	Dall's porpoise	*Phocoenoides dalli dalli*
		49	Spotted dolphin	*Stenella attenuata*
		50	Spinner dolphin	*Stenella longirostris*
		60	Saddle-backed dolphin	*Delphinus delphis*
		61	Stenellid dolphin	*Stenella sp.*
		86	Atlantic white-sided dolphin	*Lagenorhynchus acutus*
		87	Rough-toothed dolphin	*Steno bredanensis*
		100	Striped dolphin	*Stenella coeruleoalba*
		101	Dolphin	
		1001	Dolphins	
M_MAMMAL	manatee	10	West Indian manatee	*Trichechus manatus*
M_MAMMAL	pinniped	1	Steller (Northern) sea lion	*Eumetopias jubatus*
		2	Harbor seal	*Phoca vitulina*
		3	Northern fur seal	*Callorhinus ursinus*
		14	Gray seal	*Halichoerus grypus*
		15	Bearded seal	*Erignathus barbatus*
		16	Walrus	*Odobenus rosmarus*
		22	California sea lion	*Zalophus californianus*
		23	Guadalupe fur seal	*Arctocephalus townsendi*
		24	Northern elephant seal	*Mirounga angustirostris*
		51	Hawaiian monk seal	*Monachus schauinslandi*
		84	Hooded seal	*Cystophora cristata*
		85	Harp seal	*Pagophilus groenlandicus*
		91	Spotted seal	*Phoca largha*
		92	Ringed seal	*Pusa hispida*
		93	Ribbon seal	*Histriophoca fasciata*
		94	Pacific walrus	*Odobenus rosmarus divergens*
		99	Pacific harbor seal	*Phoca vitulina richardsi*
		1002	Seals	
M_MAMMAL	polar bear	90	Polar bear	*Ursus maritimus*
M_MAMMAL	sea_otter	7	Sea otter	*Enhydra lutris*
M_MAMMAL	whale	4	Killer whale	*Orcinus orca*
		5	Melon-headed whale	*Peponocephala electra*
		9	Beluga whale	*Delphinapterus leucas*
		11	Fin whale	*Balaenoptera physalus*
		12	Minke whale	*Balaenoptera acutorostrata*
		13	Humpback whale	*Megaptera novaeangliae*
		18	Pygmy sperm whale	*Kogia breviceps*
		19	Shortfin pilot whale	*Globicephala macrorhynchus*
		26	Gray whale	*Eschrichtius robustus*
		27	Sei whale	*Balaenoptera borealis*
		29	Blue whale	*Balaenoptera musculus*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		48	Sperm whale	*Physeter macrocephalus*
		81	Northern right whale	*Eubalaena glacialis*
		82	Dwarf sperm whale	*Kogia simus*
		83	Long-finned pilot whale	*Globicephala melaena*
		88	Bryde's whale	*Balaenoptera edeni*
		89	Endangered whale	
		95	Bowhead whale	*Balaena mysticetus*
		96	Goose-beaked whale	*Ziphius cavirostris*
		97	Bering Sea beaked whale	*Mesoplodon stejnegeri*
		98	North Pacific Bottle-nosed whale	*Berardius bairdii*
		102	False killer whale	*Pseudorca crassidens*
		1000	Whales	
REPTILE	alligator	1	American crocodile	*Crocodylus acutus*
		3	American alligator	*Alligator mississippiensis*
		43	Spectacled caiman	*Caiman crocodilus*
REPTILE	amphibian	14	Crawfish frog	*Rana areolata*
		15	Pig frog	*Rana grylio*
		27	Mud salamander	*Pseudotriton montanus*
		28	Red salamander	*Pseudotriton ruber*
		29	Florida gopher frog	*Rana capito aesopus*
		33	Rare frog	
		36	Rare salamander	
		41	Black-spotted newt	*Notophthalmus meridionalis*
		42	Sheep frog	*Hypopachus variolosus*
		53	California tiger salamander	*Ambystoma californiense*
		54	California red-legged frog	*Rana aurora draytonii*
		55	California toad	*Bufo boreas halophilus*
		56	Pacific treefrog	*Hyla regilla*
		61	Foothill yellow-legged frog	*Rana boylii*
		70	Guajon	*Eleutherodactylus cooki*
		71	Mottled coqui	*Eleutherodactylus eneidae*
		72	Golden coqui	*Eleutherodactylus jasperi*
		73	Web-footed coqui	*Eleutherodactylus karlschmidti*
		77	Puerto Rican crested toad	*Peltophryne lemur*
		80	Mona coqui	*Eleutherodactylus monensis*
		82	Burrow coqui	*Eleutherodactylus unicolor*
		83	Warty coqui	*Eleutherodactylus locustus*
		84	Ground coqui	*Eleutherodactylus richmondi*
		90	Highland frog	*Rana maculata*
		97	Tungara frog	*Physalaemus pustulosus*
		100	Giant toad	*Bufo marinus*
		108	Rare reptile/amphibian	
		109	Endangered reptile/amphibian	
		112	Rare amphibian	
REPTILE	lizard	31	Florida scrub lizard	*Sceloporus woodi*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		34	Rare lizard	
		44	Black iguana	*Ctenosaura similis*
		45	Common iguana	*Iguana iguana*
		52	Lizard	
		67	Cook's anole	*Anolis cooki*
		68	Culebra Island giant anole	*Anolis roosevelti*
		69	Mona ground iguana	*Cyclura stejnegeri*
		76	Mabuya	*Mabouya sloanii*
		78	Monito gecko	*Sphaerodactylus micropithecus*
		81	Pygmy anole	*Anolis occultus*
		85	St. Croix ground lizard	*Ameiva polops*
		86	Anegada ground iguana	*Cyclura pinguis*
		89	Mourning gecko	*Lepidodactylus lugubres*
		91	Anoles	*Norops sp.*
		96	Barred whiptail	*Ameiva undulata*
		99	Striped basilisk	*Basiliscus vittatus*
		103	Deppe's whiptail	*Cnemidophorus deppii*
		104		*Ameiva festiva*
		105		*Cnemidophorus lemniscatus*
		106		*Sceloporus variabilis*
REPTILE	snake	11	Atlantic salt marsh snake	*Nerodia fasciata taeniata*
		12	Gulf salt marsh snake	*Nerodia clarkii clarkii*
		17	Texas garter snake	*Thamnophis sirtalis annectens*
		23	Black pine snake	*Pituophis melanoleucus lodingi*
		24	Eastern indigo snake	*Drymarchon corais couperi*
		25	Rainbow snake	*Farancia erytrogramma*
		26	Gulf crayfish snake	*Regina rigida sinicola*
		30	Florida pine snake	*Pituophis melanoleucuc mugitus*
		37	Rare snake	
		40	Texas scarlet snake	*Cemophora coccinea lineri*
		46	Sea snake	*Pelamis platurus*
		57	San Francisco garter snake	*Thamnophis sirtalis tetrataenia*
		59	Coast garter snake	*Thamnophis elegans terrestris*
		60	Central Coast garter snake	
		63	Alameda whipsnake	*Masticophis lateralis euryxanthus*
		64	Giant garter snake	*Thamnophis gigas*
		65	Blakc-striped snake	*Coniophanes imperialis*
		66	Speckled racer	*Drymobius margaritiferus*
		74	Puerto Rican boa	*Epicrates inornatus*
		75	Mona boa	*Epicrates monensis monensis*
		79	Virgin Islands tree boa	*Epicrates monensis granti*
		92		*Loxocemus bicolor*
		93	Roadguard	*Conophis lineatus*
		94	Brown vine snake	*Oxybelis aeneus*
		95		*Micrurus nigrocinctus*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		98	Indigo snake	*Drymarchon corais*
		101		*Enulis flavitorques*
		102	Yucatan Cantil	*Agkistrodon bilineatus*
		107	Boa constrictor	*Boa constrictor*
		110	Aruba island rattlesnake	*Crotalus durissus*
REPTILE	turtle	2	Green sea turtle	*Chelonia mydas*
		4	Kemp's ridley sea turtle	*Lepidochelys kempii*
		5	Leatherback sea turtle	*Dermochelys coriacea*
		6	Loggerhead sea turtle	*Caretta caretta*
		7	Diamondback terrapin	*Malaclemys terrapin*
		8	Pacific green sea turtle	*Chelonia mydas agassizi*
		9	Hawksbill sea turtle	*Eretmochelys imbricata*
		10	Pacific hawksbill sea turtle	*Eretmochelys imbricata bissa*
		13	Turtles	
		16	Texas diamondback terrapin	*Malaclemys terrapin littoralis*
		18	Mississippi diamondback terrapin	*Malaclemys terrapin pileata*
		19	Alabama red-bellied turtle	*Pseudemys alabamensis*
		20	Mangrove terrapin	*Malaclemys terrapin rhizophorarum*
		21	Gopher tortoise	*Gopherus polyphemus*
		22	Yellow-blotched map turtle	*Graptemys flavimaculata*
		32	Spotted turtle	*Clemmys guttata*
		35	Threatened turtle	
		38	Endangered sea turtle	
		39	Threatened sea turtle	
		47	Olive ridley sea turtle	*Lepidochelys olivacea*
		48	Scorpion mud turtle	*Kinosternon scorpioides*
		49	Painted wood turtle	*Rhinoclemmys pulcherrima*
		50	Slider	*Trachemys scripta*
		51	Pacific Coast giant musk turtle	*Staurotypus salvinni*
		58	Western pond turtle	*Clemmys marmorata*
		62	Northwestern pond turtle	*Clemmys marmorata marmorata*
		87	Sea turtle spp.	*Cheloniidae spp.*
		88	Jicotea	*Trachemys stejnegeri*
		111	Rare turtle	
T_MAMMAL	bat	5	Townsend's Western big-eared bat	*Plecotus townsendii townsendii*
		6	Pallid bat	*Antrozous pallidus*
		9	Red fruit bat	*Stenoderma rufum*
		10	Fisherman bat	*Noctilio leporinus*
		18	Lesser white-lined bat	*Saccopteryx leptura*
		19		*Balantiopteryx plicata*
		23	Common vampire bat	*Desmodus rotundus*
		131	Lesser bulldog bat	*Noctilio albiventris*
		135	Cave bat	*Brachyphylla cavernarum*
		137	Tent-making bat	*Uroderma bilobatum*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		138	Jamaican fruit-eating bat	*Artibeus jamaicensis*
		139	Rare bat	
		142	Hawaiian hoary bat	*Lasiurus cinereus semotus*
		1001	Bats	
T_MAMMAL	bear	55	Brown bear	*Ursus arctos horribilis*
		56	Black bear	*Ursus americanus*
		70	Florida panther	*Felis concolor coryi*
		102	Louisiana black bear	*Ursus americanus luteolus*
		103	Florida black bear	*Ursus americanus floridanus*
		141	Threatened bear	
T_MAMMAL	canine	54	Gray wolf	*Canis lupus*
		57	Red fox	*Vulpes vulpes*
		63	Coyote	*Canis latrans*
		64	Common gray fox	*Urocyon cinereoargenteus*
		67	Red wolf	*Canis rufus*
		123	Arctic fox	*Alopex lagopus*
T_MAMMAL	feline	62	Bobcat	*Lynx rufus*
		65	Mountain lion	*Puma concolor*
		66	Ocelot	*Leopardus pardalis*
		108	Jaguarundi	*Herpailurus yaguarondi*
		109	Margay	*Felis wiedii*
		124	Lynx	*Lynx lynx*
T_MAMMAL	sm_mammal	1	California vole	*Microtus californicus*
		2	Saltmarsh wandering shrew	*Sorex vagrans halicoetes*
		3	Suisun ornate shrew	*Sorex ornatus sinuosus*
		4	Ornate shrew	*Sorex ornatus*
		7	San Pablo vole	*Microtus californicus sanpabloensis*
		8	Northern river otter	*Lutra canadensis*
		12	Sanibel Island rice rat	*Oryzomys palustris sanibeli*
		13	Jaguar	*Panthera onca*
		15	Opossum	*Didelphis marsupialis*
		16	Cottontail rabbit	*Sylvilagus floridanus*
		17	Hooded skunk	*Mephitis macroura*
		20	Variegated squirrel	*Sciurus variegatoides*
		21	Deppe's squirrel	*Sciurus deppei*
		22	Three-toed sloth	*Bradypus variegatus*
		24	Opossum	*Didelphis virginiana*
		36	Beaver	*Castor canadensis*
		37	Muskrat	*Ondatra zibethicus*
		38	Mink	*Mustela vison*
		39	Shorttail weasel	*Mustela erminea*
		40	Long-tailed weasel	*Mustela frenata*
		41	Salt-marsh harvest mouse	*Reithrodontomys raviventris*
		42	Santa Cruz harvest mouse	*Reithrodontomys megalotis santacruzae*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		43	Nutria	*Myocastor coypus*
		44	Common raccoon	*Procyon lotor*
		52	Striped skunk	*Mephitis mephitis*
		58	Meadow vole	*Microtus pennsylvanicus*
		59	Morro Bay kangaroo rat	*Dipodomys heermanni morroensis*
		68	Anastasia Island beach mouse	*Peromyscus polionotus phasma*
		69	Choctawhatchee beach mouse	*Peromyscus polionotus allophrys*
		71	Key Largo cotton mouse	*Peromyscus gossypinus allapaticola*
		72	Key Largo woodrat	*Neotoma floridana smalli*
		73	Lower Keys marsh rabbit	*Sylvilagus palustris hefneri*
		74	Big Cypress fox squirrel	*Sciurus niger avicennia*
		75	Perdido Key beach mouse	*Peromyscus polionotus trissyllepsis*
		76	Florida saltmarsh vole	*Microtus pennsylvanicus dukecampbelli*
		77	Silver rice rat	*Oryzomys argentatus*
		78	Southeastern beach mouse	*Peromyscus polionotus niveiventris*
		79	Everglades mink	*Mustela vison evergladensis*
		80	St. Andrews beach mouse	*Peromyscus polionotus peninsularis*
		89	Alabama beach mouse	*Peromyscus polionotus ammobates*
		101	Dismal swamp southeastern shrew	*Sorex longirostris fisheri*
		104	Florida long-tailed weasel	*Mustela frenata peninsulae*
		105	Round-tailed muskrat	*Neofiber alleni*
		106	Rare rodent	
		107	Threatened rodent	
		110	Spider monkey	*Ateles geoffroyi*
		111	Nine-banded armadillo	*Dasypus novemcinctus*
		112	White-nosed coati	*Nasua narica*
		113	Tamandua	*Tamandua mexicana*
		114	Agouti	*Agouti paca*
		115	Mexican hairy porcupine	*Sphiggurus mexicanus*
		116	Agouti	*Dasyprocta punctata*
		126	American marten	*Martes americana*
		127	Wolverine	*Gulo gulo*
		128	Lemming	*Dicrostonyx sp.*
		129	Ground squirrel	*Spermophilus sp.*
		130	Hare	*Lepus sp.*
		133	Pribilof Island shrew	*Sorex hydrodromus*
		134	Black-footed brown lemming	*Lemmus sibiricus*
		136	Endangered small mammal	
		140	Rare small mammal	
		1002	Small mammal	
T_MAMMAL	ungulate	14	Collared peccary	*Tayassu tajacu*
		25	Florida key deer	*Odocoileus virginianus clavium*

ELEMENT	SUB - ELEMENT	SPECIES ID	COMMON NAME	SCIENTIFC NAME
		30	Columbian white-tailed deer	*Odocoileus virginianus leucurus*
		31	White-tailed deer	*Odocoileus virginianus*
		32	Mule deer	*Odocoileus hemionus*
		33	Black-tailed deer	*Odocoileus hemionus columbianus*
		34	Elk	*Cervus canadensis*
		35	Roosevelt elk	*Cervus canadensis roosevelti*
		100	Wild hog	*Sus scrofa*
		117	Moose	*Alces alces*
		118	Caribou	*Rangifer tarandus*
		119	American bison	*Bos bison*
		120	Mountain goat	*Oreamnos americanus*
		121	Muskox	*Ovibos moschatus*
		122	Dall's sheep	*Ovis dalli*
		125	Sitka black-tailed deer	*Odocoileus hemionus sitkensis*
		132	Reindeer	*Rangifer sp.*

Appendix B

ESI-GIS Data Dictionary

BASEMAP

GEOGRAPHIC THEMES	VARIABLE NAMES	DESCRIPTION	ATTRIBUTE VALUES
ESI (ARCS)	ESI (10, 10, C)	Shoreline classification	Ranges from 1 through 10 with various combinations and subcategories. (See Table 2 in Chapter 2)
	LINE (1, 1, C)	Geographic feature	S = Shoreline I = Index for map/quad boundary H = Hydrography P = Pier B = Breakwater F or M = Non-shoreline arcs that form the boundary for a flat or marsh polygon G = Glacier E = Extent of study area
	SOURCE_ID (6, 6, I)	Source code for shoreline arcs	1 = Digital 2 = Low-altitude overflight 3 = Aerial photograph 4 = Digitized off paper topo 5 = Digitized off scanned topo 6 = National Wetlands Inventory digital data N = where N = number of additional sources
	ENVIR (1, 1, C)	Physiographic region	E = Estuarine L = Lacustrine R = Riverine
ESI (POLYS)	ESI (10, 10, C)	Habitat classification	2A, 5, 7, 9A, and 9C = Flats 10A, 10B, 10C, and 10D = Marshes U = Unclassified holes
	WATER_CODE (1, 1, C)	Land and water designations	L = Land W = Water
	ENVIR (1, 1, C)	Physiographic region	E = Estuarine L = Lacustrine R = Riverine P = Palustrine
HYDRO (ARCS)	LINE (1, 1, C)	Geographic feature	Same as LINE in ESI (ARCS)
	SOURCE_ID (6, 6, I)	Source code for shoreline arcs	Same as SOURCE_ID in ESI (ARCS)
HYDRO (POLYS)	WATER_CODE (1, 1, C)	Land and water designations	Same as WATER_CODE in ESI (POLYS)
HYDRO (ANNO)	GEOG	Geography annotations	Names of islands or points
	HYDRO	Hydrography annotations	Names of inlets, rivers, ponds, lakes, bays, oceans, and coves
	SOC	Human use annotations	Names of beaches, wildlife reserves and preserves, state and country, marine sanctuaries, cities, and parks
INDEX (POLYS)	TILE-NAME (32, 32, C)	Map number	1 through N, where N = number of maps in atlas
	TOPO-NAME (255, 255, C)	USGS quadrangle name with latest data	See the metadata report for a complete list of quad names and dates
	SCALE (7, 7, I)	Map production scale	For 11 by 17 inch paper, various scales are used and only the scale denominator is entered
	MAPANGLE (4, 8, F, 3)	Angle to rotate data to plot vertically	Ranges vary in degrees based on geographic position
	PAGESIZE (11 ,11, C)	Hardcopy map size	Usually 11 by 17 for full size; inset maps vary. See the metadata report for a complete list of page sizes

BIOLOGY

GEOGRAPHIC THEMES	VARIABLE NAMES	DESCRIPTION	ATTRIBUTE VALUES
BIRDS (POLYS)	ID (10, 10, I)	Unique identifier that links to BIO_LUT lookup table	Integer concatenating the atlas number, the element number, and the geographic feature id
	RARNUM (9, 9, I)	Link to BIORES table and BIO_LUT lookup table	Integer ranging from 1 through the number of unique combinations of species, their seasonalities, their concentrations, their geographic source, and their seasonality source concatenated to the atlas id number.
BENTHIC (POLYS)	ID (10, 10, I) RARNUM (9, 9, I)	Same as ID in BIRDS Same as RARNUM in BIRDS	Same as ID in BIRDS Same as RARNUM in BIRDS
FISH (POLYS)	ID (10, 10, I) RARNUM (9, 9, I)	Same as ID in BIRDS Same as RARNUM in BIRDS	Same as ID in BIRDS Same as RARNUM in BIRDS
FISHL (ARCS)	ID (10, 10, I) RARNUM (9,9, I)	Same as ID in BIRDS Same as RARNUM in BIRDS	Same as ID in BIRDS Same as RARNUM in BIRDS
FISHPT (POINTS)	ID (10, 10, I) RARNUM (9, 9, I)	Same as ID in BIRDS Same as RARNUM in BIRDS	Same as ID in BIRDS Same as RARNUM in BIRDS
HABITATS (POLYS)	ID (10, 10, I) RARNUM (9, 9, I)	Same as ID in BIRDS Same as RARNUM in BIRDS	Same as ID in BIRDS Same as RARNUM in BIRDS
HABPT (POINTS)	ID (10, 10, I) RARNUM (9, 9, I)	Same as ID in BIRDS Same as RARNUM in BIRDS	Same as ID in BIRDS Same as RARNUM in BIRDS
INVERT (POLYS)	ID (10, 10, I) RARNUM (9, 9, I)	Same as ID in BIRDS Same as RARNUM in BIRDS	Same as ID in BIRDS Same as RARNUM in BIRDS
INVERTL (ARCS)	ID (10, 10, I) RARNUM (9, 9, I)	Same as ID in BIRDS Same as RARNUM in BIRDS	Same as ID in BIRDS Same as RARNUM in BIRDS
INVERTPT (POINTS)	ID (10, 10, I) RARNUM (9, 9, I)	Same as ID in BIRDS Same as RARNUM in BIRDS	Same as ID in BIRDS Same as RARNUM in BIRDS
M_MAMMAL (POLYS)	ID (10, 10, I) RARNUM (9, 9, I)	Same as ID in BIRDS Same as RARNUM in BIRDS	Same as ID in BIRDS Same as RARNUM in BIRDS
M_MAMPT (POINTS)	ID (10, 10, I) RARNUM (9, 9, I)	Same as ID in BIRDS Same as RARNUM in BIRDS	Same as ID in BIRDS Same as RARNUM in BIRDS
NESTS (POINTS)	ID (10, 10, I) RARNUM (9, 9, I)	Same as ID in BIRDS Same as RARNUM in BIRDS	Same as ID in BIRDS Same as RARNUM in BIRDS
REPTILES (POLYS)	ID (10, 10, I) RARNUM (9, 9, I)	Same as ID in BIRDS Same as RARNUM in BIRDS	Same as ID in BIRDS Same as RARNUM in BIRDS
REPTPT (POINTS)	ID (10, 10, I) RARNUM (9, 9, I)	Same as ID in BIRDS Same as RARNUM in BIRDS	Same as ID in BIRDS Same as RARNUM in BIRDS
T_MAMMAL (POLYS)	ID (10, 10, I) RARNUM (9, 9, I)	Same as ID in BIRDS Same as RARNUM in BIRDS	Same as ID in BIRDS Same as RARNUM in BIRDS
T_MAMPT (POINTS)	ID (10, 10, I) RARNUM (9, 9, I)	Same as ID in BIRDS Same as RARNUM in BIRDS	Same as ID in BIRDS Same as RARNUM in BIRDS

LOOKUP TABLES	VARIABLE NAMES	DESCRIPTION	ATTRIBUTE VALUES
BIO_LUT	RARNUM (9, 9, I)	Link to BIORES table and data layers	Integer ranging from 1 through the number of unique combinations of species, their seasonalities, their concentrations, their geographic source, and their seasonality source concatenated to the atlas id number.
	ID (10, 10, I)	Links to arc, point, and polygon layers	Integer concatenating the atlas number, the element number, and geographic feature id.

DATA TABLES	VARIABLE NAMES	DESCRIPTION	ATTRIBUTE VALUES
BIORES	RARNUM (9, 9, I)	Resource at risk number which is linked to RARNUM in BIO_LUT and can have multiple records with the same RARNUM	Integer ranging from 1 through the number of unique combinations of species, their seasonalities, their concentrations, their geographic source, and their seasonality source concatenated to the atlas id number.
	SPECIES_ID (5, 5, I)	Species identification number	Unique integer within each element (See Species Number in Appendix A). The species numbers do not change between ESI atlases; they are used across the United States
	CONC (20, 20, C)	Concentration of the species	May be descriptive or a number of individuals and must be documented in the metadata
	SEASON_ID (2, 2, I)	A number code used to differentiate the same species, but different seasonal distributions	Integer ranging from 1 to N and have no implied meaning. These link to the SEASONAL data table
	G_SOURCE (6, 6, I)	Unique identifier for the geographic source	Integer ranging from 1 through the total number of sources and have no implied meaning. These links to SOURCES data table.
	S_SOURCE (6, 6, I)	Unique identifier for the seasonality source	Same as G_SOURCE in BIORES
	ELEMENT (10, 10, C)	Category of species	BIRD FISH HABITAT INVERT M_MAMMAL REPTILE T_MAMMAL
	EL_SPE (6, 6, C)	Concatenation of first character of the ELEMENT and the SPECIES_ID	B00001-BNNNNN F00001-FNNNNN H00001-HNNNNN I00001-INNNNN M00001-MNNNNN R00001-RNNNNN T00001-TNNNNN Where N is an integer between 0 and 9.
	EL_SPE_SEA (8, 8, C)	Concatenation of first character of the ELEMENT, the SPECIES_ID, and the SEASON_ID	Same as EL_SPE with the addition of SEASON_ID
SOURCES	SOURCE_ID (6, 6, I)	Unique identifier for each source used in the atlas	Integer ranging from 1 through the total number of sources. These link to the BIORES and SOC_DAT data tables.
	ORIGINATOR (35, 35, C)	Person or organization who provided data	Free Text
	DATE_PUB (10, 10, I)	Publication or data collection date if interview with resource expert	Formatted as year-month (i.e., 199509)
	TITLE (80, 80, C)	Name of the data set, publication, or contents of informa- gathered from interview	Free Text
	DATA_FORMAT (80, 80, C)	Type of Media	Hard-copy map, text, or table; expert knowledge; or digital data (points, polygons, arcs, or tables)
	PUBLICATION (120, 120, C)	Citation of source if applicable	Free Text
	SCALE (20, 20, C)	Source scale denominator	1-N (i.e., 24000)
	TIME_PERIOD (22, 22, C)	Beginning and ending dates of data collection	Free Text
SPECIES	SPECIES_ID (5, 5, I)	Species identification number	Same as SPECIES_ID in BIORES
	NAME (35, 35, C)	Species common name	See Common Name in Appendix A
	GEN_SPEC (45, 45, C)	Scientific name	See Scientific Name in Appendix A

DATA TABLES	VARIABLE NAMES	DESCRIPTION	ATTRIBUTE VALUES
DATA TABLES	VARIABLE NAMES	DESCRIPTION	ATTRIBUTE VALUES
SPECIES, cont.	ELEMENT (10, 10, C)	Category of species	Same as ELEMENT in BIORES
	SUBELEMENT (10, 10, C)	Element sub-group	See Subelement in Appendix A
	NHP (10, 10, C)	Natural Heritage Program global rank	Various text
	DATE_PUB (10, 10, I)	Publication date for the Natural Heritage Program global status list	Formatted as year-month (i.e., 199509)
	EL_SPE (6, 6, C)	Concatenation of first character of the ELEMENT and the SPECIES_ID	Same as EL_SPE in BIORES
STATUS	ELEMENT (10, 10, C)	Category of species	Same as ELEMENT in BIORES
	SPECIES_ID (5, 5, I)	Species identification number	Same as SPECIES_ID in BIORES
	STATE (2, 2, C)	State abbreviation	Standard two-letter code
	S_F (3, 3, C)	State and/or Federal status	S = State F = Federal S/F = State and Federal
	T_E (3, 3, C)	Threatened and/or endangered	C = Species of Special Concern T = Threatened E = Endangered T/E = State Threatened and Federal Endangered E/T = State Endangered and Federal Threatened C/T = State Concerned and Federal Threatened C/E = State Concerned and Federal Endangered
	DATE_PUB (10, 10, I)	Publication date for the federal or state status list	Same as DATE_PUB in SPECIES
	EL_SPE (6, 6, C)	Concatenation of first character of the ELEMENT and the SPECIES_ID	Same as EL_SPE in BIORES
SEASONAL	ELEMENT (10, 10, C)	Category of species	Same as ELEMENT in BIORES
	SPECIES_ID (5, 5, I)	Species identification number	Same as SPECIES_ID in BIORES

DATA TABLES	VARIABLE NAMES	DESCRIPTION	ATTRIBUTE VALUES
SEASONAL, cont.	SEASON_ID (2, 2, I)	A number code used to differentiate the same species, but different seasonal distributions	Same as SEASON_ID in BIORES
	JAN (1, 1, C)	Present in January	X = present; blank = not present
	FEB (1, 1, C)	Present in February	Same as JAN
	MAR (1, 1, C)	Present in March	Same as JAN
	APR (1, 1, C)	Present in April	Same as JAN
	MAY (1, 1, C)	Present in May	Same as JAN
	JUN (1, 1, C)	Present in June	Same as JAN
	JUL (1, 1, C)	Present in July	Same as JAN
	AUG (1, 1, C)	Present in August	Same as JAN
	SEP (1, 1, C)	Present in September	Same as JAN
	OCT (1, 1, C)	Present in October	Same as JAN
	NOV (1, 1, C)	Present in November	Same as JAN
	DEC (1, 1, C)	Present in December	Same as JAN
	EL_SPE_SEA (8, 8, C)	Concatenation of first character of the ELEMENT, the SPECIES_ID, and the SEASON_ID	Same as EL_SPE in SPECIES data table with the addition of SEASON_ID
BREED	EL_SPE_SEA (8, 8, C)	Concatenation of first character of the ELEMENT, the SPECIES_ID, and the SEASON_ID	Same as EL_SPE_SEA in the SEASONAL data table
	MONTH (2, 2, I)	Specifies a month (can have up to twelve records per EL_SPE_SEA)	1-12
	BREED1 (1, 1, C)	Reproductive or life-stage activities varying by element:	Y = occurring
			N = not occurring
		BIRD = nesting	- = not applicable
		FISH = spawning	
		INVERT = spawning	
		M_MAMMAL = mating	
		REPTILE = nesting	
	BREED2 (1, 1, C)	Same as BREED1 except:	Y = occurring
		BIRD = laying	N = not occurring
		FISH = eggs	- = not applicable
		INVERT = eggs	
		M_MAMMAL = calving	
		REPTILE = hatching	
	BREED3 (1, 1, C)	Same as BREED1 except:	Y = occurring
		BIRD = hatching	N = not occurring
		FISH = larvae	- = not applicable
		INVERT = larvae	
		M_MAMMAL = pupping	
		REPTILE = internesting	

DATA TABLES	VARIABLE NAMES	DESCRIPTION	ATTRIBUTE VALUES
BREED, cont.	BREED4 (1, 1, C)	Same as BREED1 except: BIRD = fledging FISH = juvenile INVERT = juvenile M_MAMMAL = molting REPTILE = juveniles	Y = occurring N = not occurring - = not applicable
	BREED5 (1, 1, C)	Same as BREED1 except: BIRD = not applicable FISH = adults INVERT = adults M_MAMMAL = not applicable REPTILE = adults	Y = occurring N = not occurring - = not applicable

HUMAN-USE

GEOGRAPHIC THEMES	VARIABLE NAME	DESCRIPTION	ATTRIBUTE VALUES
MGT (POLYS)	TYPE (2, 2, C)	Code identifying a human-use feature	AQ = Aquaculture Site AR = Artificial Reef AS = Archaeological Site B = Beach CH = Designated Critical Habitat FO = National Forest IR = Indian Reservation MA = Management Area MS = Marine Sanctuary NC = Nature Conservancy NP = National Park P = Regional or State Park SR = Scenic River WR = Wildlife Refuge
	ID (10, 10, I)	Unique identifier that links to SOC_LUT lookup table	Integer containing the atlas number, the element number, and the polygon number
	HUNUM (9, 9, I)	Identification number linked to HUNUM in the SOC_DAT data table	Integer ranging from 1 through the number of unique human-use features concatenated to the atlas id number.
SOCECON (ARCS)	TYPE (2, 2, C)	Code identifying a human-use feature	AB = Area Boundary B = Beach IB = International Border IE = Ice Extent IR = Indian Reservation PL = Pipeline R = Road, transportation, or bridge SB = State Border SR = Scenic River SW = State Waters

GEOGRAPHIC THEMES	VARIABLE NAME	DESCRIPTION	ATTRIBUTE VALUES
SOCECON (POINTS)	TYPE (2, 2, C)	Code identifying a human-use feature	A = Airport A2 = Access AQ = Aquaculture AR = Artificial Reef AS = Archaeological Site BR = Boat Ramp C = Campground C2 = Casino CF = Commercial Fishing CG = Coast Guard CO = Community CP Collection Point DV = Diving Site EQ = Equipment F = Ferry F2 = Factory FS = Field Station H = Hoist HA = Hatchery HP = Heliport HS = Historical Site HW - Hazardous Waste Site LD = Lock and Dam LS = Log Storage M = Marina M2 = Mine Site MA = Management Area OF = Oil Facility P2 = Process Facility PF = Platform RF = Recreational Fishing S = Subsistence S2 = Surfing SO = Sewage Outfall ST = Staging Site W = Well WD = Waste Disposal Site WI = Water Intake WO = Wash Over
	ID (10, 10, I)	Same as ID in MGT	Same as ID in MGT
	HUNUM (9, 9, I)	Same as HUNUM in MGT	Same as HUNUM in MGT

LOOKUP TABLES	VARIABLE NAMES	DESCRIPTION	ATTRIBUTE VALUES
SOC_LUT	HUNUM (9, 9, I)	Identification number linked to HUNUM in the SOC_DAT data table	Integer ranging from 1 through the number of unique human-use features concatenated to the atlas id number.
	ID (10, 10, I)	Same as ID in MGT	Same as ID in MGT

DATA TABLE	VARIABLE NAME	DESCRIPTION	ATTRIBUTE VALUES
SOC_DAT	HUNUM (9, 9, I)	Same as HUNUM in SOC_LUT	Same as HUNUM in SOC_LUT
	TYPE (20, 20, C)	Type of human-use feature	ACCESS AIRPORT AQUACULTURE ARCHAEOLOGICAL SITE ARTIFICIAL REEF BEACH BOAT RAMP CAMPGROUND CASINO COAST GUARD COMMERCIAL FISHING COMMUNITY CRITICAL HABITAT DIVING EQUIPMENT FACTORY FERRY HATCHERY HAZARDOUS WASTE SITE HELIPORT HISTORICAL SITE HOIST INDIAN RESERVATION INTERNATIONAL BORDER LOCK AND DAM LOG STORAGE MANAGEMENT AREA MARINA MARINE SANCTUARY MINE SITE NATIONAL PARK NATURE CONSERVANCY OIL FACILITIES PARK (REGIONAL OR STATE) PIPELINE PLATFORM RECREATIONAL FISHING ROAD SCENIC RIVER SEASHORE SEWAGE OUTFALL STAGING STATE BORDER STATE WATERS SUBSISTENCE SURFING WATER INTAKE WASH OVER WASTE DISPOSAL WELL WILDLIFE REFUGE
	NAME (40, 40, C)	The name of the facility	Used for water intakes, aquaculture sites, and other features, if available
	CONTACT (80, 80, C)	Person and location to contact	If available
	PHONE (20, 20, C)	Phone Number	If available
	G_SOURCE (6, 6, I)	Geographic source number	Integer ranging from 1 through the total number of sources. This is a link to SOURCES data table
	A_SOURCE (6, 6, I)	Attribute source number	Same as G_SOURCE

Appendix C

ESI Atlas Identification Numbers

ATLAS NUMBER	ATLAS NAME	ATLAS NUMBER	ATLAS NAME
1	Lake Ontario	42	Eastern Lake Michigan
2	Western Lake Michigan	43	St. Lawrence River
3	Lake Huron	44	St. Marys River
4	Northern Lake Michigan	45	Massachusetts
5	Southern Lake Michigan	46	Connecticut
6	Lake Superior	47	Maryland
7	Northern California	42	Eastern Lake Michigan
8	Central California	48	Midcoast Maine
9	Southern California	49	Downeast Maine
10	Southeast Alaska	50	Southern Maine and New Hampshire
11	Cook Inlet	51	New York Harbor
12	Delaware/New Jersey/Pennsylvania	52	Hudson River
13	Upper Coast Texas	53	New York–Long Island
14	Texas–Galveston Bay	54	Rhode Island
15	Mid Coast Texas	55	Virginia
16	South Coast Texas	56	Alaska: Bristol Bay Region
17	Lake Erie	57	Alaska: Shelikof Strait Region
18	West Florida	58	Alaska: Norton Sound and Pribilof Islands
19	West Peninsula Florida, Vol. 1	59	Alaska: Prince William Sound
20	West Peninsula Florida, Vol. 2	60	Alaska: Cook Inlet/Kenai Peninsula (1985)
21	South Florida	61	Alaska: Southern Peninsula
22	East Florida	62	American Somoa
23	West Florida Region 2	63	Mariana Islands, Vol. 1
24	West Florida Region 3	64	Mariana Islands, Vol. 2
25	Apalachicola River, Florida	65	Hawaii
26	West Peninsula	66	Puerto Rico
27	South Florida, Vol. 1	67	U.S. Virgin Islands
28	South Florida, Vol. 2	68	Leaf River, Mississippi
29	Northeast Florida	69	Kodiak
30	San Francisco, California	70	North Slope
31	Alabama	71	Rhode Island/New Jersey
32	Mississippi	72	Aleutians
33	Louisiana	73	North West Arctic
34	South Carolina	74	Western Alaska
35	North Carolina	75	Chukchi Sea
36	Georgia	76	American Samoa
37	St. Johns River, Florida	101	Gulf of Aqaba
38	Oregon–Columbia River	102	Gaza
39	Washington–Strait of Juan de Fuca and Northern Puget Sound	103	El Salvador
40	Washington–Central and Southern Puget Sound	104	Gulf of Fonseca
41	Columbia River	105	Honduras
		106	Guatemala

Appendix D

Creating “Regions” from Biology Polygon Data Layers

Creating "Regions" from Biology Polygon Data Layers

For users who have Arc/INFO®, the polygon data layers (BIRDS, FISH, HABITATS, M_MAMMAL, REPTILES, SHELLFSH, and T_MAMMAL) may be topologically stored as "regions" and eliminate the need for the lookup tables. To convert the polygons to regions the following commands may be used:

```
joinitem incover.pat poly_lut incover.pat ID ID

polyregion incover outcover bio

regiondissolve incover outcover bio rarnum

regionclean incover
```

After creating the new region data layer delete the original data layer (e.g., BIRDS) and rename the recently generated coverage.

Appendix E

Integrating NOAA's ELMR Database

and

ESI Biology Data Layers and Data Tables

On occasion, ESI atlases have incorporated NOAA's Estuarine Living Marine Resources (ELMR) databases to model fish and invertebrates into salinity zones throughout estuaries. This incorporation of ELMR into ESI integrates all of the attribute data into the current ESI data structure. However, many users may find the original salinity geospatial data interesting and applicable in their GIS and desktop mapping applications. Therefore, the data layer SALINITY is added to those atlases that have used ELMR data. The SALINITY polygon data includes WATER_CODE (specifies a polygon as either water or land as in the HYDRO data layer), ESTUARY (the name of the estuary and bathymetry zone for ocean areas, SAL_HIGH (salinity level during the high-salinity time period), SAL_LOW (salinity level during the low-salinity time period), SAL_TRAN (salinity level during the transitional salinity time period), UNIQUE_HIGH (identification number that links to the original ELMR database and links to those records associated with the high-salinity time period), UNIQUE_LOW (same as UNIQUE_HIGH except the linked records are for the low-salinity time period), and UNIQUE_TRAN (same as UNIQUE_HIGH except the linked records are for the transitional salinity time period). The SALINITY arc data includes BOUND (identifies the arc as a boundary for the salinity time period) and SYMBOL (the number of the map symbol used to color-shade the arc for either high [red] or low [blue] salinity and increasing or decreasing on either side of the line). The SALINITY data layer is generated by NOAA's ELMR program (within the National Centers for Coastal Ocean Science Division) using the HYDRO as a base and then adding the above attributes.

The three fundamental steps associated with the integration process (Figure E-1) are: 1) develop seasonal salinity isohalines by 5 parts per thousand (ppt) for each estuary; 2) update fish and invertebrate species distribution and abundance data; and 3) via GIS technology, organize species distribution data by biologically relevant estuarine salinity zones.

The ELMR fish and invertebrate polygons organize the species spatial and temporal distribution data via salinity zones. Salinity analysis for the National Estuarine Inventory (NEI) estuarine systems focuses on two three-month periods (high- and low-salinity time periods) and one transitional salinity time period. These periods represent the typical high-, transitional-, and low-salinity conditions experienced under average seasonal freshwater inflow conditions. This organizational structure results in estuarine salinity zone polygons that are synonymous with the fish distribution polygons. Salinity is chosen to provide the underlying structure for portraying the fisheries information

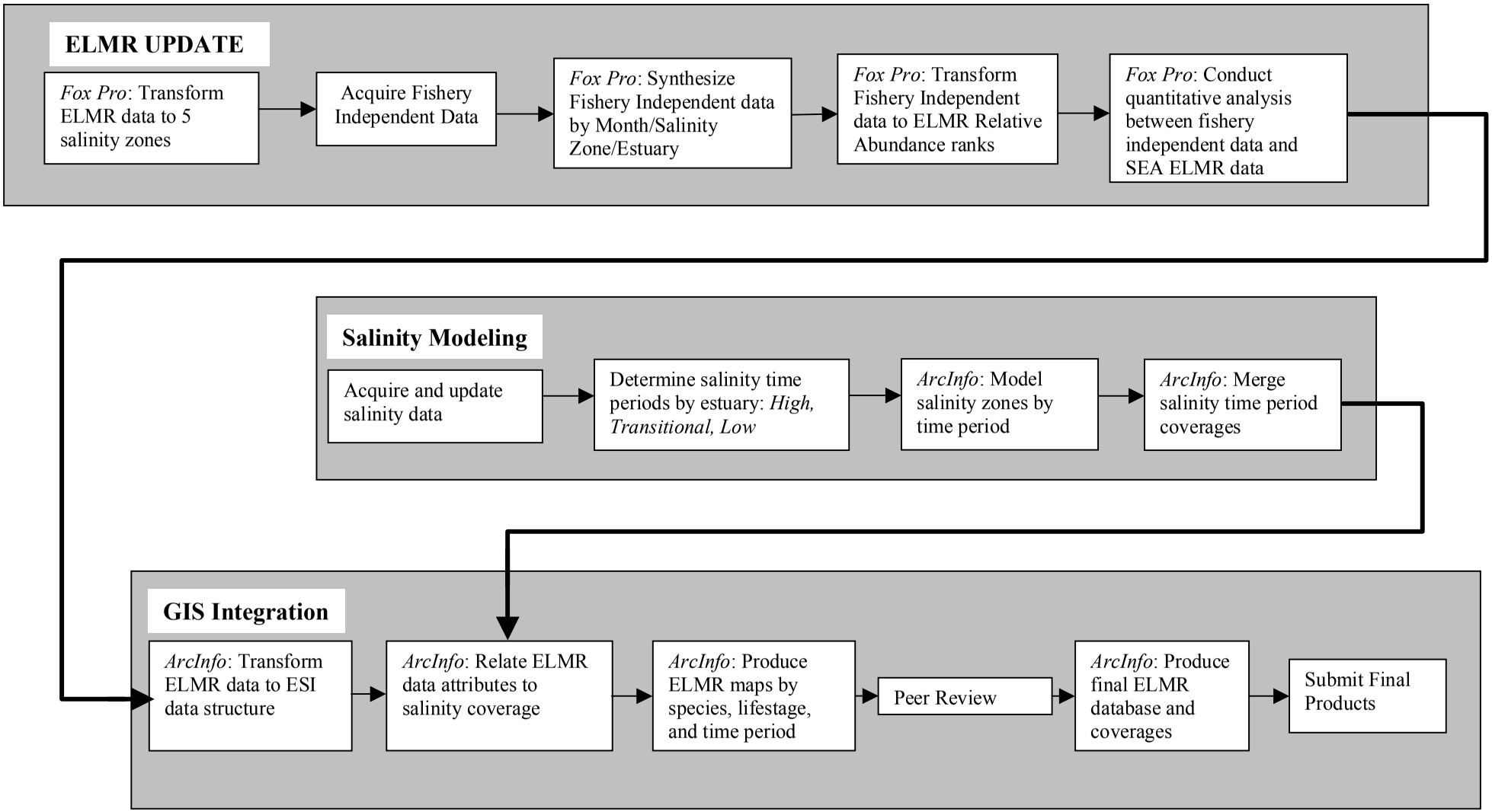

Figure E-1. Fundamental steps associated with the ELMR/NEI/ESI integration process.

since it is a primary factor affecting the distribution of estuarine species (Bulger et al. 1993; Monaco et al. in review). In addition, ELMR data are organized by month to account for the influence of water temperature.

The spatial and temporal distribution of ELMR's categorical relative abundance data are assigned to estuaries based on regional and local fisheries science experts, survey reports, peer-reviewed literature, and existing quantitative data. Species relative abundance rankings (highly abundant, abundant, common, rare, and not present) are determined by month for each of the selected species (Nelson 1991; Monaco 1995).

The relative abundance of a species are classified using the following species categories (Nelson 1991):

- Highly Abundant (5) - species is numerically dominant relative to other species within an assemblage.
- Abundant (4) - species is often encountered in substantial numbers relative to other species within an assemblage.
- Common (3) - species is generally encountered but not in large numbers; does not imply an even distribution over a specific salinity zone.
- Rare (2) - species is present, but not frequently encountered.
- No information available (1) - no data available, and after expert review it was determined that even an educated guess would not be appropriate.

There is approximately an order of magnitude difference in species abundance between each of these categories (Monaco 1995).

Fish and invertebrate relative abundance and seasonal life-stage data are aggregated for the seasonality data shown on the ESI maps. A hierarchical method uses the relative abundance information for the juvenile life-stage in the appropriate time period as the default. Using this method, the relative abundance information shown in the atlas represents the juvenile life-stage for the vast majority of the months. When juveniles are not present in a given month, information from the adult and larval life-stage is used, in that order. An ELMR supplement to the ESI atlas is available for those seeking a more detailed explanation of fish and invertebrate distribution and relative abundance data (Battista and Monaco 1996). However, in the ESI-GIS, all abundance values for all life-stages are stored in the BREED table.

As stated in Chapter 3, special concentration area polygons are included on the ESI maps for selected fish and invertebrate species to provide additional detail beyond ELMR-based distributions. For fish, these areas would emphasize important spawning, nursery, and migratory areas; and for invertebrates they would include harvested shellfish beds. Furthermore, these polygons may be attributed with concentration data for fish and invertebrates when this information is requested and when the data is available. Threatened or endangered species are an example of biological resources that warrant the development of these additional special concentration polygons.

NOAA conducts an array of GIS procedures to spatially integrate the ELMR data with the salinity information. The isohalines that define the salinity zones are modeled in time and space using GIS contouring techniques that use data from long-term point sampling stations. ELMR fishery data are then integrated with the salinity polygon features using unique attributes and digital relates between various tables. A unique attribute is created to enable the integration process that is a combination of salinity zone, estuary, and life-stage. Thus, separate time period, estuary, and life-history tables are linked in time and space. The ELMR data are completely merged into the BIORES, SEASONAL, and BREED data tables and the polygons are merged into the FISH and INVERT data layers. The RARNUMs and IDs are calculated and lookup tables are created.

Appendix F

Quality Control Procedures for Delivering ESI Data to NOAA

The following section describes Quality Assurances procedures that are performed on the ESI data before it is delivered to NOAA. Many of these processes are necessary due to the different data structures used for map production vs. the digital data product. Other checks simply verify the integrity of the digital geographic and attribute data. Once the data are delivered to NOAA, additional modification and QA procedures are performed. The culmination of these processes is delivery of the data on CD in all of the formats discussed in Section 5.

The QA/QC procedures, prior to delivery to NOAA, can be divided into four main tasks: 1) Creating/checking master coverages, 2) Converting regions to polygon *ID*s, 3) Importing/checking data tables, 4) Final delivery preparation. These procedures are performed by the GIS Manager or a senior GIS Analyst and follow a similar QA/QC procedure (emulating task1) performed by a GIS Technician.

1) Creating/checking master coverages. During atlas production, the various ESI data layers are produced and manipulated on an individual map basis corresponding to the tiles in the index coverage. For final delivery, these individual maps are joined into master coverages for the whole atlas with each data layer (e.g. birds, nests, socecon) listed separately.

The following general checks are performed for each data layer:
- Label Errors: Check that all polygons have a label (except for the universe polygon)
- Edge-matching: Check that polygon/region *RARNUM*s match across old index boundaries
- Slivers: Check that polygons below a certain area are legitimate polygons (e.g,. small islands)
- Dangles: Check that lines with dangles (unconnected nodes) are legitimate (e.g., streams or breakwaters)
- Topology: Check that coverage has proper topology (is built for polygons)
- Tolerances: Check that precision = double, dangle = .000, and fuzzy = .002
- Projection: Check that coverage projection is defined
- Tics: Check that the number of tics in each coverage = number of tics in the index coverage

- Items: Check that the data layer has the proper items, item widths, and item order for its type (e.g. biology layer vs. socio-economic layer)
- Item Values: Check that items have legitimate values
- Duplicate points: For point coverages, check that there are no overlapping points
- Check that coverage names are correct (benthic, birds, esi, fish, habitats, hydro, index, invert, m_mammal, mgt, nests, reptiles, salinity, socecon, t_mammal, fishl, invertl, fishpt, habpt, invertpt, m_mampt, t_mampt, reptpt)

The HYDRO data layer should contain all arcs that define land and water polygons, as well as arcs for hydrographic features. The ESI data layer should only contain arcs that make up ESI-ranked shoreline or ESI ranked polygons. The following checks are performed specifically for the ESI data layer:

- Check for blank aat and pat items
- Check that shoreline bordering flats have double rankings (e.g. 10A/7 or 5/9A)
- Check other polys that might need double shoreline rankings (e.g. 10A,2A,8A)
- Check for proper line codes on land polys (i.e., no “F" on land polys)
- Check for proper line codes on water polys (no ‘M’ on water polys)
- Check only outline (study area boundary) codes = ‘I’ or ‘E’
- Check that dangles are piers and breakwaters

2) Converting regions to polygon ids. During atlas production, Biology and Management *RARNUM*s are created and manipulated as region features. In this system, many polygons can constitute a single region with a single *RARNUM*. For final delivery, each polygon in a data layer receives a unique *ID* and region features are dropped. This unique *ID* relates the individual polygon to the *RARNUM* for that polygon (i.e., the *RARNUM* for the region to which that the polygon belonged during production). At this stage, it is possible for new *RARNUM*s to be created where two or more regions overlap (i.e., where a polygon is part of two different regions). The new *RARNUM* would contain the BIORES table information for all of the *RARNUM*s that the polygon was associated with in region format.

A series of AMLs (ARC Macro Language programs) are used to convert the region-formatted data layers to polygon based data layers, and to add *RARNUM*'s created during this procedure to the database. Also produced are a series of look-up tables (LUTs),

which relate the polygon *ID* to its associated *RARNUM*. The newly created polygon data layers are then checked for the following:

- Label errors
- Items
- Topology
- General visual inspection

3) Importing/checking data tables. During atlas production, the data tables are stored and manipulated in separate database software. For final delivery, these tables are converted to INFO format.

The following checks are performed on the data tables:

- Items: Check that each table has the proper items, item widths, and item order
- Item Values: Check that items have legal values (as outlined in this document)
- Check that all *RARNUM*s in LUTs are also in BIORES and SOC_DAT (delete extras)
- Check that all records in BIORES and SOC_DAT have related records in SOURCES (delete extras in SOURCES)
- Check that all records in BIORES have related records in SPECIES, SEASONAL, STATUS and BREED
- Check table names

4) Final delivery preparation. In the final stage, the data is prepared for delivery to NOAA where further modifications and data checks will be performed and the data is distributed.

- The data layers are projected to geographic coordinates, and the projected coverages are checked for label errors, and correct topology
- Coverages and data tables are loaded into ArcMap and related to one another, then random checks are performed comparing the digital data with the hard-copy atlas maps and tables
- Export files for the projected and geographic coordinate data sets are created for the coverages and data tables
- Metadata documents are finalized
- Export files, metadata, and hardcopy atlas PDFs are written to CD